Celebrating the Year's Successes

Restoring Ecosystems.. .
-Providing Options for Wise' Use and Management...
Understanding Environmental and Biological Threats.. .
Aligning Products with- Customer Needs.. .

Celebrating the Year's Successes

This year, our Report presents highlights from our Research Work Units which demonstrate the wide scope of the research and technology transfer conducted by Station scientists. Much of our work is based on studies that take place over a few or many years, some are long-term spanning decades. The results we' report may be based on findings from the recent past, current progress, or interim updates. The benefits we provide to the American people, and to the world, vary from findings that are specific to certain types of southern ecosystems and individual species,, to findings 'that have international relevance and application.

Restoring Ecosystems...

Understanding the Role of Wetlands in Sustainable Management

Research Work Unit 4103
'Center for Forested Wetlands 'Research

Only one-quarter 'of the precolonial acreage of bottomland hardwood forests remains in the contiguous United States; these forests tend to be. seriously fragmented and may have lost many of their original characteristics. Presently, there is a need to have a better understanding about healthy bottomland hardwood forests so that they can be more effectively managed, conserved and restored.

Cooperative participants, characterization of "reference wetland."

The Coosawhatchie Bottomland Ecosystem Study site, in southeastern South Carolina, was developed as a "reference wetland." Scientists at the Center for Forested Wetlands Research (CFWR), Charleston, SC, have established the long-term research site for the quantification of relatively undisturbed ecosystem characteristics. The characterization includes studies of soils, hydrology, water quality, sedimentation, aquatic chemistry and organisms, vegetation dynamics, nutrient' cycling, tree physiology, woody debris dynamics, wintering and bre'e 'ding Neotropical migratory birds, invertebrates, and microbes. Some of the studies conducted on the sitk also were conducted on two other reference bottomland hardwood sites, in Arkansas and Louisiana.

define

In addition to CFWR scientists, researchers participating in the characterization were from several other federal agencies. Academic cooperators are from Auburn' University, Clemson University, Michigan Technological University, North Carolina State University, University of Georgia (Athens), and the Savannah River Ecology Laboratory. Westvaco Corporation's scientific staff members, located at Summerville, SC, are also collaborating in research on the site. Of the three reference sites, the Coosawhatchie Bottomland Ecosystern Study site is the only one on private land, owned and managed by the Westvaco Corporation.

Celebrating the Year's Successes

Restoring Ecosystems...

Research Work Unit 4104
Disturbance and Management of Southern Pine Ecosystems

Studying Individual Longleaf Pine Trees in the Sandhills: Towards Restoring the Natural Stands

Research Work Unit 4105, in cooperation with Auburn 'University School of Forestry, is developing an individual tree, spatially explicit, and biologically based growth model for natural longleaf pine stands at Eglin Air Force Base in Florida. Eglin's 200,000 acres of longleaf pine are being returned to full health'and expanded in size under a comprehensive Ecosystem Management plan coordi-, nated by The Nature Conservancy. The goal of the growth model is to provide a tool for the'land managers to 'compare silvicultural practices effects on the light and water environment in addition to stand structure of the trees.

We are addressi' ng longleaf pine ecosys tem restoration in collaboration with other agencies.

Individual trees are being selected within 3 site classes at Eglin, to fit a predetermined matrix of tree height, diameter, and crown ratio. The field data taken on-eaoh selected tree includes, stem' taper on the subject tree and location relative to the subject tree, species, size, and crown dimensions on competitors. Branches and the top of the subject tree are then lowered to the ground before the stem is cut. The stem is then cut into sections and brought back to Auburn for reconstruction. Complete crown architecture for the past three years is measured by reattaching the branches to the stem sections within a three dimensional grid. Disc samples are collected at 1 -meter intervals along the stem for measurements of heartwood and sapwood relationships, tree ring growth, and dry wood density. In the field,' every fourth branch is selected to be a sample branch from which fresh needles are removed within every meter out from the stem to determine weight, density, length, and nitrogen content. Branch discs are also taken at the base of every sample branch after crown architecture to determine sapwood, branch radial growth, and wood density.

Over 50 trees have been finished so far, ranging in diameter from seedlings just out of the grass stage to mature trees over 30 cm in diameter. Other factors such as light penetration through the crown and soil nutrients, and water holding capacity are still in the planning stages. Another 1.5 years of data collection will be required to fill out the tree size matrix at which time a preliminary model will be completed for review.

Celebrating the 'Year's Successes

Restoring Ecosystems...

Producing Longleaf Pine Seedlings in Containers Enhances Restoration Efforts

Research Work Unit 4111
Ecology and Management of Southern Pines

Longleaf pine savannas once dominated the Lower Coastal Plain, stretching from Virginia to eastern Texas. Wildlife proliferate in this Landscape and longleaf pine stands evoke passion among diverse groups because they are aesthetically pleasing, ecologically diverse, and profitable to harvest. Although longleaf pine is a highly desirable species and produces high quality solidwood products, it. now occupies only about 5 percent of its original range. The demand for high quality longleaf pine container stock in the South is rapidly increasing due to the interest in restoring longleaf pine on many of the sites, where it originally grew. Regeneration of longleaf pine sites is difficult because of the botanical characteristics of the species:

1. low and infrequent seed production
2. a seedling "grass" stage characterized by delayed stem. elongation
3. poor storability of bareioot nursery stock that results in low survival; and
4. seedling intolerance to shade conditions caused by competition.

We published "Practical Guidelines for Producing Longleaf Pine Seedlings in Containers" to help forest landowners be successful in regenerating longleaf pine sites.

The knowledge 'and technology to reestablish longleaf pine by planting bareroot nursery stock have improved in the last decade, but planting success of bareroot stack still remains elusive. Successful bareroot regeneration relies on five components: well-prepared, competition free sites; healthy, top-quality, Fresh planting stock; meticulous care of stock from lifting to planting; precision planting; and proper post-planting care. All these elements are essential to, successful planting of bareroot stock, but controlling all five is difficult.

Studies show that container-grown seedlings survive better and remain in the grass stage for a shorter period of time than bareroot stock on typical

Celebrating the 'Year's Successes

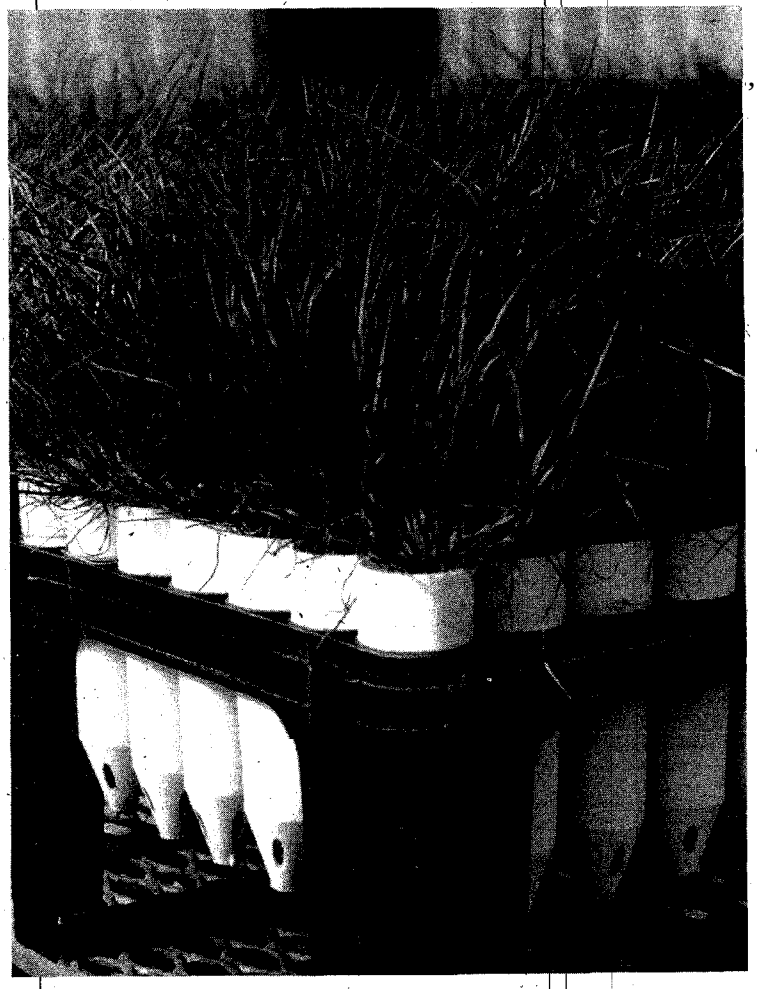
Restoring Ecosystems...

Research Work Unit 4111
Ecology and Management of Southern Pines

Producing Longleaf Pine Seedlings in Containers Enhances Restoration Efforts

longleaf pine sites. Improved survival and growth rates are generally attributed to root systems that remain intact during lifting, while roots of bareroot stock are severely damaged. Container seedlings experience 'a significantly shorter period of transplant shock or adjustment. Thus, planting of container stock improves reforestation success.

Production of longleaf seedlings in' containers has recently increased to about 40 million annually, and the demand remains for even more' quality seedlings. Because a guide to producing longleaf seedlings in containers would enhance this relatively new technology, -a silviculturist and biological technician at the Southern Research Station in Pineville, LA coauthored "Practical Guidelines for Producing Longleaf Pine Seedlings in Containers"' (GTR SRS-14). This publication provides the key information necessary to produce quality seedlings which will result in successful longleaf pine regenera-, tion and facilitate restoration of this important ecosystem,



Celebrating the Year's Successes

Restoring Ecosystems...

Bringing Back the Bottomland Hardwood Ecosystems Along the Mississippi

Research Work Unit 4115
Bottomland Hardwoods and Wetlands

The potential for restoring bottomland hardwood ecosystems in the Lower Mississippi River Valley has barely been tapped. Over the next decade, as many as 500,000 acres could be reforested. Restoration currently relies on planting native species-primarily single-species, widely spaced oak-to allow natural invasion 'of other species. However, this treatment does not work for sites that flood infrequently or sites more than 100 yards from existing seed sources.

Our improved understanding of reforestation treatments is leading to success in restoring bottomland hardwood sites.

Four different treatments were installed, examined, and compared: standard planting treatment using seedlings; standard planting treatment using acorns; new treatment using the fast-growing native species, Eastern cottonwood, as a nurse crop for interplanted oak seedlings; and treatment allowing natural regeneration and succession. This study has improved our understanding of both short-term and long-term effects of common and innovative afforestation treatments on restoring bottomland hardwood wetlands functions, including wildlife (small mammals, hawks, songbirds), soil quality and carbon sequestration,' and understory biodiversity. In addition, the quick restoration of an early successional forest ecosystem-the cottonwood/Nuttall oak interplanting-has quickly restored other ecological processes. Soil quality is restored through deeper rooting and'higher organic matter inputs to soil than would be true under continued cropping. As Eastern cottonwood ages, it sheds lower branches, thereby increasing coarse woody debris on the forest floor.

As a result of this project, forestation treatments have improved the. performance of public restoration efforts such as the Wetlands Reserve Program in Mississippi, Louisiana, and Arkansas. In 1998, the documented feasibility of the cottonwood interplanting treatment encouraged its use on approximately 6,000 acres in these states. This treatment gives a landowner "multiple options-including managing the cottonwood for timber that provides financing for other manipulations-without damaging the emerging oak stand. The treatment provides landowners with the incentive and means to actively manage their restored stands to maximize wildlife and other benefits. The project has enhanced partnerships between several Federal agencies, private, landowners, and forest industry.

Celebrating the Year's Successes

Restoring Ecosystems...

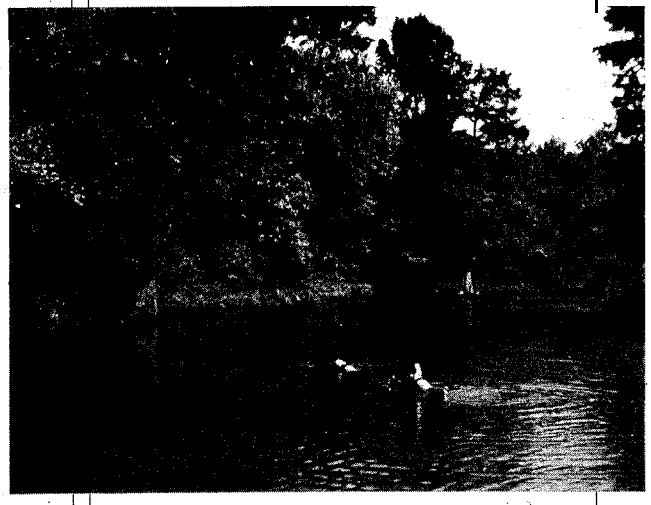
Research Work Unit 4155
Bottomland Hardwoods and Wetlands

Fish and Mussel Habitat Improvement

The, Little Tallahatchie River in north-central Mississippi was channelized approximately 50 years ago, leaving a 23-mile reach of the original river channel intact but with greatly reduced flow. Consequently, this section of river experiences stagnation at low flow and some areas have filled in completely. The "Reriver the Little Tallahatchie," project is a community-based local initiative to redirect flow from'a large tributary, from the drainage canal to the old river channel, providing year-round flow in the original channel. The project is being considered for funding under ecorestoration funds available to the Army Corps of Engineers.

We are evaluating fish and mussel ***habitat before and after restoration efforts to improve*** *streamflow.*

One of the major benefits of this project is expected to be improvement of fisheries habitat. Fisheries scientists have begun a research 'project to evaluate changes in the fish and mussel communities in the old river channel in response to restoration of flow. In the fall of 1998, they completed field sampling designed to provide a quantitative description of the fish and mussel fauna and their habitat at autumn base flow, prior to restoration. Sites on the old river channel were characterized by a diverse fish and mussel fauna typical of lentic, wetland habitats. Sites on the drainage canal were characterized by a less diverse fauna typical of degraded, lotic aquatic habitats. In the spring of 1999, field sampling will be conducted to provide a quantitative description of the fish 'and mussel fauna and their habitats at spring base flow, prior to restoration. Upon flow diversion, sampling of these sites will continue in an effort to document changes in the fish and mussel fauna and their habitats' in the context of restoration actions.



Celebrating the Year's Successes

Restoring Ecosystems...

Temporary Housing for Red-Cockaded Woodpeckers

Research Work Unit 4201
Threatened and
Endangered Species

The red-cockaded woodpecker *(Picoides borealis)* is an endangered species native to the open pine woodlands of the Southeast. These birds construct cavities in living pine trees for nightly roosting throughout the year and for nesting during the breeding season.

Recovery has focused on increasing population size and on reestablishing birds in abandoned habitat. Translocation has been a useful tool in minimizing the loss of genetic diversity in small populations and in facilitating population recovery after a catastrophic event. The numerous translocations of endangered red-cockaded woodpeckers have beneficially affected the status of many small populations. However, these releases have relied on a "hard" release approach whereby a bird is captured, taken to the release site, and immediately released. Such relocations have met with mixed results in that the bird often leaves the release site and is not incorporated into the population.

We are evaluating the use of a mobile aviary to improve relocation success of red-cockaded woodpeckers.

A mobile aviary was designed to allow a "soft" release whereby a captured bird can be maintained at the release site for 10 to 14 days before release. Maintaining the bird at the release site may help it develop an affinity for the site and be more likely to remain upon release. The aviary consists of a circular frame about 5.1 meters high and 4.7 meters in diameter with hardware and shade cloth on the outside. It is erected around a living pine tree that contains an artificial cavity insert that the bird can use for nightly roosting. The mobile aviary is currently being tested at the Savannah River Site near Aiken, South Carolina.

The study consists of three phases: 1) designing, constructing, and testing the aviary for durability; 2) determining whether a red-cockaded woodpecker can be successfully maintained in the aviary; and 3) determining whether the aviary can instill in the bird an attachment for its release site. Partners in this research include the Department of Energy and the Savannah River Natural Resources Management and Research Institute. If the use of the mobile aviary proves successful, the consequences to the recovery of the red-cockaded woodpecker could be far-reaching.

Celebrating the Year's Successes

Restoring Ecosystems...

Research Work Unit 4251
Wildlife Habitat
and Timber Resources

Studying Endangered Species in Texas

The endangered red-cockaded woodpecker *(Picoides borealis)* is a cooperatively breeding species that lives in groups composed of two to seven members. The quality of. the cavity selected by the breeding male is important to all group members because the breeding male's cavity is used as the nest tree , during the breeding season. Consequently research defining cavity tree quality is important.

Roosting and nesting red-cockaded woodpeckers make daily excavations at small wounds, called resin wells, around their cavity entrance from which resin flows down the tree. Our research has shown that the breeding male selects, cavity trees with-greater resin flow than other active cavity trees within the cluster. Longleaf pine cavity trees selected by breeding males as nest trees produced significantly greater resin yields than cavity trees used for roosting by other group members. This preference was also observed in loblolly and shortleaf pine cavity trees, but to a lesser extent. Use of cavity trees that produce copious pine resin enhances the quality of the resin barrier against rat snakes *(Elaphe spp.)*, thereby increasing the probability of nestling survival and the safety of the dominant, breeding male. Rat snakes regularly attempt to climb active red-cockaded woodpecker cavity trees, but are generally unable to reach cavities because of the resin barrier.

Studies of the, habits of red-cockaded woodpeckers and Louisiana pine snakes are expected to remit in methods which may prevent the extinction of 'these endangered species.

The Louisiana pine snake *(Pituophis ruthveni)* is a large constrictor endemic to the longleaf pine savannahs of eastern Texas and western Louisiana. There are only about 100 records known for this species. When our 'research was initiated, the Louisiana pine snake was one of the least known snakes in the U.S.

Celebrating the Year's Successes

Restoring Ecosystems,..

Studying Endangered Species in Texas

Research Work Unit 4251
Wildlife Habitat
and Timber Resources

The Louisiana pine snake inhabits primarily- longleaf pine savannahs with sandy, well-drained soils.

Radio-telemetry studies confirmed this -relationship and also demonstrated a very intimate association with Baird's pocket gophers *(Geomys breviceps).* Louisiana pine snakes spend much of their time within pocket gopher burrows or nearby on the surface. They also escape periodic fires in pocket gopher burrows and use the-m as sites for hibernation. 'Research on prey composition has also confirmed that' pocket gophers are the primary prey of Louisiana pine snakes. Laboratory 'experiments revealed specialized prey handling behavior **that** allows Louisiana pine snakes to efficiently capture pocket gophers within the confines of burrow systems.

Preliminary data indicate that pocket gophers, which feed primarily on roots and tubers of herbaceous plants, are most abundant in frequently burned pine habitats with well-drained sandy soils. Alteration of the fire. regime results in encroachment of woody vegetation that competitively eliminates herbaceous vegetation. Our working hypothesis is that alteration of fire regimes that reduce herbaceous vegetation result in the decline of pocket gophers, and may be a primary cause of the decline of Louisiana pine snakes.

Telemetry studies have also demonstrated that vehicle mortality of Louisiana pine **snakes** is significant. Moderately heavy traffic on a roadway appears to depress snake populations by 50% or more for hundreds of meters from the road corridor. The consequences of this level of mortality at- **the** landscape level are only beginning to be addressed, but are of obvious significance in understanding and managing Louisiana pine snake populations.

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Research Work Unit 4106
Managing Upland Forest Ecosystems in the Mid-South

Alternatives to Clearcutting on Public and Private Lands

The Research Work Unit's special focus is in uneven-aged silviculture. Unit scientists were invited to contribute' a synthesis of research in uneveh-aged silviculture of southern pines to a national publication about the current status of uneven-aged silviculture in the nation. There is a sixty year record of data from the "Good and Poor Farm Forestry" uneven-aged silviculture demonstration studies on the Crossett Experimental Forest, plus fifteen active studies that apply to uneven aged silviculture iri three different forest types: loblolly-shortleaf pine stands on the West Gulf Coastal Plain, pure stands of shortleaf pine and pine-hardwood stands in the Ouachita Mountains, and oak-hickory stands in the Arkansas Ozarks.. With this database, unit scientists are developing the applied ecology and silvicultural technology information needed to properly manage the upland forest ecosystems of the Mid-South using uneven-aged silviculture.

Society continues to insist on alternatives to traditional forms of timber management on public and private lands. Scientists in the Monticello/ Crossett Research Work Unit in Arkansas prqvided several key advances along these lines in FY '98.

A set of four publications appearing concurrently in one of the major forestry journals analyzed the development of poorly-stocked loblolly-shortleaf pine stands on the Crossett Experimental Forest and elsewhere in the West Gulf Coastal Plain. These studies demonstrate a much greater potential for recovery of poorly stocked cutover stands than has been previously thought. Traditional advice has been to site-prepare the cutover stand and replant, which is often too expensive for landowners. These studies suggest that such stands can be rehabilitated from far poorer stocking than previously thought, at a much lower cost than 'that incurred by site preparation and planting. The result is that they will provide high-value sawtimber returns within a relatively short period of time.

We distributed , over 200 copies of uneven-aged silviculture guidelines across the South, and published a four-part series on management of understocked stands in a major regional applied journal.

These findings have implications for every landowner who acquires or inherits 'a cutover tract, and points to the need for professional advice in evaluating the developmental potential of such tracts on a case-by-case basis.

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Integrated Ecosystem Management Studies Lead to Adaptive Management

Research Work Unit 4351
Watershed Responses to Disturbance

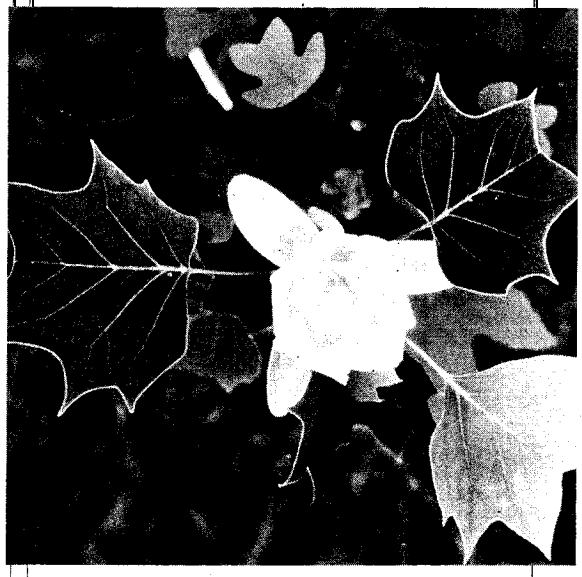
We are meeting , the growing demand for means to monitor the effects of land management activities on water quality by testing monitoring methodology in association with forest road construction and streambank restoration.

Multiple needs and uses of forest resources require an integrated, interdisciplinary ecosystem approach to research, planning, and management. The Wine Spring Creek Ecosystem Management Project in the Nantahala National Forest in North Carolina is providing both a framework and specific information to address those needs. This project in the 4,500-acre Southern Appalachian basin has multiple goals: achieving forest plan desired future conditions and demonstrating, developing, and testing alternative means to reach those conditions by using available and new research to predict and evaluate ecosystem responses.

Organized around themes of watershed restoration, forest sustainability, human and economic values, and ecosystem structure and function, the multifaceted studies in the Win'e Spring Ecosystem Management Project 'provide substantial benefits:

- Stand restoration burning in the. mixed pine-hardwood stands has reversed the decline in this forest type. This prescription stimulated pine regeneration, increased vegetation diversity, maintained small mammal and soil arthropod diversity, improved wildlife habitat, and maintained water quality and soil fertility.

- Three methods of selection harvesting in mixed oaks stands were applied to improve oak regeneration; enhance wild turkey, ruffed grouse, and Neotropical bird habitat; and increase vegetation diversity.



Caring for the Land and Serving People

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Research Work Unit 4351
Watershed Responses to Disturbance

Integrated Ecosystem Management Studies Lead to Adaptive Management

- The impoverished aquatic habitat and associated insect and fish populations are being enhanced by increasing stream structures through scientifically based additions of coarse woody debris to streams..

- Soil erosion and stream sedimentation research are showing the benefits of best management practices associated with forest roads and other management prescriptions. Results have been used to develop a landscape sediment model to assess the relative effects of alternative management practices.

- Recreation studies identified human uses of the watershed and customer preferences for future uses. A larger scale study showed how economic tools can be extended to quantify complex social and biological values associated with ecological processes. Both of these efforts provide an improved basis for management planning.

- Improved methods, developed to classify ecosystem units on the watershed, are being melded with other research and management activities to test the utility of the procedure.

These research findings, among others, are being synthesized and formulated for inclusion in a decision support system to assist and improve the forest management plan process. In the short-term, results from this research are reviewed and management techniques changed, if appropriate, in on-going feedback known as adaptive management.

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Adhesive Technology for Bonding Green Lumber

Research Work Unit 4701
Southern Forest
Resource Utilization

End-jointed lumber is sold at premium prices because it has more uniform strength and less tendency to warp than straight-sawn lumber. An adhesive system that bonds wood at a wide range of moisture contents would permit the use of low-quality plantation grown timber, short-length processing wastes, and green wood in the manufacture of. high-quality structural lumber. Such adhesives to produce end-jointed lumber that meets industry standards for structural lumber have not been available.

SoyBond resin adhesive developed which allows end-joint bonding of lumber at a wide range of moisture content.

Through the cooperative efforts of a Southern Research Station scientist and a private consultant in Washington State, the capability to end-joint wood with high moisture contents was first demonstrated using vegetable tannins to alter the cure properties of standard phenol-resorcinol-formalde! hyde (PRF) adhesives. An adhesive formulation was developed using a tannin with alkaline catalyst on one face of the joint, and a PRF resin with hardener on the opposite face. When brought together to mate the joint, the components mix and rapidly gel to form a durable adhesive bond. Because the availability and price of the tannin component stalled further development of this process, a soy protein derivative was investigated. These soy-based adhesives also bonded different wood species with wide-ranging moisture contents. Evaluated in a number of full-scale plant trials, the SoyBond resin technology has successfully met industry standards for structural lumber. Currently used commercially in one plant, the adhesive is under consideration by other lumber manufacturers.

The development of this adhesive technology provides at least four benefits for the forest industry. First, bonding short length sections from green defective lumber produces premium quality lumber from low-quality timber. Second, by end-jointing the lumber before drying, energy is not used in drying defective wood. Third, the uniform board lengths that result from this process translate into a more efficient use of the dry kiln. Fourth, by reducing the amount of resinous knot defects (common to southern pine lumber) subjected to the drying process, the amount of volatile organic compound emissions that contribute to the blue haze from dry kilns is also reduced.

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Research Work Unit 4703
Biological/Engineering Technologies

Monitoring Impacts from Forest Harvesting with Global Positioning System (GPS) Technology

Maintenance of soil productivity has been identified as a key component in sustainable forest management. Two primary indicators have been used to monitor changes in soil productivity: soil compaction and stand productivity. Neither indicator completely characterizes the influence of management on soil pro: ductivity. Stand growth, for example, is confounded with climatic, genetic, and other management factors, making conclusions about soil productivity drawn from growth measurements alone highly suspect. Degree of soil compaction is intuitively a better measure of soil productivity, and compaction has been shown to occur with various management practices, most notably with machinery traffic. Significant increases in soil compaction, however, often occur, on relatively small, widely distributed areas within a treated stand. Information on the distribution of impacts across a stand is difficult to collect in practice. Iheally, an indicator of soil productivity would be sensitive to changes in soil physical properties, be related strongly to stand growth, and be measurable at fine resolution over large areas to fully capture the effects of highly variable management activities.

Global positioning sys terns (GPS) provide a robust and practical means of tracking movements of machinery engaged in forest management activities.

Global positioning systems (GPS) provide a robust and practical means' of tracking movements of machinery engaged in forest management activities. These systems provide data on, not only where a machine went, but how often it passed over a given location. We are currently using this technology in evaluating the impacts of forest harvesting on soil physical properties at a stand level. Results of the tracking process are maps showing traffic' intensity over an entire stand. Given that traffic intensity i-s directly related to changes in' soil physical properties, the maps could be used in conjunction with data on soil, moisture at the time of traffic and soil type to identify areas within a stand receiving levels of machine traffic that could be limiting to subsequent stand growth.

Research this year has led to the'first large-scale, detailed maps of traffic patterns resulting from tree length

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Monitoring Impacts from For&t Harvesting with Global Positioning System (GPS) Technology

Research Work Unit 4703
Biological/Engineering Technologies

harvesting in the Southeast. The maps show how many times each 0.5 meter square section of a stand was traversed by harvesting machinery. Further research has been done to use the traffic maps to predict changes in soil physical properties associated with a known level of traffic passes. 'This information provides a means of estimating, with great spatial detail, the soil-related impacts from forest harvesting. Combining these results with subsequent tracking of growth in these stands will provide a clearer understanding of the relationship between traffic intensity and site productivity. Other benefits derived from'using GPS technology include near real time feedback on progress of harvesting, and the ability to remotely monitor the work. of- harvesting crews. Coupling GPS with tree measure-. ment sensors on felling equipment will provide 'precision, forestry' technology, making the flow of timber accountable from the stump to the mill and mapping stand yield without preharvest cruising. Positional data could also be used by loggers to increase productivity of their operations. We are currently doing research in all of these areas of application for GPS technology.

Celebrating the Year's Successes

Providing Options for Wise Use and Management...

Research Work Unit 4851
Economics of
Forest Resources

Forecasting Land Use and the Urban/Wildland Interface in the South

Land use and resource management choices are perhaps the most important determinants of -forest structure and condition in the South. The South's rich diversity of land 'ownership, forest types, physiography, and wood products industries defines complex interactions between people and forests. As social systems experience rapid change, the implications for the region's forests could be substantial.

Computer models provide a foundation for regional assessments of forest sustainability.

Scientists at the Southern Station's Research Triangle Park Lab and several Universities have developed spatially explicit computer models of land use change at various scales. These models simulate the effects of economic, demographic, and physical conditions on land use allocations, Projections of these driving variables — e.g., population growth and markets for agricultural goods — can then be used to forecast how and where land use would change in the future. 'Fine scale models have been linked to water quality and biodiversity for large watersheds in the Southern Appalachians. Broad scale models forecast land use shares at the county level, and have been developed for the South and the Mid-Atlantic regions. These models provide a foundation for regional assessments of forest sustainability.

The land use model for the South is also being used to assess the potential growth in the region's urban/wildland interface over the next thirty years. This change in the "human-context" of forests holds important implications for the relative values of various forest uses.' To investigate one aspect of these changing forest val-. ues, 'the land use model is also being integrated into an assessment of the south's timber markets.

Land use forecasts for the South suggest a high degree of flux between agriculture, forest, and urban land uses. However, these changes are spatially focused with urban growth concentrated in places like the Piedmont Crescent — Raleigh, North 'Carolina to Atlanta, Georgia — the coastal areas, and central Tennessee. Forest cover will, decline in these areas and residual forests will be more "urban" than "rural." In other parts of the South, the critical variables in determining the extent of forests are the relative values of forest and agricultural products. Here again, change is spatially focused with, for example, shifts from agriculture to forest being most likely in southwestern Georgia' and parts of the Mississippi Delta region.

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

An Option for Controlling American Chestnut Blight Disease

Research, Work Unit 4153
Southern Institute
of Forest Genetics

Chestnut blight is a devastating fungal disease-of American chestnut trees. The forest ecosystem of the eastern United States has been greatly altered by this catastrophic disease. Eighty years ago, chestnut trees were a major component of hardwood forests. After the accidental introduction of this fungus from Asia, it spread rapidly, and within 50 years reduced the species to a minor understory component.

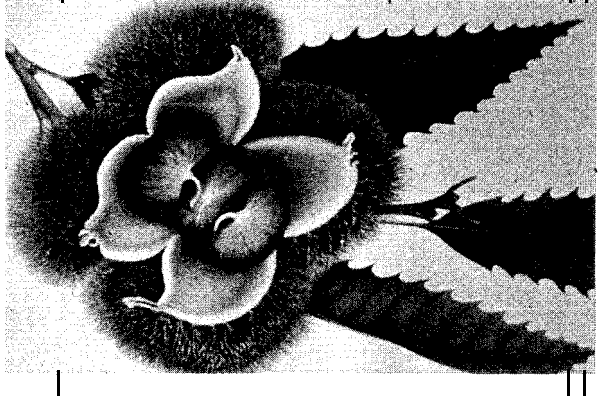
Just as this fungus is able to infect and cause disease on chestnut trees, the fungus is infected by a virus. Fungal isolates infected with virus are less virulent, producing nonlethal, superficial cankers on trees. The virus cannot be transferred sexually in the fungus,' but moves readily through fungal filaments — the transfer process controlled by vegetative compatibility (vic) genes.

Use of molecular markers minimizes cost of laboratory, testing to study virus transmission dynamics.

A transfer results in conversion of the recipient fungal strain to lesser virulence. Therefore, information about the number and prevalence of vegetative compatibility groups in natural populations of the fungus may help in developing a blight control strategy utilizing less virulent virus-infected strains.

Scientists at the Southern Research Station, Southern Institute of Forest Genetics in Saucier, Mississippi have developed molecular markers as tools for better understanding the fungal vic genes and virus transmission. To date, molecular markers linked to five of seven known vic genes have been identified. These molecular markers are being used to minimize the costs of laboratory testing.

'Using molecular markers, the time required for identifying genetically an unknown,isolate of the fungus has been reduced 'from several weeks to a single day. Our ability to quickly identify large numbers of' isolates has made virus transmission dynamics easier to study, permitting scientists to evaluate the practicality of virus transmission as an option for fungus control at a population level.



Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

Research Work Unit 41.54
Biological Foundations of Sustainability

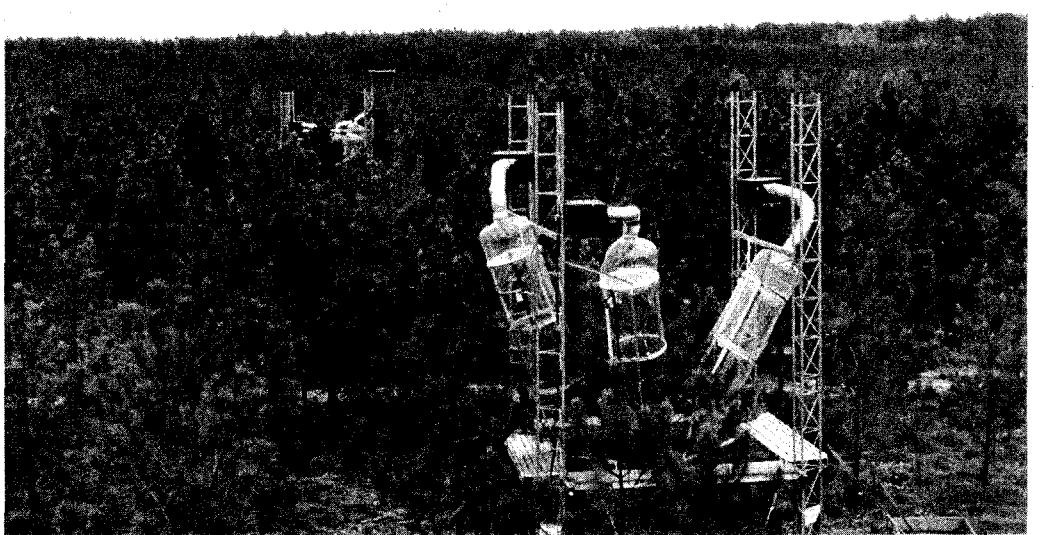
Large-Scale Outdoor Laboratory Offers Significant Research Results

The Southeast Tree Research and Education Site (SETRES), located in Scotland County, North Carolina, is a large-scale outdoor laboratory designed to study multiple aspects of sustainable southern pine forestry. SETRES was established in 1992 as an important. component of the Southern Global Change Program and <represents a major collaboration among the Forest Service, industry, and universities. SETRES has provided an excellent opportunity to assess interactions among different levels of resource availability including water, nutrition, and atmospheric carbon dioxide (CO_2).

We have shown that elevated levels of carbon dioxide increase photosynthesis and growth in loblolly pine.

In 1998, research on loblolly pine responses to elevated CO_2 neared completion. Original wdrk at SETRES increased atmospheric CO_2 surrounding individual branches and demonstrated that loblolly pine increased net photosynthesis and growth under elevatkd CO_2. No changes in branch water use were observed.

This work was followed by an intensive 2.5 year study where entire 13-year-old trees were surrounded by 40-foot-tall who'le-tree Chambers. The use of large trees for this work is novel and has permitted responses of the entire tree canopy and root systems to be evaluated. Again, elevated CO_2 has been Shown to increase growth rate and no negative consequences to tree physiology and function have been observed.



Celebrating the Year's Successes

Understanding Environmental and Biological Threats,. .

Detecting Disease Damage in Living Trees

Research Work Unit 4155
Bottomland Hardwoods
and Wetlands

Various disease-causing microbes, such as wood-decay fungi and wetwood bacteria, are foundational components of bottomland hardwood forest ecosystems. Roughly 30 percent of the total timber volume harvested in the United States is destroyed or decreased in value by heart decay each year. Lost value due to bacterial wetwood in the oak resource alone has been estimated to be $25 million a year. Whether one is interested in evaluating the relative health of a certain stand of trees, or a forested region, or wants to have the most accurate volume estimates of sound timber, it is important to-accurately estimate the incidence and severity of diseases such as heart rots and bacterial wetwood infections.

We are improving techniques to use technology to identify diseased living trees.

Progress is being made to develop ways of detecting fungal and bacterial infections in living hardwoods in the absence of obvious indicators 'and without damaging trees in the process. One set of tests indicates that ultrasound passed through the diameter of a tree can identify incipient as well as advanced heart decay in individual trees. In addition, ultrasound was able to separate a population of trees with bacterial wetwood from healthy trees, but could not detect individual wetwood-infected trees with any degree of certainty. Current efforts are focused. on improving the technique in order to identify infections in individual trees.

Another set of tests is evaluating the use of electronic aromascan technology to detect disease-causing microbes. This technology electronically measures volatile compounds given off by the microbes. So far, it has been used to separate pure cultures of wood decay fungi isolated from decayed trees. This technology has the potential to'identify wood decay fungi, vascular wilt fungi, bacterial wetwood, bacterial leaf scorch, and many other microbes capable of causing lumber degrade in wood samples. Early detection of these organisms using simple portable units would allow forest managers to adjust harvest schedules to minimize volume lost to rots, decays, and other organisms in standing trees. Aromascan and ultrasound technologies could be used' in virtually any forest ecosystem.

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

Research Work Unit 4202
Coldwater Streams
and Trout Habitat

A Bioindicator Technique for Water Quality Assessment

Watershed health and restoration is a key theme of the Forest Service's Natural Resource Agenda, and much effort has gone into the development of best management practices to protect water quality on national forests. The new insect-bacteria bioindicator has direct application to these efforts. Information gained from this technique provides a first step in the implementation of programs to initiate stream recovery. This new method evaluates detrimental effects of excess nutrients in streams.

New insect-bacteria bioindicator shows promise for evaluating stream quality.

The technique is based on the physical appearance of aquatic insects, which become covered by filamentous bacteria when excess nutrients are present. Stimulated into a bloom stage of growth by elevated concentrations of nitrate and phosphate, the bacteria readily colonize the gills and body surface of insects. By simply viewing insects collected from a stream, nutrient-impacted sites can be identified.

In laboratory studies, more than 90 percent of insects whose bodies were more than 25 percent covered, by bacteria died within 30 days, but those without bacteria survived and grew normally. The diagnostic ability of the technique was confirmed through field studies, where, a strong positive relationship was found between the degree of bacterial growth and the reduction in density of insects at nutrient-enriched locations.

Practical application of the bioindicator in a field setting requires only a hand lens with 10-15x magnification. Qualitative samples of insects can be viewed on site, allowing a screening-level assessment to be conducted within minutes. Preservation of insects in alcohol or formalin or manipulation of insects with collection equipment does not dislodge the bacteria. Consequently, severity of infestation can be confirmed in the laboratory without loss of data. Archived samples collected as part of a long-term monitoring program or for other research purposes can also be evaluated. Common stream insects such as mayflies are adequate for the assessment and no detailed taxonomic identification is required.

The bioindicator also shows promise as a significant addition to the Environmental Protection Agency's Rapid Bioassessment Protocol (RBP), a method widely used in North Anierica and Europe for stream quality rating. The simplicity and speed of the bioindicator allow it to be incorporated into the RBP with little additional effort by those conducting stream surveys.

The bioindicator should be a valuable tool for use in watershed management because it can detect nutrient impacts and evaluate the success of actions taken to control nutrients from point or nonpoint sources.

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

Advances in Control of Southern Pine Beetle

Research Work Unit 4501
Southern
Pine Beetle

We continued our exploration of interrelationships between bark infesting insects and their symbiotic fungi. We demonstrated that mites associated with the southern pine beetle (SPB) successfully, feed and develop on a fungus which competes with SPB, but do not develop well on the fungus which is mutualistic with SPB. In studies on the effects of growing season burns in longleaf pine, we found thar burns of moderate severity resulted in higher levels of root-infesting weevils and beetles in longleaf pine than did low level burns or no burning. This indicates that damage from growing season burns may result in increased presence of secondary root infesting insects and their associated fungi which can become pathogenic in stressed trees.

Patent received for beetle repellent.

Patent Number 5,695,807 was received December 9, 1997 for an invention identifying four additional analogs of 4-allylanisole, which effectively repel Scolytid beetles.' This technology is significant in that the analogs are repellents, not broad spectrum insecticides. We have also been exploring the. effects of visual silhouette modification on host selection behavior in bark beetles. The presence of a vertical black silhouette appears to be especially important, to SPB. Attractant-baited white traps significantly and dramatically reduced catch compared to standard black traps. In fact, the reduction due to this visual deterrent was stronger than that observed with semiochemical deterrents such as 4-allylanisole, a host derived compound. Importantly, the combination of visual and semiochemical deterrents produced an additive effect, suggesting that this combination may be useful in tree protection strategies with tree-killing bark beetles. We have also evaluated the effects of visual disruption treatments on another important species of bark beetle — the western pine beetle, a close relative of SPB. White traps again caught significantly fewer beetles; however, the effect was not as strong as observed in SPB. The combination of visual and semiochemical deterrents again pro-, duced the greatest effect, suggesting that this treatment be pursued to determine its efficacy as a tree protectant.

In our studies of the relationship between growth and resistance to pests and pathogens, our most significant highlight came from studying the effects of severe wounding. We conducted this wounding to reduce the reservoir of previously, synthesized oleoresin. When we combined this with repeated measurements of resin flow from bark wounds, we found that trees with large live-crown ratios recovered most rapidly. Within a few days such trees produced resin, flow greatly exceeding that measured prior to the severe wounding treatment. Such responses indicate that sampling the reservoir of preformed resin may not always lead to accurate predictions of levels of pest resistance within a tree.

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

Research Work Unit 4505
Insects and Diseases
of Southern Forests

Exotic Pests of Eastern Forests

At least 4,500 pest species of foreign origin have established free-living populations in the United States. These exotic pests have direct economic consequences, estimated 'in 1991 to have accumulated to 96 billion dollars. In addition to these direct costs for control and for lost forest, range and wildlife habitat productivity and recreation/ aesthetic value, exotic pests also cause incalculable damage by threatening biological diversity and altering key ecosystem processes, such as hydrology, nitrogen fixation, and fire regimes.

A Proceedings has been published, Exotic Pests of Eastern Forests, *which represents state-of-the-art exotic pest manage-men t in forests today.*

USDA Forest Service Research (Southern Research Station and Northeastern Forest Experiment Station) and Forest Health Protection (Southern and Eastern Regions) sponsored a conference that highlighted the impact of exotic pests in forest ecosystems and' explored management options. Developed for managers in the National Forest System and other forest land managers, the conference< included 'speakers from the USDA Forest Service,. State governments and-universities, and private enterprises engaged in impact assessment, exotic pest control, habitat preservation efforts, and ecosystem restoration work.

The proceedings of this conference were published in 1998, under the title *Exotic Pests of Eastern Forests,* in collaboration with the Tennessee Exotic Pest Plant Council and Southern, Appalachian Man and the Biosphere (SAMAB). Intended to represent state of the art exotic pest management in forests today, the publication also spotlights the need for increased interception and eradication of new pests as they are identified to reduce the ultimate' costs of invasive exotic species.

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

I Cooperative Approach to Forest Health Monitoring

Research Work Unit 4803
Forest Health
Monitoring Program

The Forest Health Monitoring (FHM) program started in 1990 when the Forest Service, the New England State Foresters, and the Environmental Protection Agency agreed to join forces to develop a national, interagency Forest Health Monitoring program. Although FHM has undergone many changes since its inception, the program has benefited over the years from support and expertise from a variety of organizations. Within the Forest Service, Research & Development, State & Private Forestry, and the National Forest System all have a role. In addition to the Forest Service, six Federal and 38 State agencies and more than a dozen universities have made important contributions toward reaching a common goal. Melding Forest Service needs, with those of different Federal, State, and university partners, into a cohesive whole has been a challenge. Though challenging, FHM's success shows that this cooperative approach will succeed for developing both the scientific underpinnings, and the administrative framework, for collecting, managing, assessing, and reporting forest health information critical to a wide range of policy and management decisions.

A cooperative approach shows success in developing the scientific and administrative framework for collecting and reporting forest health information.

Although FHM has yet to fully reach the goal of "developing and implementing a cooperative, multi-agency program to monitor, assess, and report on the long-term status and trends in forest ecosystem health in the United States," the program has made good progress. It is integrated with the Forest Service's Forest Inventory and Analysis units and is implemented in 37 States covering about 70 percent of forest land in the lower 48 States. Monitoring information increasingly responds to agency and partner information and reporting needs, is based on Santiago Declaration criteria and indicators, and includes strong quality assurance and quality control measures. FHM aims to provide scientifically sound information for formulating strategic national and regional resource plans and policy, for making ecoregion-scale resource management planning decisions, and for evaluating Forest Service success in meeting forest health protection responsibilities.

As with other resource monitoring projects, collecting data is only half the task. Communicating results to a diverse group of constituents is a key part of Forest Health Monitoring. Information is available through various national, regional, and State publications and the FHM Web site: http://www.fs.fed.us/foresthealth/

Celebrating the Year's Successes

Understanding Environmental and Biological Threats...

Research Work Unit 4852
(Southern Global
Change Program

Effects of Global Environmental Change on Southern Forests

The -assumption thatforests will grow the same way in the future as they did in the past may be invalid.

Over the last eight years, scientific research has greatly advanced our understanding of global environmental change and its repercussions for southern forest ecosystems. During this period, international scientific consensus was reached by the Intergovernmental Panel on Climate-change that "the balance of evidence suggests that there is a discernible human influence on global climate." In 1998, global average temperatures were warmer for each month of the year than in any previous time in recorded history and the global atmospheric carbon dioxide concentration rose again by 0.5 percent. Changes in the atmospheric composition and climate will have a significant influence on ecosystems in our region. The region's forest ecosystems are experiencing changes in their chemical and physical environments at heretofore unprece-. dented rates.

The Southern Global Change Program published a summary of the first five years of research conducted by the program of the critical findings from projects conducted by Southern Research Station scientists and university and private industry partners. There was consistency among these studies on one important point; the direct effects of elevated carbon dioxide on physiological factors affecting productivity were large and this leads to the expectation that there will be increases in growth for southern forests Climate change is likely to involve changes in atmospheric carbon dioxide, temperature, and precipitation-all occurring simultaneously. Current regional mode1 simulations suggest that growth will increase based on our current understanding of forest growth and physiological processes. Some of the more complex models suggest that less understood processes such as nutrient limitations, inter-tree competition, stand-closure dynamics, and water balance have the capacity to mitigate potential growth increases.

Many of the forests in the southeastern United States are currently under intensive management. The degree to which these forests continue to be managed in the future may determine how responsive they will be to global environmental changes. If limitations imposed by new climate conditions can be overcome, for example, with thinning of canopies or fertilizer additions, then managed systems may show greater response to climate change than would be otherwise anticipated. Rapid growth-pattern changes'induced by a quickly changing climate 'will invalidate the key assumption used in most management models today-that forests will grow the same way in the future as they did in the past. The analysis of regional forest process models suggests that. we can make some strong inference about growth trends under future climates based on extrapolation of our current scientific knowledge, while improving our understanding of forest-climate interactions.'

Celebrating the Year's Successes

Aligning Products with Customer Needs...

Sorting Mixed Hardwoods by Color

Research Work Unit 4702
Tree Quality,
Processing, and Recycling

While the demand for hardwood products, such as flooring, millwork, furniture, and kitchen cabinets, is increasing, the potential supply of timber is decreasing, as many forest areas are removed from timber harvesting. Because the timber industry is asked to produce more products from fewer resources, it must process mixed species, such as lower quality red oaks, which previously remained in the forest.

Commercial version of computer vision system improves material utilization.

To help industry maintain the production of high quality wood products, scientists in the Tree Evaluation, Processing and Recycling Research Work Unit and at Virginia Tech University cooperatively developed a computer vision system that separates cuttings from lumber by wood color. The cuttings are automatically separated, and cuttings of like color are processed into higher value products. These scientists then helped industrial cooperatorsdevelop a commercial version of the computer vision system, This commercial machine has been successfully operating in a plant for more than 1.5 years.

These research efforts were awarded the 1997 Hardwood Research Award from the National Hardwood Lumber Association. The work was selected as the research with the most significant implications for the hardwood industry. Evolving from research, this commercial machine is helping industry adjust to the changing hardwood resource by improving material utilization.

Caring for the Land and Serving People

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Aligning Products with Customer Needs...

Research Work Unit 4801
Forest inventory
and Analysis

Implementing an Annual Forest Inventory System

For more than 70 years, the Forest, Inventory and Analysis (FIA) program has been the only inventory work that produces a comprehensive account of natural resources on both public and, private lands. It has also been the only inventory work that historically focused on broad regions of the country where it conducted inventories on a State-'by-state, cyclic basis with cycles of 8 to 15 years. Using this design, inventory crews' measured all field plots in one State before moving into another State. However, data collected under this design are only accurate for a State for 1 to 3 years after, that State's inventory is completed. In addition, the data are not connected in time across State boundaries, either between or within regions. Because more timely, consisterit data across the entire South were need.ed, the concept of an annual inventory system was introduced in 1995.

Annual inventory data for each southern State will provide critical data to address forest sus tainabili ty issues.

The annual forest inventory system provides the basis for integrating the Forest Health Monitoring (FHM) and the FIA 'program,' thereby increasing the effectiveness of each. The objectives of this system are to create and to maintain a database of current inventory estimations. To meet -these objectives, 20 percent of the ground plots in all of the 13 southern States must be'measured annually. Components of the annual system include plot strategies; field logistics; greater use of remote sensing, models and statistical procedures; quality assurance; database management; and an annual sample of measured plots.

The annual forest inventory system has, now been scheduled for implementation in all 13 Southern States. Because the scope of annual inventories is large, partnerships have been formed with several organizations, most notably the Southern State Foresters. At the end of FY '98, six States were actively collaborating with the Southern Research Station in, the implementation of annual inventories. These six States expended a total of $2,328,000 in FY '98, an amount above and beyond the efforts and resources provided by the USDA Forest Service. Plans are in place to implement annual inventories in the remaining seven southern States within the next 2 years.

Annual data for each State will provide critical data to assess criteria, and indicators for forest sustainability and to address forest sustainability issues. Data acquired using the new annual procedures have produced a number of specific benefits:, 1) more uniform information among states; 2) confidence intervals that are more stable from year-to-year; 3) the ability to immediately incorporate innovations into each State's inventory; and, 4) annual observations of inventory events.

Celebrating the Year's Successes

Aligning Products with Customer Needs...

Wood Products Markets in China

Research Work Unit 4802
Legal, Tax, and
Economic Influences

In the 1980s China emerged as the world's second largest importer of forest products and the second largest export market for U.S. forest products. However, United states wood products exports to China declined nearly 93 percent from 1988 to 1996, from $448 million to $33 million. Little was known about the factors that caused this decline. More generally, less is known about the forestry and wood products market in China than most other United States trading partners.

As an importer of wood products, China shows an emerging interest in United States hardwood species.

A scientist' from the Southern Research Station was a member of a 3-person team, participating under the Scientific Cooperation Program of the USDA Foreign Agricultural Service, that visited China for research and fact-finding to assess recent trends in China's wood product imports and the competitiveness of U.S. wood product exports. Trade statistics were collected from Chinese sources, and interviews were conducted with importers that accounted for more than 90 percent of the wood products imported into the country. After the trip was completed, data were compiled and analyzed. A major finding was that wood product import demand had shifted from softwood logs and lumber to hardwood products, especially tropical hardwood; however, there was an emerging interest in United States hardwood species. The competitive advantages of American wood products in Chinese markets were found to be product quality, service, and reputation of exporting firms; disadvantages were price, transportation time, and lack of credit provided by exporters. Results were disseminated at the Society of American Foresters National Convention and through the proceedings, and as the feature article in the June 1998 issue of the Forest Products Journal:

This research can help enhance the competitiveness of the domestic forest products industry, which increases jobs and incomes, and benefits wood products manufacturers, workers, and forest landowners. In China, consumers will benefit, and substitution of imports for domestic timber from environmentally-sensitive areas will promote sustainable forest management. Also, the successful collaboration in data-gathering, analysis, and publication with Beijing Forestry University should foster future cooperative research efforts.

'Celebrating!, the Year's Successes ,

Aligning Products with Customer Needs...

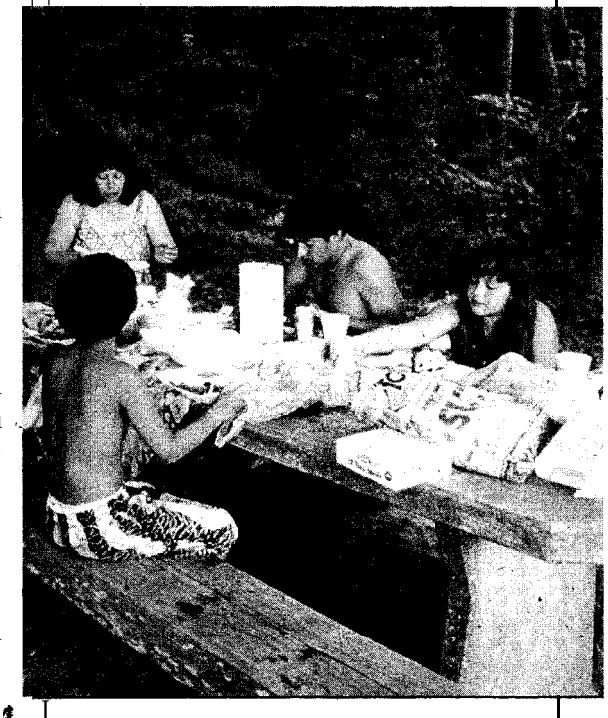
Research Work Unit 4901
Trends in Recreation
and Wilderness

Ethnicity Recreation Research

Demographic trends indicate. that growth of minority groups has been increasing faster than the overall United States population. Forecasted population growth is expected to follow these trends with 82 percent of the nation's growth over the next 30 years coming from minorities. Increased population diversity creates a managerial need to better understand minority preferences and behavior related to natural settings and outdoor recreation as the Forest Service and other land management agencies define and fulfill their missions.

. We are studying the relationships among increasing minority populations and recreation uses.

Researchers at the Southern Research Station's Outdoor Recreation and Wilderness Unit are examining social and economic issues pertaining to ethnicity and recreation nationally and in the Southeast. Social scientists from the Southern Research Station and Florida A&M University provide a review and synthesis of theory and empirical investigations of Anglo and African American participation in outdoor recreation in *Theoretical Perspectives of Ethnicity and Outdoor Recreation! A Review and Synthesis of African American and European American Participation.* Recent empirical research with southern rural African American and Anglo populations has uncovered insights about visitation, use, meanings, and perceptions of forested areas. For example, in *-Race, Rural Residence, and Wildland Visitation: Examining the Influence of Sociocultural Meaning,* Southern Research Station and University of Georgia, scientists find that the, meanings rural blacks and whites attach to wildlands are fundamental to explaining differences in visitation rates between the two groups.



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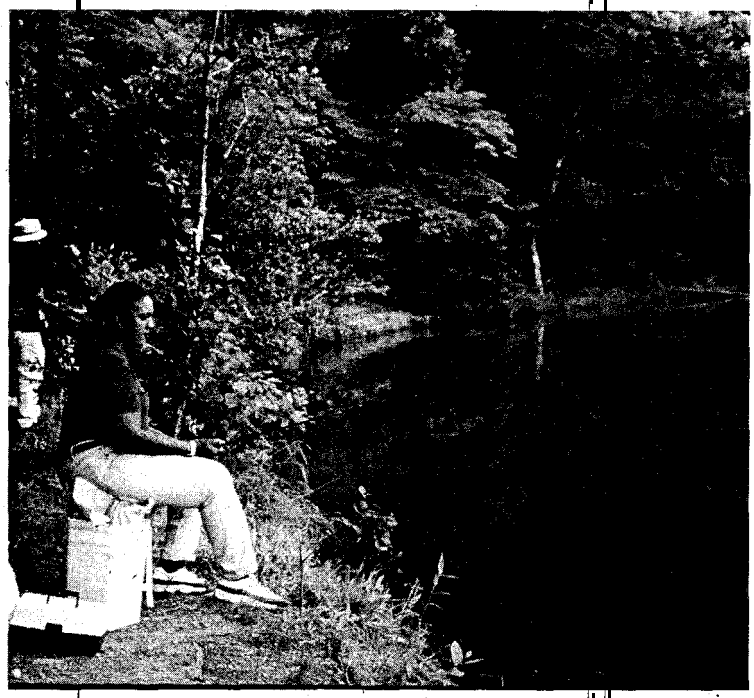
Aligning Products with Customer Needs...

Ethnicity Recreation Research

Research Work Unit 4901
Trends in Recreation
and Wilderness

In the reiated paper, *Wildland Recreation in the Rural South: An 'Examination of Marginality and Ethnicity Theory,* social scientists from the Southern Research Station and Florida A&M University use logistic regression models to test competing theoretical explanations for black and white -visitation rate differences to wildlands. Their findings suggest that race, sex, and age are strong predictors of wildland visitation among rural residents.. Moreover, contrary to theory and previous research, race and income interact among blacks to effect. greater visitation among poor blacks than more affluent blacks. Underlying reasons for black and white visitation differences are explored further in A Consideration of Collective Memory in African Attachment to Wildland Recreation Places. Sex, age, and race are important determinants of wildland place attachment f-or rural southerners.



Working with an economist from the National Oceanic and Atmospheric Administration, natural resource-based recreation travel demand by whites and Hispanics to the Florida Keys is examined in *Accounting for Ethnicity in- Recreation Demand: A Flexible Count Data Approach.* Using nonlinear regression, models, researchers find significant differences in price response between whites and Hispanics. Higher'demand elasticity for Hispanics means price increases related to recreation trips to the area is likely. to disproportionately displace Hispanic visitors. This result implies that pricing policies, like user fees, could have important distribution and equity consequences.

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Research Work Unit 4104
Disturbance and Management of Southern Pine Ecosystems

Smoke from Wildfires Causes Problems at Night

Recent catastrophic wildfires in Florida emphasize the 'need to reduce fuel loadings. in southern forests. Improved models of smoke movement and dispersion would permit more widespread prescribed burning, which is currently limited by smoke problems. Daytime smoke can be a nuisance when it moves into sensitive areas and a traffic hazard when it drifts across roadways. However, the most severe impacts can occur at night when small amounts of smoke from smoldering heavy fuels are trapped near the ground and carried long distances in slow-moving air with little dispersion. Smoke can also be entrapped within moist shallow valleys at night,, thereby initiating' or intensifying local fog. Development and validation of nighttime smoke models has been limited because it has been impossible to observe smoke near the ground at night in detail; this barrier to model development is being surmounted. Smoke trapped near the ground at night has been recorded in moonlight by an,. intensified multispectral video camera from aircraft at approximately 5,000 feet above ground level.

Remote sensing allows study of smoke movement at night.

Results verify the hypothesis that smoke can be observed from the air under moonlight if the smoke is sufficiently dense. A light-intensified video camera can be used for remote sensing of smoke moving near the ground at night. This technology is critical for smoke management because airborne observation is the only way to observe and understand the movement 'of an entire smoke plume and to validate computer models for ground-level smoke movement and dispersal at night.

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Increasing Foresters' Skill Levels

Research Work Unit *4101*
Southern Appalachian Hardwoods,

We have improved, the instruction' in our Silvicul ture *Short-course and expanded the range of participants.*

Since 1992, all Bent Creek scientists and several outside speakers have channeled their efforts, to train foresters in the fundamentals of hardwood silviculture. They present an annual workshop which focuses on the principles and, practices of silviculture and closely related disciplines for managing hardwood dominated upland forests in the Appalachian Mountains and Interior Uplands.

The target audience for this annual training is southeastern State service foresters, forestry consultants, and industrial foresters Speakers blend classroom lectures with hands-on field exercises to ensure comprehension of complex concepts. Participants are trained in:

- forest disturbance history
- site classification.
- forest health
- economics
- wildlife management
- stand and forest dynamics
- hardwood autecology and synecology
- hardwood regeneration
- managing mixed stands of pines and hardwoods
- managing low-value hardwood stands
- intermediate stand treatments

Since 1992, about 200 foresters have benefited from this intensive training. This training is offered annually in June or July.

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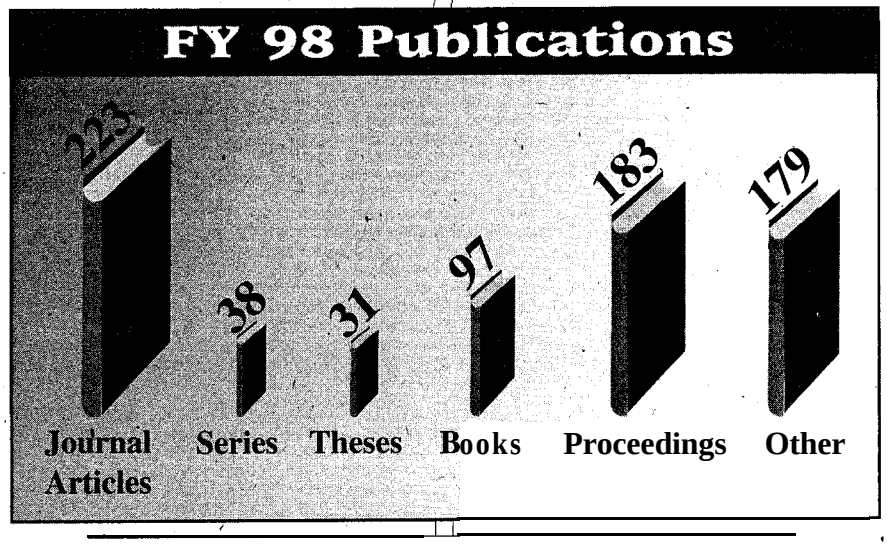
We have responded to new customer needs with improved product delivery.

We have been making a concentrated effort to increase the distribution of our research results, by traditional means, and modern electronics communications. We distribute our hard copy "Catalog of Recent Publications" four times a year, listing the articles and publications that our scientists author- or co-author. These publications are distributed free by request to people throughout the country and internationally. The FY '98 List of Publications is the last section of this Report.

The Stand Management and Forest Health Team at Research Work Unit 4155—Bottomland Hardwoods and Wetlands-has produced four insect and disease image CDs that may be purchased from that Unit.

We have developed, a major World Wide Web presence with our Web site at www.srs.fs.fed.us, which contains a wealth of information about the Southern Research Station and hundreds of Portable Document Format (PDF) files of individual publications. The Web site also serves to distribute the "Catalog of Recent 'Publications" electronically to a mailing list (listserv) of over 1,000 addresses-see Web site page www.srs.fs.fed.us/pubs/pubs_list.htm to subscribe. The site includes directory information, the Strategic Framework for the Southern Research Station, links to Web sites of our Research Work Units, links to other forestry sites, and other information. By the end of 1998, 12 of our Research Work Units had sites available on the Web. Visitation to the Southern Research Station Web site has been expanding at a dramatic rate and information is being added to it frequently.

Scientists and other 'employees participate, in a variety of information-sharing activities: tours and site visits; training sessions; informal and formal presentations, such as giving scientific papers and doing poster sessions'; and staffing exhibits at' meetings and conferences.



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In tern teams visit summer camps with messages 'about natural resource conservation and careers.

The goal of the Conservation Education Outreach Program is to provide basic conservation education to urban youngsters-children who may never have been exposed to the concepts of conservation, recycling, or forest management. The Southern Research Station hosted two teams of 4 college interns. during the summer to provide a fun, learning experience for children at sites throughout the South.

The visits include environmental games that teach conservation concepts, usually with 20 to '35 children at a time. One 4-person team was located in Asheville, North Carolina, and one was in Huntsville, Alabama. The team in Asheville started a beneficial relationship with the YMI Cultural Center in downtown Asheville to provide conservation educational programming in exchange for office space.

The Southern Research Station teams worked with approximately 2,400 youngsters in FY '98, and conducted the intern training and provided overhead support for two other teams, located in Atlanta, Georgia and Milwaukee, Wisconsin.

We continue to emphasize improving service to those who use our products and information.

Customer Service at the Southern Research Station is providing the products and services needed by our external and internal customers-getting the research results out to the people who can benefit from them. The Station's standards for customer service include:

1. listening and responding to the needs of our customers—incorporating our customers' needs and responding to our customers when feasible;
2. meeting commitments made to our customers in a timely and efficient manner;
3. providing quality advice and work products that meet our customers needs 'and expectations; and
4. seeking, evaluating and being responsive to feedback from our customers to improve personal and organizational effectiveness.

If you have any comments on the products or services provided by the Southern Research Station, please contact our Customer Service Coordinator at 828-257-4342, or use the comment form on our Web site.

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