

COMPASS

Recent Publications  
of the Southern Research Station

Fall 2002

The Southern Research Station of the USDA Forest Service produces *Compass*, a quarterly catalog of recent publications and technologies. The Southern Station works with universities, other Government agencies, corporations, and non-government organizations on studies that contribute to the sustainability of southern forest resources. We employ about 150 research scientists in disciplines ranging from tree physiology to the social sciences, from genetics to landscape ecology. Each year, our scientists' names appear as authors on 500 to 600 journal articles, research papers, resource assessments, handbooks, videotapes, and computer programs.

In addition to featuring a few highlights, *Compass* lists our most recent publications. You can order hard copies, or download electronic versions from our Web site ([www.srs.fs.fed.us](http://www.srs.fs.fed.us)) by using the reference number in bold print. We welcome input on the quality of our research program and our success in offering products that meet customer needs. For more information, contact Claire Payne at 828-257-4392.



Constance Gist, 1953–2002

Constance Gist worked for the USDA Forest Service for 27 years before dying tragically October 30, 2002. Constance's position in the Property and Acquisitions Group put her skills in demand daily. She excelled at serving customers and interacting with vendors. Constance was a 20-year veteran of the Army Reserves. Since she had worked for the Agricultural Research Service 2 years before coming to the Forest Service, Constance had completed 29 years of Federal service at the age of 49.

Losing Constance leaves huge gaps in the lives of her family: a son and daughter-in-law; 4 siblings; 8 grandchildren; and her stepfather. Constance's friends and co-workers feel her absence and miss her. Throughout the Southern Research Station and the Eastern Administrative Zone, we counted on being able to "call Constance" for help, frequently at the last minute. When Constance had listened to our pleas and said "Alright," we knew she would use her wealth of experience and historical knowledge to make things happen. We honor you by our sadness, Constance, and we remember you with gratitude and laughter.

# Table of Contents

## **Highlights**

Southern Forest Resource Assessment .....	1
Hypertext Encyclopedia Debuts with Southern Appalachian Edition .....	3
Station News .....	5

## **Research**

Southern Pine Ecosystems .....	7
Wetlands, Bottomlands, and Streams .....	18
Mountain and Highland Ecosystems .....	21
Large-Scale Assessment and Modeling .....	25
Inventory and Monitoring .....	37
Foundation Programs .....	42

Research Work Units .....	47
---------------------------	----



## Southern Forest Resource Assessment

The Southern Forest Resource Assessment captures the South at the turn of the 21st century. Challenges include urban sprawl; air, water, and forest health; timber demand; and a rapidly growing and increasingly diverse population. Development of the Southern Forest Resource Assessment (SFRA) grew from concerns expressed by natural resource managers, the science community, and the public regarding the status and likely future of forests in the South. In 1999 these SFRA partners began collaborating:

- USDA Forest Service, the Southern Research Station and the Southern Region;
- U.S. Environmental Protection Agency;
- USDI Fish and Wildlife Service;
- Tennessee Valley Authority;
- Southern Group of State Foresters; and
- Southeastern Association of Fish and Wildlife Agencies

Under the steady guidance of SFRA coleaders Dave Wear, Southern Research Station, and John Greis, Southern Region, Federal and State managers, subject area team leaders, authors, and reviewers brought SFRA to life. The Assessment's details deliver the promise of its topics, which include:

- Forces of change;
- Social and economic systems;
- Forest area and conditions;
- Terrestrial ecosystems; and
- Water quality, wetlands, and aquatic ecosystems

More than 100 scientists from universities, State and Federal agencies, and conservation organizations provided peer reviews to enhance the report's accuracy and completeness. Review, analysis, and incorporation of public comments collected from November 2001 through February 2002 increase the value of the assessment's findings.

Thanks to the assessment, we now know the complexity and the scale of our resources and the pressures brought to bear against them. Wear and Greis sum up the potential of the assessment by saying its information should enhance public understanding of southern forests, inform public debate, and improve public policies that result.

You can choose your preferred version of the Southern Forest Resource Assessment: Web access (<http://www.srs.fs.fed.us/sustain>); a searchable compact disk; the 651 page general technical report; or the concise and colorful summary. Its photographs capture the essence of the South's forests: natural diversity, unique cultural characteristics, and emerging competition for use.

---

**24** Prestemon, Jeffrey P.; Abt, Robert C. 2002. **The southern timber market to 2040**. Journal of Forestry. 100 (7): 16-22.

---

**28** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment**. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.



---

**29** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment.** Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. [CD-ROM].

---

**30** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment; summary of findings.** Journal of Forestry. 100 (7): 6-14.

---

**31** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment; summary report.** Gen. Tech. Rep. SRS-54. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 103 p.

## Hypertext Encyclopedia Debuts with Southern Appalachian Edition

The USDA Forest Service Southern Research Station, and the Southern Regional Extension Forestry Office are developing an online hypertext encyclopedia system to make forestry research information available to the public. The system stands to revolutionize the way scientific knowledge and information are organized and communicated. Originally designed for natural resource professionals and others who desire direct, comprehensive access to the research literature on forestry topics, the hypertext encyclopedia is geared to provide valuable resources to anyone with related interests.

The initial encyclopedia being developed on the Web site focuses specifically on the ecology and management of Southern Appalachian forest ecosystems. Specific information is organized under broad topics:

- Landscape
- Resource management
- Forest ecology
- Forest health management
- Social sciences
- Economics

The Southern Appalachian hypertext encyclopedia serves as a pilot project from which other encyclopedias will be developed. Work has already begun on a fire history, ecology, and management encyclopedia.

The Forest Service and the Cooperative Extension Service invite comments on this project while it is still under development. More materials will be added in the coming months. Public input on the structure, content, and other features will be used to improve the Web site. To review and comment about the pilot encyclopedia, please visit <http://www.forestryencyclopedia.net>. An online comment form is available.

The Southern Appalachian hypertext encyclopedia consists of about 800 Web “pages”—another 500 are being prepared by contributing authors. Designed to be dynamic, updates and additions will occur regularly over the coming years.

Evaluators will encounter occasional “dead ends” where links are in place for material still under

development. Plans for this edition and future hyper-text encyclopedias include subjecting the content to a peer review process to ensure that the information represents the best available science knowledge on the included topics.

## Station News

**Greg Reams** moved east to lead the Forest Health Monitoring project in Research Triangle Park, NC. Greg's work in the Forest Inventory and Analysis research unit since 1995 complements his project leadership in the Southern Forest Experiment Station. Congratulations, Greg!

**Floyd Bridgwater** began a sabbatical in October to develop a problems analysis and propose policy for the application of biotechnology to preserve and promote forest health in the National Forest System. Working in partnership with the Institute of Forest Biotechnology, Floyd is exploring applications and priorities for critical and emerging forest health issues. **Dana Nelson** is acting project leader for the Southern Institute of Forest Genetics, Saucier, MS.



## Southern Pine Ecosystems

---

- 1 Barnett, James P.; McGilvray, John M. 2002. **Guidelines for producing quality longleaf pine seeds.** Gen. Tech. Rep. SRS-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 21 p.

Longleaf pine (*Pinus palustris* Mill.) seeds are sensitive to damage during collection, processing, treatment, and storage. High-quality seeds are essential for successfully producing nursery crops that meet management goals and perform well in the field. Uniformity in the production of pine seedlings primarily depends on prompt and uniform seed germination, early seedling establishment, and a variety of cultural practices that are applied as the seedlings develop. The best collecting, handling, and processing methods maximize performance attributes and reduce the need for extensive nursery cultural practices to compensate for poor seed quality. Guidelines are presented that will help seed dealers, orchard managers, and nursery personnel produce high-quality longleaf pine seeds and improve the efficiency of nursery production.

- 
- 2 Conner, Richard N.; Saenz, Daniel; Rudolph, D. Craig; Schaefer, Richard R. 2002. **Does the availability of artificial cavities affect cavity excavation rates in red-cockaded woodpeckers?** Journal of Field Ornithology. 73 (2): 125-129.

Rates of cavity excavation by red-cockaded woodpeckers (*Picoides borealis*) were examined from 1983 to

1999 on the Angelina National Forest in East Texas. We compared the rate of natural cavity excavation between 1983 and 1990 (before artificial cavities were available) with the rate of cavity excavation between 1992 and 1999, a period when artificial cavities were regularly installed within active woodpecker cavity-tree clusters. Our comparison was restricted to cavity-tree clusters in longleaf pine (*Pinus palustris*) and loblolly (*P. taeda*)-shortleaf (*P. echinata*) pine habitats where woodpecker groups were present for the entire period between 1983 and 1999. Excavation rate of new cavities was significantly higher in longleaf pine habitat when artificial cavities were not available than during the subsequent period when artificial cavities were provided in all active cavity-tree clusters. In loblolly-shortleaf pine habitat, we did not detect a significant difference in the rate of new cavity excavation between the periods before and after the use of artificial cavities. We attribute the difference in results between habitats to a relative scarcity of cavities in loblolly-shortleaf pine sites due to higher bark beetle-induced cavity tree mortality.

- 
- 3 Fraedrich, Stephen W.; Cram, Michelle M. 2002. **The association of a *Longidorus* species with stunting and root damage of loblolly pine (*Pinus taeda* L.) seedlings.** Plant Disease. 86: 803-807.

A *Longidorus* species was consistently associated with patches of stunted and chlorotic loblolly pine seedlings at a forest-tree nursery in Georgia. Seedlings from affected areas had poorly developed root systems that lacked lateral and feeder roots. *Longidorus* population densities in composite soil samples from the margins of

patches ranged from 9 to 67 nematodes per 100 cm<sup>3</sup> of soil. In a growth chamber experiment, seedling root dry weight decreased with respect to the initial *Longidorus* dose as well as the final *Longidorus* populations in containers. The dry root weight of seedlings were 0.117, 0.090, 0.066, and 0.065 g in containers initially infested with 0, 50, 100, and 200 *Longidorus*, respectively. Lateral and fine roots were lacking on seedlings at the highest doses. Populations of *Longidorus* increased in all containers during the experiment. Damage to loblolly pine seedlings caused by *Longidorus* is a previously undescribed problem in southern pine nurseries. Proper diagnosis of the problem by nematode testing laboratories may require the use of extraction techniques specific for larger nematodes such as *Longidorus*.

- 
- 4 Groom, Les; Shaler, Stephen; Mott, Laurence. 2002. **Mechanical properties of individual southern pine fibers. Part III: Global relationships between fiber properties and fiber location within an individual tree.** Wood and Fiber Science. 34 (2): 238-250.

This is the third and final paper in a three-part series investigating the effect of location within a tree on the mechanical properties of individual wood tracheids. This paper focuses on the definition of juvenile, transition, and mature zones as classified by fiber stiffness, strength, microfibril angle, and cross-sectional area. The average modulus of elasticity and ultimate tensile stress of all loblolly pine fibers were, in equal proportion of earlywood and latewood, 17.3 GPa and 824 MPa, respectively. The average microfibril angle was found to be 15.4 degrees, with rings 5 and 48

averaging 26.8 and 6.1 degrees, respectively. Normalization of all mechanical and physical properties showed that the juvenile zone is not cylindrical but rather biconical, tapering from stump to below the live crown and then again from the live crown to the bole tip. The transition zone parallels the juvenile zone, ranging in width from 3 to 15 rings. Fiber properties continued to improve slightly throughout the duration of the mature zone.

- 
- 5 Hanula, James L.; DeBarr, Gary L.; Weatherby, Julie C. [and others]. 2002. **Degree-day model for timing insecticide applications to control *Dioryctria amatella* (Lepidoptera: Pyralidae) in loblolly pine seed orchards.** *The Canadian Entomologist*. 134: 255-268.

Because *Dioryctria amatella* (Hulst) is a key pest in loblolly pine, *Pinus taeda* L. (Pinaceae), seed orchards in the Southeastern United States, improved timing of insecticide applications would be valuable for its control. To time two fenvalerate (Pydrin® 2.4 EC) applications, we tested four variations of a degree-day model that was developed to predict when various proportions of *D. amatella* eggs would hatch during the spring generation. We compared reductions in *Dioryctria* spp. cone damage to unsprayed checks and a standard operational spray regime of four monthly applications of fenvalerate. In addition, we examined seeds from healthy cones to determine if sprays to control *D. amatella* also reduced seed damage caused by *Leptoglossus corculus* Say (Heteroptera: Coreidae) and *Tetyra bipunctata* (Herrich-Schäffer) (Heteroptera: Scutelleridae). Trials were conducted from 1984 to



1986 in two orchards in South Carolina and one in Alabama. Degree-day accumulations (threshold = 11°C) were begun on the day when the cumulative number of male *D. amatella* equaled or exceeded five captured in 15 Pherocon 1C® traps baited with 100 µg of Z-11-hexadecenyl acetate. One application per year was insufficient to control *D. amatella* or reduced seed-bug damage. Two sprays based on *D. amatella* phenology significantly reduced coneworm and seed bug damage, and were as effective as four sprays applied monthly. None of the treatments reduce spring cone losses, which are primarily caused by *Dioryctria merkei* Mutuura and Monroe. Several variations of the model performed well, but we suggest that the best, based on efficacy and ease of use, was when sprays were applied immediately after five males were caught (degree-day = 0) and again when the model predicted 50 percent of the spring generation eggs had hatched.

- 
- 6 Horn, Scott; Hanula, James L. 2002. **Comparison of arthropod prey of red-cockaded woodpeckers on the boles of longleaf and loblolly pines.** Wildlife Society Bulletin. 30 (1): 131-138.

Red-cockaded woodpeckers (*Picoides borealis*) forage on the boles of most southern pines. Woodpeckers may select trees based on arthropod availability, yet no published studies have evaluated differences in arthropod abundance on different species of pines. We used knockdown insecticides to sample arthropods on longleaf (*Pinus palustris*) and loblolly (*P. taeda*) pine to determine which harbored the greater abundance of potential prey. Longleaf pine had significantly greater arthropod abundance ( $278 \pm 44.4/\text{tree}$ ,  $P = 0.013$ ) and

biomass ( $945 \pm 28$  mg/tree,  $P = 0.007$ ) than loblolly pine ( $132 \pm 13.2$ /tree and  $395 \pm 28$  mg/tree). Certain groups were found in significantly higher numbers on longleaf, including Thysanura ( $P = 0.0004$ ), Hemiptera ( $P = 0.0209$ ), and Pseudoscorpiones ( $P = 0.0277$ ). Biomass of woodroaches (Blattaria: Blattellidae) also was greater on longleaf boles, but number of individuals did not differ significantly, suggesting that larger arthropods may prefer the bark structure of longleaf pine. We altered the bark surface of longleaf pine to determine whether bark structure may affect arthropods residing on a tree's bole. When the loose bark was removed by scraping, we recovered fewer arthropods from scraped than from unscraped control trees 8 weeks after scraping. We also lightly scraped the outer bark of both tree species and found that longleaf pine had significantly more loose, flaking bark scales than loblolly ( $P = 0.0012$ ). These results suggest that bark structure and not the chemical nature of the bark is responsible for differences in arthropod abundance and biomass observed on the 2 tree species. Retaining or restoring longleaf pine in red-cockaded woodpecker habitats should increase arthropod availability for this endangered bird and other bark-foraging species.

- 
- 7 Lai, Chun-Ta; Katul, Gabriel; Butnor, John; [and others]. 2002. **Modelling night-time ecosystem respiration by a constrained source optimization method.** *Global Change Biology*. 8: 124-141.

One of the main challenges to quantifying ecosystem carbon budgets is properly quantifying the magnitude of night-time ecosystem respiration. Inverse

Lagrangian dispersion analysis provides a promising approach to addressing such a problem when measured mean CO<sub>2</sub> concentration profiles and nocturnal velocity statistics are available. An inverse method, termed “constrained source optimization” or CSO, which couples a localized near-field theory (LNF) of turbulent dispersion to respiratory sources, is developed to estimate seasonal and annual components of ecosystem respiration. A key advantage to the proposed method is that the effects of variable leaf area density on flow statistics are explicitly resolved via higher-order closure principles. In CSO, the source distribution was computed after optimizing key physiological parameters to recover the measured mean concentration profile in a least-square fashion. The proposed method was field-tested using 1 year of 30-min mean CO<sub>2</sub> concentration and CO<sub>2</sub> flux measurements collected within a 17-year-old (in 1999) even-aged loblolly pine (*Pinus taeda* L.) stand in Central North Carolina. Eddy-covariance flux measurements conditioned on large friction velocity, leaf-level porometry, and forest-floor respiration chamber measurements were used to assess the performance of the CSO model. The CSO approach produced reasonable estimates of ecosystem respiration, which permits estimation of ecosystem gross primary production when combined with daytime net ecosystem exchange (NEE) measurements. We employed the CSO approach in modeling annual respiration of aboveground plant components (c. 214g Cm<sup>-2</sup> year<sup>-1</sup>) and forest floor (c. 989g Cm<sup>-2</sup> year<sup>-1</sup>) for estimating gross primary production (c. 1800g Cm<sup>-2</sup> year<sup>-1</sup>) with a NEE of c. 605g Cm<sup>-2</sup> year<sup>-1</sup> for this pine forest ecosystem. We conclude that the CSO approach can utilize routine CO<sub>2</sub> concentration profile measurements to corroborate forest carbon

balance estimates from eddy-covariance NEE and chamber-based component flux measurements.

- 
- 8 Ludovici, K.H.; Allen, H.L.; Albaugh, T.J.; Dougherty, P.M. 2002. **The influence of nutrient and water availability on carbohydrate storage in loblolly pine.** Forest Ecology and Management. 159: 261-270.

We quantified the effects of nutrient and water availability on monthly whole-tree carbohydrate budgets and determined allocation patterns of storage carbohydrates in loblolly pine (*Pinus taeda*) to test site resource impacts on internal carbon (C) storage. A factorial combination of two nutrient and two irrigation treatments were imposed on a 7-year-old loblolly pine stand in the Sandhills of North Carolina. Monthly collections of foliage, branch, stem, bark, and root tissues were made and total non-structural carbohydrate analyses were performed on samples collected in years 3 and 4 after treatment initiation. Seasonal fluxes of carbohydrates reflected the hypothesized use and storage patterns. Starch concentrations peaked in the spring in all tissues measured; however, minimum concentrations in aboveground tissue occurred in late winter, while minimum concentrations in belowground tissue occurred in late fall. Increased nutrient availability generally decreased starch concentrations in current year tissue, while increasing starch in 1-year-old woody tissue. Irrigation treatments did not significantly impact carbohydrate flux. The greatest capacity for starch storage was in below ground tissue, accounting for as much as 400 kg C/ha per year, and more than 65 percent of the total stored starch C pool.

The absolute amount of C stored as starch was significantly increased with increased nutrient availability, however, its relative contribution to the total annual C budget was not changed.

- 
- 9 Mott, Laurence; Groom, Les; Shaler, Stephen. 2002. **Mechanical properties of individual southern pine fibers. Part II: Comparison of earlywood and latewood fibers with respect to tree height and juvenility.** Wood and Fiber Science. 34 (2): 221-237.

This paper reports variations in mechanical properties of individual southern pine fibers and compares engineering properties of earlywood and latewood tracheids with respect to tree height and juvenility. Results indicate that latewood fibers exhibit greater strength and stiffness than earlywood fibers irrespective of tree height or juvenility. Average earlywood loblolly pine fibers had modulus of elasticity and ultimate tensile stress values of 14.8 GPa and 604 MPa, respectively. Corresponding latewood fibers had modulus of elasticity and ultimate tensile stress values that were, respectively, 33 and 73 percent higher. These differences are attributable to microfibril angles and pitting. Juvenility as defined by the mechanical properties of individual wood fibers is not a cylindrical cone surrounding the pith but appears to be biconical, tapering from the base to below the live crown and then again from the live crown to the apex.

- 
- 10 Pitts-Singer, Theresa; Hanula, James L.; Walker, Joan L. 2002. **Insect pollinators of three rare plants in a Florida longleaf pine forest.** Florida Entomologist. 85 (2): 308-316.

As a result of human activity, longleaf pine (*Pinus palustris* Miller) forests in the Southern United States have been lost or drastically altered. Many of the plant species that historically occupied those forests now persist only as remnants and are classified as threatened or endangered. In order to safeguard such species, a better understanding of their pollination ecology is needed. We identified insect visitors and potential pollinators of *Harperocallis flava* (McDaniel) (Amaryllidaceae), *Macbridea alba* Chapman (Lamiaceae), and *Scutellaria floridana* Chapman (Lamiaceae) that occur in longleaf pine habitat on the Apalachicola National Forest in Florida. We observed that potential pollinators of *H. flava* were Halictidae, of *M. alba* were bumble bees (Apidae: *Bombus*), and of *S. floridana* were Megachilidae and Halictidae. However, the rates at which these insects visited the flowers were very low. Our results raise important concerns about how forest management practices affect the survival of rare plants, as well as their pollinators.

- 
- 11 Shelton, Michael G.; Cain, Michael D. 2002. **Recovery of 1-year-old loblolly pine seedlings from simulated browse damage.** Canadian Journal of Forest Research. 32: 373-377.

Loblolly pine (*Pinus taeda* L.) seedlings are frequently browsed by a wide variety of animals during the first

few years of their development. Although anecdotal observations indicate that the potential for seedling recovery is good, there is little quantitative information on the factors affecting the recovery process. Thus, we conducted a study to evaluate the effects of the extent and season of simulated browse damage on the recovery of 1-year-old loblolly pine seedlings under controlled conditions. Seedlings were clipped at five positions: at the midpoint between the root collar and cotyledons and so that 25, 50, 75, and 100 percent of the height between the cotyledons and the terminal remained after clipping. Clipping treatments were applied in two seasons: winter and spring. All seedlings clipped below the cotyledons died, confirming that dormant buds or lateral shoots are required for recovery. Survival of seedlings clipped above the cotyledons was 97 percent for winter clipping and 96 percent for spring clipping. Most of the seedling mortality (73 percent) was for seedlings with only 25 percent of their height remaining. Regression analysis revealed that second-year seedling size was positively affected by first-year size and percentage of remaining height after clipping and that seedlings clipped in winter were larger at 2 years than those clipped during spring. Logistic regression indicated a higher probability of multiple stems resulting from the more severe clipping treatments. Clipping season and severity also significantly affected the probability for tip moth (*Rhyacionia* spp.) damage, which occurred more frequently in the larger seedlings. Results suggest that planting seedlings deep, with the cotyledons just below ground level, may be an advantage in areas where browse damage is common.

## Wetlands, Bottomlands, and Streams

---

- 12** Haag, Wendell R.; Warren, Melvin L., Jr.; Wright, Keith; Shafer, Larry. 2002. **Occurrence of the rayed creek-shell, *Anodontoidea radiatus*, in the Mississippi River Basin: implications for conservation and biogeography.** *Southeastern Naturalist*. 1 (2): 169-178.

We document the occurrence of the rayed creekshell (*Anodontoidea radiatus* Conrad), a freshwater mussel (Unionidae), at eight sites in the Upper Yazoo River drainage (Lower Mississippi River Basin) in Northern Mississippi. Previously, *A. radiatus* was thought to be restricted to Gulf Coast drainages as far west only as the Tickfaw River system (Lake Pontchartrain Basin), La. The eight populations reported herein represent the only known occurrences of this species in the Mississippi River Basin. This distributional pattern, along with distributions of other aquatic organisms, suggests that headwater stream capture events occurred historically between Lower Mississippi River Basin tributaries and the Upper Tombigbee River drainage (Mobile Basin). Because *A. radiatus* is a rare species, considered imperiled throughout its range, the discovery of eight additional populations and the extension of its known range are of significance to its conservation.

- 
- 13** Holland, Marjorie M.; Warren, Melvin L.; Stanturf, John A., eds. **Proceedings of a conference on sustainability of wetlands and water resources: how well can riverine wetlands continue to support society into the 21st century?** Gen. Tech. Rep. SRS-50.



Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 191 p.

The conference focused on recent work in freshwater wetlands (both natural and constructed) with a view toward understanding wetland processes in a watershed context. Since humans have played important roles in watershed dynamics for years, attention was given to the human dimensions of wetland and watershed uses. Contributed sessions were organized on: biogeochemical cycling in wetlands; human health issues related to water; wetland restoration and reforestation; the role of wetlands in agricultural systems; wetlands and USA environmental law; chemical ecology and natural products from wetlands; water and wetlands in science education; and regional water strategies. The lead paper in the proceedings was prepared by conference plenary speaker Dr. Sandra Postel, director of the Global Water Policy Project in Amherst, MA. Examples and experiences from eight countries were shared during the conference, providing valuable global perspectives.

- 
- 14 Roghair, Craig N.; Dolloff, C. Andrew; Underwood, Martin K. 2002. **Response of a brook trout population and instream habitat to a catastrophic flood and debris flow.** Transactions of the American Fisheries Society. 131: 718-730.

In June 1995, a massive flood and debris flow impacted fish and habitat along the lower 1.9 km of the Staunton River, a headwater stream located in Shenandoah National Park, Virginia. In the area

affected by debris flow, the stream bed was scoured and new substrate materials were deposited, trees were removed from a 30-m-wide band in the riparian area, and all fish were eliminated. In the area that was unaffected by debris flow, habitat was moderately altered by the flood and fish populations persisted at decreased densities. Basinwide fish population and habitat surveys provided data to compare (1) the pre- and post event population densities of brook trout *Salvelinus fontinalis* and instream habitat conditions; and (2) post event population density, brook trout growth, and instream habitat in the debris-flow-affected and unaffected areas. By June 1998, brook trout had recolonized the entire debris-flow-affected area, and population density exceeded pre-event levels. Brook trout growth was significantly greater in the debris-flow-affected area than in the unaffected area through fall 1998, but it was not significantly greater in 1999. Population density appeared to have a negative influence on fish growth. A 1995 post event habitat survey revealed increases in the number of pools and riffles and substrate size and decreases in pool and riffle surface area and depth. By 1999, the total number, surface area, and depth of pools and riffles had returned to near pre-event levels and substrate size had decreased. Between 1995 and 1999, the amount of large woody debris increased in the debris-flow-unaffected area, where riparian trees had remained intact, and decreased in the affected area, where riparian trees had been eliminated. A number of factors, including a relatively intact watershed and nearby source populations, allowed the Staunton River to quickly respond to this dramatic natural event. Given the proper conditions for recovery, such events are less catastrophic than activities that lead to chronic stream degradation.

## Mountain and Highland Ecosystems

---

- 15 Elliott, Katherine J.; Boring, Lindsay, R.; Swank, Wayne T. 2002. **Aboveground biomass and nutrient accumulation 20 years after clear-cutting a Southern Appalachian watershed.** Canadian Journal of Forest Research. 32: 667-683.

In 1975, we initiated a long-term interdisciplinary study of forest watershed ecosystem response to clearcutting and cable logging in watershed 7 at the Coweeta Hydrologic Laboratory in the Southern Appalachian Mountains of North Carolina. This paper describes  $\approx 20$  years of change in species composition, aboveground biomass, leaf area index (LAI), and nutrient pools in the 59-ha mixed hardwood forest of watershed 7 following commercial clear-cutting in winter 1977. We measured woody species in 24 permanently marked plots before cutting in 1974 and during subsequent years (1977-1997). By 1997 ( $\approx 20$  years after cutting), aboveground biomass was 81.7, 96.9, and 85.4  $\text{Mg}\cdot\text{ha}^{-1}$  in the cove hardwood; mesic, mixed-oak; and dry, mixed-oak communities, respectively. Leaf biomass and LAI accumulated relatively faster than total aboveground biomass in all three communities. By 1984, only 7-8 years after cutting, leaf biomass and LAI were nearly equal to the amount estimated for the precut forest. In 1997, nitrogen accumulation was 36, 44, and 61 percent and phosphorus accumulation was 48, 66, and 59 percent in the cove-hardwoods; mesic, mixed-oak; and dry, mixed-oak communities of the corresponding precut communities, respectively. Potassium, calcium, and magnesium accumulations were less than either nitrogen or phosphorus accumulation.

- 
- 16 Greenberg, Cathryn H.; Smith, Lindsay M.; Levey, Douglas J. 2001. **Fruit fate, seed germination, and growth of an invasive vine—an experimental test of “sit and wait” strategy.** *Biological Invasions*. 3: 363-372.

Oriental bittersweet (*Celastrus orbiculatus* Thunb.) is a non-indigenous, invasive woody vine in North America that proliferates in disturbed open sites. Unlike most invasive species, *C. orbiculatus* exhibits a “sit and wait” strategy by establishing and persisting indefinitely in undisturbed, closed canopy forest and responding to canopy disturbance with rapid growth, often overtopping trees. We compared fruit fates of *C. orbiculatus* and native American holly (*Ilex opaca*). We also explored mechanisms for this “sit and wait” invasion strategy by testing the effect of *C. orbiculatus* fruit crop density on removal rates and by examining the influence of seed treatment and light intensity on seed germination and seedling growth. More *C. orbiculatus* than *I. opaca* fruits became damaged, and damage occurred earlier. More fruit fell from *C. orbiculatus* than *I. opaca*, but removal rates by frugivores did not differ ( $76.0 \pm 4.2$  percent versus  $87.5 \pm 3.7$  percent, respectively). Density (number of fruits in a patch) of *C. orbiculatus* did not influence removal rates. Scarification (bird-ingestion) of *C. orbiculatus* seed delayed germination but seeds germinated in similar proportion to manually defleshed seeds (sown either singly or all seeds from a fruit). Germination of seeds within intact fruits was inhibited and delayed compared to other treatments. Seed treatment did not affect seedling growth. The proportion of seeds germinating and time until germination was similar among five light intensity

levels, ranging from full sun to closed-canopy. Seedlings in >70 percent photosynthetically active radiation (PAR) had more leaves, heavier shoots, and longer, heavier roots than seedlings at lower PAR levels. Results show that most (>75 percent) *C. orbiculatus* seeds are dispersed, seedlings can establish in dense shade, and plants grow rapidly when exposed to high light conditions. Control strategies for this highly invasive species should likely focus on minimizing seed dispersal by vertebrates.

- 
- 17 Spetich, Martin A.; Dey, Daniel C.; Johnson, Paul S.; Graney, David L. 2002. **Competitive capacity of *Quercus rubra* L. planted in Arkansas' Boston Mountains.** *Forest Science*. 48 (3): 504-517.

Results of an 11 yr study of the growth and survival of planted northern red oak (*Quercus rubra* L.) seedlings (2-0 bare-root) are presented. More than 4,000 seedlings were planted under shelterwood overstories that were harvested 3 yr after planting. Results are expressed as planted-tree dominance probabilities. Dominance probability is the probability that a planted tree will live to attain a favorable competitive position (i.e., at least 80 percent of the mean height of dominant competitors) at a specified year. We interpret the resulting probability as a measure of the competitive capacity of an individual seedling, i.e., its potential of attaining dominance in a specified environment. Based on logistic regression analysis, dominance probabilities increase with time after shelterwood overstory removal for any given environment and initial seedling characteristics. At any specified time, dominance probabilities depend on

initial seedling basal diameter before planting (stem caliper 2 cm above the root collar), site quality, intensity of weed control, and shelterwood percent stocking. Dominance probabilities increase with decreasing shelterwood stocking, increasing initial stem caliper, and increasing intensity of weed control. Other factors being equal, top clipped seedlings have higher dominance probabilities than unclipped seedlings. The reciprocals of the dominance probabilities provide silviculturally useful estimates of the numbers of trees that would need to be planted to obtain, on the average, one competitively successful tree. For example, if clipped seedlings averaging 6 mm in caliper were planted where oak site index was 24 m, shelterwood stocking was 80 percent, and the site was given no weed control before or after planting, obtaining one competitively successful tree 11 yr after planting (8 yr after shelterwood removal) would require planting 144 seedlings. Other factors remaining the same, increasing initial caliper to 22 mm would require planting only 5 trees to obtain one competitively successful tree. For the same size (22 mm) and type of seedling planted on site index 18 m under a shelterwood at 40 to 60 percent stocking and given two weed control treatments, only 1.4 trees would need to be planted. Results emphasize the sensitivity of competitive capacity, and thus the silvicultural potential, of planted northern red oaks in the Boston Mountains of Arkansas to the joint effects of field environment and initial seedling characteristics.

## Large-Scale Assessment and Modeling

---

- 18** Brose, Patrick; Wade, Dale. 2002. **Potential fire behavior in pine flatwood forests following three different fuel reduction techniques.** *Forest Ecology and Management*. 163: 71-84.

A computer modeling study to determine the potential fire behavior in pine flatwood forests following three fuel hazard reduction treatments: herbicide, prescribed fire, and thinning, was conducted in Florida following the 1998 wildfire season. Prescribed fire provided immediate protection but this protection quickly disappeared as the rough recovered. Thinning had a similar effect on fireline intensity. Herbicides produced a dramatic decrease in fireline intensity from year 2 to 6 but had little effect on fire severity, thus increasing the likelihood of root kill resulting in tree death if wildfire occurs during drought conditions. Treatment combinations, such as thinning and herbicide, may provide immediate and long-term fireline intensity reductions as long as forest managers take into account each alternative's strengths and weaknesses.

- 
- 19** Holmes, Thomas P.; Blate, Geoffrey M.; Zweede, Johan C. [and others]. 2002. **Financial and ecological indicators of reduced impact logging performance in the eastern Amazon.** *Forest Ecology and Management*. 163: 93-110.

Reduced impact logging (RIL) systems are currently being promoted in Brazil and other tropical countries in response to domestic and international concern over the ecological and economic sustainability of

harvesting natural tropical forests. RIL systems are necessary, but not sufficient, for sustainable forest management because they reduce damage to the forest ecosystem during the initial forest entry. If conditions were identified where RIL costs were clearly less than conventional logging (CL) costs, then a strong incentive for RIL adoption would exist.

In this paper, a comparison of costs and revenues was made for typical RIL and CL operations in the eastern Amazon. An economic engineering approach was used to estimate standardized productivity and cost parameters. Detailed data on productivity, harvest volume, wasted wood, and damage to the residual stand were collected from operational scale harvest blocks. Productivity and cost data were also collected using surveys of forest products firms.

The major conclusion of the study was that RIL was less costly, and more profitable, than CL under the conditions observed at the eastern Amazon study site. Full cost accounting methods were introduced to capture the direct and indirect costs associated with wasted wood. The impact of wasted wood on effective stumpage price provided the largest gain to RIL. Large gains attributable to RIL technology were also observed in skidding and log deck productivity. In addition, investment in RIL yielded an “environmental dividend” in terms of reduced damage to trees in the residual stand and reduction of the amount of ground area disturbed by heavy machinery. Developing institutions that can monetize the value of the environmental dividend remains a major challenge in the promotion of sustainable forest management in the tropics.



- 
- 20** Lemly, A. Dennis. 2002. **A procedure for setting environmentally safe total maximum daily loads (TMDLs) for selenium.** *Ecotoxicology and Environmental Safety*. 52: 123-127.

This article presents a seven-step procedure for developing environmentally safe total maximum daily loads (TMDLs) for selenium. The need for this information stems from recent actions taken by the United States Environmental Protection Agency (EPA) that may require TMDLs for selenium and other contaminants that are impairing water bodies. However, there is no technical guidance from EPA or elsewhere that deals exclusively with selenium. This leaves biologists and environmental contaminant specialists without the tools needed to effectively address the TMDL issue for selenium. This article provides guidance by laying out an assessment method that links the basic components of EPA's TMDL process to the contaminant-specific information required for selenium. The underlying principle in this process is that selenium concentrations be kept below levels that threaten reproduction of fish and aquatic birds. The steps are: (1) Delineate and characterize the hydrological unit (HU, i.e., water body) of interest. (2) Determine selenium concentrations and assess biological hazard. (3) Determine sources, concentrations, and volumes of selenium discharges; calculate existing selenium load. (4) Estimate retention capacity of HU for selenium. (5) Calculate the total allowable selenium load and specify reductions needed to meet the target loading. (6) Allocate selenium load among discharge sources. (7) Monitor to determine effectiveness of selenium load reduction in meeting environmental quality goals. Proper application of this

procedure will ensure compliance with EPA regulatory requirements and also protect fish and wildlife resources.

- 
- 21 Lemly, A. Dennis. 2002. **Symptoms and implications of selenium toxicity in fish: the Belews Lake case example.** *Aquatic Toxicology*. 57: 29-49.

Belews Lake, NC was contaminated by selenium in wastewater from a coal-fired power plant during the mid-1970s and toxic impacts to the resident fish community (20 species) were studied for over two decades. Symptoms of chronic selenium poisoning in Belews Lake fish included, (1) telangiectasia (swelling) of gill lamellae; (2) elevated lymphocytes; (3) reduced hematocrit and hemoglobin (anemia); (4) corneal cataracts; (5) exophthalmus (popeye); (6) pathological alterations in liver, kidney, heart, and ovary (e.g. vacuolization of parenchymal hepatocytes, intracapillary proliferative glomerulonephritis, severe pericarditis and myocarditis, necrotic and ruptured mature egg follicles); (7) reproductive failure (reduced production of viable eggs due to ovarian pathology, and post-hatch mortality due to bioaccumulation of selenium in eggs); and (8) teratogenic deformities of the spine, head, mouth, and fins. Important principles of selenium cycling and toxicity were documented in the Belews Lake studies. Selenium poisoning in fish can be “invisible” because the primary point of impact is the egg, which receives selenium from the female’s diet (whether consumed in organic or inorganic forms), and stores it until hatching, whereupon it is metabolized by the developing fish. If concentrations in eggs are great enough (about 10 µg/g or greater)

biochemical functions may be disrupted and teratogenic deformity and death may occur. Adult fish can survive and appear healthy despite the fact that extensive reproductive failure is occurring—19 of the 20 species in Belews Lake were eliminated as a result of this insidious mode of toxicity. Bioaccumulation in aquatic food chains causes otherwise harmless concentrations of selenium to reach toxic levels, and the selenium in contaminated sediments can be cycled into food chains for decades. The lessons learned from Belews Lake provide information useful for protecting aquatic ecosystems as new selenium issues emerge.

- 
- 22 Lemly, A. Dennis; Ohlendorf, Harry M. 2002. **Regulatory implications of using constructed wetlands to treat selenium-laden wastewater.** *Ecotoxicology and Environmental Safety*. 52: 46-56.

The practice of using constructed wetlands to treat selenium-laden wastewater is gaining popularity in the United States and elsewhere. However, proponents of treatment wetlands often overlook important ecological liabilities and regulatory implications when developing new methods and applications. Their research studies typically seek to answer a basic performance question—are treatment wetlands effective in improving water quality—rather than answering an implicit safety question—are they hazardous to wildlife. Nevertheless, wetland owners are responsible for both the operational performance of treatment wetlands and the health of animals that use them. This is true even if wetlands were not created with the intent of providing wildlife habitat; the owner is still legally responsible for toxic hazards.

If poisoning of fish and wildlife occurs, the owner can be prosecuted under a variety of Federal and State laws, for example, the Migratory Bird Treaty Act and the Endangered Species Act. In considering this type of treatment technology, it is important to document the selenium content of the wastewater, understand how it cycles and accumulates in the environment, and evaluate the threat it may pose to fish and wildlife before deciding whether or not to proceed with construction. Many of the potential hazards may not be obvious to project planners, particularly if there is no expressed intention for the wetland to provide wildlife habitat. Ecological risk assessment provides an approach to characterizing proposed treatment wetlands with respect to wildlife use, selenium contamination, and possible biological impacts. Proper application of this approach can reveal potential problems and the associated liabilities, and form the basis for selection of an environmentally sound treatment option.

- 
- 23** Maier, Chris A.; Johnsen, Kurt H.; Butnor, John. [and others]. 2002. **Branch growth and gas exchange in 13-year-old loblolly pine (*Pinus taeda*) trees in response to elevated carbon dioxide concentration and fertilization.** *Tree Physiology*. 22: 1093-1106.

We used whole-tree, open-top chambers to expose 13-year-old loblolly pine (*Pinus taeda* L.) trees, growing in soil with high or low nutrient availability, to either ambient or elevated (ambient + 200  $\mu\text{mol mol}^{-1}$ ) carbon dioxide concentration ( $[\text{CO}_2]$ ) for 28 months. Branch growth and morphology, foliar chemistry, and gas exchange characteristics were measured periodically in the upper, middle, and lower crown

during the 2 years of exposure. Fertilization and elevated  $[\text{CO}_2]$  increased branch leaf area by 38 and 13 percent, respectively, and the combined effects were additive. Fertilization and elevated  $[\text{CO}_2]$  differentially altered needle lengths, number of fascicles, and flush length such that flush density (leaf area/flush length) increased with improved nutrition but decreased in response to elevated  $[\text{CO}_2]$ . These results suggest that changes in nitrogen availability and atmospheric  $[\text{CO}_2]$  may alter canopy structure, resulting in greater foliage retention and deeper crowns in loblolly pine forests. Fertilization increased foliar nitrogen concentration ( $N_M$ ), but had no consistent effect on foliar leaf mass ( $W_A$ ) or light-saturated net photosynthesis ( $A_{\text{sat}}$ ). However, the correlation between  $A_{\text{sat}}$  and leaf nitrogen per unit area ( $N_A = W_A N_M$ ) ranged from strong to weak depending on the time of year, possibly reflecting seasonal shifts in the form and pools of leaf nitrogen. Elevated  $[\text{CO}_2]$  had no effect on  $W_A$ ,  $N_M$ , or  $N_A$ , but increased  $A_{\text{sat}}$  on average by 82 percent. Elevated  $[\text{CO}_2]$  also increased photosynthetic quantum efficiency and lowered the light compensation point, but had no effect on the photosynthetic response to intercellular  $[\text{CO}_2]$ , hence there was no acclimation to elevated  $[\text{CO}_2]$ . Daily photosynthetic photon flux density at the upper, middle and lower canopy position was 60, 54 and 33 percent, respectively, of full sun incident to the top of the canopy. Despite the relatively high light penetration,  $W_A$ ,  $N_A$ ,  $A_{\text{sat}}$ , and  $R_d$  decreased with crown depth. Although growth enhancement in response to elevated  $[\text{CO}_2]$  was dependent on fertilization,  $[\text{CO}_2]$  by fertilization interactions and treatment by canopy position interactions generally had little effect on the physiological parameters measured.

- 
- 24 Prestemon, Jeffrey P.; Abt, Robert C. 2002. **The southern timber market to 2040.** *Journal of Forestry*. 100 (7): 16-22.

Timber market analysis of the South's predominantly private timberland finds that the 13 southern States produce nearly 60 percent of the Nation's timber, an increase from the mid-1900s. Projections with the Subregional Timber Supply model show that, despite a 60 percent increase in the area of pine plantations, the South will experience a 1 percent decline in private timberland area as other forest types shrink. Because of expected productivity gains for plantation forests and conversions of some agricultural lands to natural forests, the South's industrial wood output is projected to increase by more than 50 percent between 1995 and 2040.

- 
- 25 Rauscher, H. Michael; Potter, Walter D. 2001. **Decision support for ecosystem management and ecological assessments.** In: Jensen, Mark E.; Bourgeron, Patrick S., eds. *A guidebook for integrated ecological assessments.* New York: Springer-Verlag New York, Inc.: 162-183.

In the face of mounting confrontation and after almost 20 years of increasingly contentious public unhappiness with the management of national forests, the USDA Forest Service officially adopted ecosystem management as a land management paradigm. Other Federal forest land management agencies, such as the USDI Bureau of Land Management, the USDI National Park Service, the USDI Fish and Wildlife Service, the USDC NOAA, and the Environmental Protection Agency, have also made the commitment to adopt

ecosystem management principles. Ecosystem management represents different things to different people. At the heart of the ecosystem management paradigm lies a shift in emphasis away from sustaining yields of products toward sustaining the ecosystems that provide these products. The ecosystem management paradigm represents the latest attempt, in a century-long struggle between resource users and resource preservers, to find a sensible middle ground between ensuring the necessary long-term protection of the environment while protecting the right of an ever-growing population to use its natural resources to maintain and improve human life.

- 
- 26 Steele, Philip H.; Araman, Philip A.; Boden, Craig. 2002. **Economic choice for hardwood sawmill operations (ECHO)**. Forest and Wildlife Research Center, Bulletin FP252. Starkville, MS: Mississippi State University: 21 p.

Reductions in sawkerf on headrigs and resaws can dramatically increase lumber recovery. Research has also shown that lumber target size reductions are even more important than kerf reductions in providing increased lumber recovery. Decreases in either sawkerf or lumber size, however, always come at some cost in both capital and variable costs. Determining whether the financial benefits from increased lumber yield outweigh the incurred costs can be a difficult task. The Economic Choice for Hardwood Sawmill Operations (ECHO) is a software package developed to help analyze the economic benefit of installing thinner-kerf and higher-accuracy sawing machines. Replacement of headrigs and resaws with reduced kerfs and increased sawing accuracy can be tested. ECHO will assist in the

estimation of the increased lumber recovery and the resultant increased revenue from reducing kerf or lumber sizes on headrigs and resaws. As an alternative, users may make their own increased revenue estimate. Users must also determine the estimated increased costs expected from equipment changes. Based on the estimated increased revenues and costs, a discounted cash flow analysis is performed by ECHO. The investment feasibility measures of present net value, rate of return, and payback period are provided. The software also addresses Federal tax implications.

- 
- 27 Van Sickle, Charles. 2001. **Southern Appalachian case study**. In: Jensen, Mark E.; Bourgeron, Patrick S., eds. A guidebook for integrated ecological assessments. New York: Springer-Verlag New York, Inc.: 472-488.

The Southern Appalachian study covers a region of 37.4 million acres. Its mountains, foothills, and valleys stretch from northern Virginia and northern West Virginia to northern Georgia and Alabama. When Native Americans came to the region, forests dominated the landscape and they still do, covering 70 percent of the land. Terrain characteristics are significant in shaping the ecology of the Southern Appalachians. The region's location and its mountains produce a wide range of climatic conditions that are largely responsible for the great diversity of plants and animals found there. These ecological characteristics also influenced the cultural history and economic development of the region.



- 
- 28** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment.** Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.

The Southern Forest Resource Assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits they provide.

- 
- 29** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment.** Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. [CD-ROM].

The Southern Forest Resource Assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. This CD-ROM includes the entire contents of the print version of the Southern Forest Resource Assessment—25 chapters and an index—in a searchable format.

- 
- 30** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment; summary of findings.** *Journal of Forestry*. 100 (7): 6-14.

The Southern Forest Resource Assessment (SFRA) was initiated in spring 1999 to address broad questions concerning the status, trends, and likely future of southern forests. A descriptive assessment such as SFRA can be used to highlight the major dynamics and uncertainties at play within a region's forested ecosystems, thereby focusing public discourse. Because SFRA has only recently been completed, however, it is too early to examine its effectiveness as a basis for debate and policy. This summary describes five major forces of change affecting southern forests and then characterizes the trends in various forest conditions and their implications.

- 
- 31** Wear, David N.; Greis, John G. 2002. **Southern forest resource assessment; summary report.** Gen. Tech. Rep. SRS-54. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 103 p.

The Southern Forest Resource Assessment (SFRA) provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. This report draws together and synthesizes the detailed findings contained in the SFRA Technical Report (General Technical Report SRS-53). The mechanisms of several forces of change influencing southern forests and their effects on social systems, terrestrial and aquatic ecosystems, and forest health are described. Several broad findings regarding

the future of southern forests and subregions of conservation concern are identified.

## Inventory and Monitoring

---

- 32** Bentley, James W.; Johnson, Tony G.; Becker, Charles W. 2002. **Virginia's timber industry—an assessment of timber product output and use, 1999**. Resour. Bull. SRS-74. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 41 p.

In 1999, roundwood output from Virginia's forests totaled 492 million cubic feet, 8 percent more than in 1995. Mill byproducts generated from primary manufacturers remained stable at 167 million cubic feet. Almost 72 percent of the plant residues were used primarily for fuel and fiber products. Saw logs were the leading roundwood product at 246 million cubic feet; pulpwood ranked second at 175 million cubic feet; composite panels were third at 46 million cubic feet. The number of primary processing plants increased from 289 in 1995 to 290 in 1999. Total receipts increased 1 percent to almost 490 million cubic feet.

- 
- 33** Hartsell, Andrew J.; Brown, Mark J. 2002. **Forest statistics for Alabama, 2000**. Resour. Bull. SRS-67. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 76 p.

This report summarizes a 2000 inventory of the forest resources of Alabama. Major findings are highlighted

in text and graphics; detailed data are presented in 49 tables.

- 
- 34** Howell, Michael; Gober, Jim R.; Nix, J. Stephen. 2002. **Alabama's timber industry—an assessment of timber product output and use, 1999**. Resour. Bull. SRS-75. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 39 p.

In 1999, roundwood output from Alabama's forests totaled 1.2 billion cubic feet. Mill byproducts generated from primary manufacturers amounted to 469 million cubic feet. Almost all plant residues were used primarily for fuel and fiber products. Pulpwood was the leading roundwood product at 641 million cubic feet; saw logs ranked second at 426 million cubic feet; veneer logs were third at 109 million cubic feet. The number of primary processing plants was 181. Total receipts amounted to 1.3 billion cubic feet.

- 
- 35** Johnson, Tony G.; Brown, David R. 2002. **North Carolina's timber industry—an assessment of timber product output and use, 1999**. Resour. Bull. SRS-73. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 39 p.

In 1999, industrial roundwood output from North Carolina's forests totaled 793 million cubic feet, 9 percent less than in 1997. Mill byproducts generated from primary manufacturers increased 1 percent to 311 million cubic feet. Almost all plant residues were used primarily for fuel and fiber products. Saw logs were the leading roundwood product at 422 million

cubic feet; pulpwood ranked second at 272 million cubic feet; veneer logs were third at 61 million cubic feet. The number of primary processing plants declined from 280 in 1997 to 278 in 1999. Total receipts declined 2 million cubic feet to 769 million cubic feet.

- 
- 36** Johnson, Tony G.; Harper, Richard A.; Bozo, Michael J. 2002. **South Carolina's timber industry—an assessment of timber product output and use, 1999.** Resour. Bull. SRS-70. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 34 p.

In 1999, roundwood output from South Carolina's forests totaled 625 million cubic feet, 1 percent less than in 1997. Mill byproducts generated from primary manufacturers declined 2 percent to 197 million cubic feet. Almost all plant residues were used primarily for fuel and fiber products. Pulpwood was the leading roundwood product at 324 million cubic feet; saw logs ranked second at 242 million cubic feet; veneer logs were third at 54 million cubic feet. The number of primary processing plants declined from 92 in 1997 to 90 in 1999. Total receipts declined 5 percent to 587 million cubic feet.

- 
- 37** Johnson, Tony G.; Lowe, Larry. 2002. **Kentucky's timber industry—an assessment of timber product output and use, 1999.** Resour. Bull. SRS-71. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 45 p.

In 1999, roundwood output from Kentucky's forests totaled 220 million cubic feet, 13 percent more than in 1997. Mill byproducts generated from primary manufacturers increased 10 percent to 108 million cubic feet. Ninety-five percent of plant residues were used, primarily for fuel and fiber products. Saw logs were the leading roundwood product at 179 million cubic feet; pulpwood ranked a distant second at 19 million cubic feet; other industrial products were third at 14 million cubic feet. The number of primary processing plants declined from 391 in 1997 to 348 in 1999. Total receipts increased 10 percent to 237 million cubic feet.

- 
- 38** Johnson, Tony G.; Steppleton, Carolyn D. 2002. **Southern pulpwood production, 2000**. Resour. Bull. SRS-69. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 34 p.

In 2000, the South's production of pulpwood declined 6 percent to 66.6 million cords. Roundwood production dropped to 44.4 million cords and accounted for 67 percent of the total pulpwood production. The use of wood residue increased 2 percent to 22.3 million cords. Alabama continued to lead the South in total production, number of mills, and pulping capacity. In 2000, 98 mills were operating and drawing wood from the 13 Southern States. Southern mills' pulping capacity of 130,337 tons per day accounted for more than two-thirds of the Nation's total pulping capacity.

- 
- 39** Johnson, Tony G.; Wells, John L. 2002. **Georgia's timber industry—an assessment of timber product output and use, 1999.** Resour. Bull. SRS-68. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 40 p.

In 1999, industrial roundwood output from Georgia's forests totaled 1.24 billion cubic feet, 3 percent less than in 1997. Mill byproducts generated from primary manufacturers declined 1 percent to 474 million cubic feet. Almost all plant residues were used, primarily for fuel and fiber products. Pulpwood was the leading roundwood product at 594 million cubic feet; saw logs ranked second at 509 million cubic feet; veneer logs were third at 75 million cubic feet. The number of primary processing plants increased from 186 in 1997 to 188 in 1999. Total receipts declined 7 percent to 1.3 billion cubic feet.

- 
- 40** Reams, Gregory A.; McRoberts, Ronald E.; Van Deusen, Paul C., eds. 2001. **Proceedings of the second annual Forest Inventory and Analysis symposium.** Gen. Tech. Rep. SRS-47. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 143 p.

This publication documents progress in developing techniques in remote sensing, statistics, information management, and analysis required for full implementation of the national Forest Inventory and Analysis program's annual forest inventory system.

## Foundation Programs

---

- 41** Floyd, Myron F; Johnson, Cassandra Y. 2002. **Coming to terms with environmental justice in outdoor recreation: a conceptual discussion with research implications.** *Leisure Sciences.* 24: 59-77.

Much of the research on environmental justice centers on environmental hazards. This article offers an overview of the emergence of environmental justice issues in outdoor recreation management and research. The authors argue that a major challenge to future research on environmental justice in outdoor recreation is clarifying definitions of environmental justice and generating awareness of the different dimensions of environmental justice. The authors also examine recent empirical studies of environmental justice issues related to outdoor recreation and other resource amenities. Based on an overview of the literature and these recent studies, the authors set forth some broad outlines to guide future research.

- 
- 42** Grace, J.M., III. 2002. **Effectiveness of vegetation in erosion control from forest road sideslopes.** 45(3): 681-685.

Forest roads have been identified as the major contributor to sediment production from forested lands, accounting for perhaps as much as 90 percent of all sediment produced. In recent years, increased concern and societal pressure has focused on the impacts of forest roads and the effectiveness of erosion control measures. In addition, the re-introduction of native species for erosion control has become a priority



on many forestlands. This study evaluates the effectiveness of a wood excelsior erosion mat, native species vegetation, and exotic species vegetation treatments in erosion control from forest road sideslopes in the Talladega National Forest in Alabama over a 4-year period. In comparison to bare soil control plots, treatments significantly reduced sediment and runoff yield from the road sideslopes. Mean sediment yield from the native species vegetation, exotic species vegetation, and erosion mat treatments were 1.1, 0.45, and 0.80 g m<sup>-2</sup> mm<sup>-1</sup>, respectively. The native species vegetation was as effective as the exotic species vegetation and erosion mat in reducing sediment yield from the forest road sideslopes.

- 
- 43** Perry, Roger W.; Brown, Raymond E.; Rudolph, D. Craig. 2001. **Mutual mortality of great horned owl and southern black racer: a potential risk of raptors preying on snakes.** *Wilson Bulletin*. 113 (3): 345-347.

We encountered a dead southern black racer snake (*Coluber constrictor priapus*) coiled around a dead great horned owl (*Bubo virginianus*). We suggest the owl was strangled by the snake before the snake died of wounds inflicted by the owl. There are previous reports of intense physical struggle between great horned owls (and other raptors) and large constrictors, but this is the first documented report of mutual mortality between a great horned owl and a snake.

- 
- 44** Schelhas, John. 2002. **Activities of the Alabama Consortium on forestry education and research, 1993—1999.** Gen. Tech. Rep. SRS-49. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 32. p.

The Alabama Consortium on Forestry Education and Research was established in 1992 to promote communication and collaboration among diverse institutions involved in forestry in the State of Alabama. It was organized to advance forestry education and research in ways that could not be accomplished by individual members alone. This report tells the story of the consortium's first 8 years, documenting its collaborative projects and accomplishments. It contains the historical record of the development of consortium objectives and priorities, as well as details about collaborative research projects and publications in two areas: socioeconomic relationships between forests and people, and forest operations.

- 
- 45** Schiff, Nathan; Flemming, Anthony J.; Quicke, Donald L. J. 2001. **Spermatodesmata of the sawflies (Hymenoptera: Symphyta): evidence for multiple increases in sperm bundle size.** *Journal of Hymenoptera Research*. 10 (2): 119-125.

We present the first survey of spermatodesmata (bundles of spermatozoa connected at the head by an extracellular "gelatinous" matrix) across the sawfly superfamilies. Spermatodesmata occur in all examined taxa within the sawfly grade (Xyelidae-Orussidae inclusive), but are not found in the Apocrita. Using

DAPI staining, the numbers of individual sperm per spermatodesm were calculated and the values obtained are mapped on to the current phylogenetic hypothesis. The plesiomorphic spermatodesm in the Hymenoptera, based on that observed in the putatively basal family Xyelidae, contains relatively few sperm, approximately 16. However, in the Tenthredinoidea and in the Siricidae, far larger numbers are found, reaching up to 256 in the Cimbicidae.



## Research Work Units

<b>Location &amp; Project Leader</b>	<b>Unit</b>	<b>Name &amp; Web Site</b>	<b>Phone</b>
Asheville, NC David Loftis	4101	Ecology and Management of Southern Appalachian Hardwood Forests <b><a href="http://www.srs.fs.fed.us/bentcreek">www.srs.fs.fed.us/bentcreek</a></b>	828-667-5261
Athens, GA John Stanturf	4104	Disturbance and the Management of Southern Pine Ecosystems <b><a href="http://www.srs.fs.fed.us/disturbance">www.srs.fs.fed.us/disturbance</a></b>	706-559-4315
Athens, GA Kerry Britton	4505	Insects and Diseases of Southern Forests <b><a href="http://www.srs.fs.fed.us/4505">www.srs.fs.fed.us/4505</a></b>	706-559-4285
Athens, GA Ken Cordell	4901	Assessing Trends, Values, and Rural Community Benefits from Outdoor Recreation and Wilderness in Forest Ecosystems <b><a href="http://www.srs.fs.fed.us/trends">www.srs.fs.fed.us/trends</a></b>	706-559-4264
Auburn, AL Charles McMahon	4105	Vegetation Management Research and Longleaf Pine Research for Southern Forest Ecosystems <b><a href="http://www.srs.fs.fed.us/4105">www.srs.fs.fed.us/4105</a></b>	334-826-8700
Auburn, AL Robert Rummer	4703	Biological/Engineering Systems and Technologies for Ecological Management of Forest Resources <b><a href="http://www.srs.fs.fed.us/forestops">http://www.srs.fs.fed.us/forestops</a></b>	334-826-8700
Blacksburg, VA Andrew Dolloff	4202	Coldwater Streams and Trout Habitat in the Southern Appalachians <b><a href="http://www.trout.forprod.vt.edu">www.trout.forprod.vt.edu</a></b>	540-231-4016
Blacksburg, VA Philip Araman	4702	Integrated Life Cycle of Wood: Tree Quality, Processing, and Recycling <b><a href="http://www.srs4702.forprod.vt.edu">www.srs4702.forprod.vt.edu</a></b>	540-231-4016

## Research Work Units

<b>Location &amp; Project Leader</b>	<b>Unit</b>	<b>Name &amp; Web Site</b>	<b>Phone</b>
Charleston, SC Carl Trettin	4103	Center for Forested Wetlands Research <b><a href="http://www.srs.fs.fed.us/charleston">www.srs.fs.fed.us/charleston</a></b>	843-727-4271
Clemson, SC Susan Loeb	4201	Endangered, Threatened, and Sensitive Wildlife and Plant Species in Southern Forests <b><a href="http://www.srs.fs.fed.us/4201">www.srs.fs.fed.us/4201</a></b>	864-656-3284
Coweeta, NC James Vose	4351	Evaluation of Watershed Ecosystem Responses to Natural, Management, and Other Human Disturbances	828-524-2128
Knoxville, TN James Perdue	4801	Forest Inventory and Analysis <b><a href="http://www.srsfia.usfs.msstate.edu">www.srsfia.usfs.msstate.edu</a></b>	865-862-2027
Monticello, AR James Guldin	4106	Managing Upland Forest Ecosystems in the Midsouth <b><a href="http://www.srs.fs.fed.us/4106">www.srs.fs.fed.us/4106</a></b>	870-367-3464
Nacogdoches, TX Ronald Thill	4251	Integrated Management of Wildlife Habitat and Timber Resources <b><a href="http://www.srs.fs.fed.us/wildlife">www.srs.fs.fed.us/wildlife</a></b>	936-569-7981
New Orleans, LA James Granskog	4802	Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management <b><a href="http://www.srs.fs.fed.us/4802">www.srs.fs.fed.us/4802</a></b>	504-589-6652
Pineville, LA James Barnett	4111	Ecology and Management of Even-Aged Southern Pine Forests <b><a href="http://www.srs.fs.fed.us/4111">www.srs.fs.fed.us/4111</a></b>	318-473-7215

## Research Work Units

<b>Location &amp; Project Leader</b>	<b>Unit</b>	<b>Name &amp; Web Site</b>	<b>Phone</b>
Pineville, LA Kier Klepzig	4501	Ecology, Biology, and Management of Bark Beetles and Invasive Forest Insects of Southern Conifers <b><a href="http://www.srs.fs.fed.us/4501">www.srs.fs.fed.us/4501</a></b>	318-473-7232
Pineville, LA Les Groom	4701	Utilization of Southern Forest Resources <b><a href="http://www.srs.fs.fed.us/4701">www.srs.fs.fed.us/4701</a></b>	318-473-7268
Raleigh, NC Steven McNulty	4852	Southern Global Change Program <b><a href="http://www.sgcp.ncsu.edu">www.sgcp.ncsu.edu</a></b>	919-513-2974
Research Triangle Park, NC Kurt Johnsen	4154	Biological Foundations of Southern Forest Productivity and Sustainability <b><a href="http://www.rtp.srs.fs.fed.us/soils/soilhome.htm">www.rtp.srs.fs.fed.us/soils/soilhome.htm</a></b>	919-549-4092
Research Triangle Park, NC Greg Reams	4803	Forest Health Monitoring <b><a href="http://willow.ncfes.umn.edu/fhm/fhm_hp.htm">http://willow.ncfes.umn.edu/fhm/fhm_hp.htm</a></b>	919-549-4014
Research Triangle Park, NC David Wear	4851	Economics of Forest Protection and Management <b><a href="http://www.rtp.srs.fs.fed.us/econ">www.rtp.srs.fs.fed.us/econ</a></b>	919-549-4093
Saucier, MS Floyd Bridgewater	4153	Southern Institute of Forest Genetics	228-832-2747
Starkville, MS Terry Wagner	4502	Wood Products Insect Research <b><a href="http://www.srs.fs.fed.us/termites">www.srs.fs.fed.us/termites</a></b>	662-338-3100
Stoneville, MS Ted Leininger	4155	Center for Bottomland Hardwoods Research <b><a href="http://www.srs.fs.fed.us/cbhr">www.srs.fs.fed.us/cbhr</a></b>	662-686-3154



The Forest Service, United States Department of Agriculture (USDA), is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

The USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410 or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.