Compass–Winter 2001

The Southern Research Station
Recent Publications Catalogue

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Characterizing and Measuring Southern Forested Wetlands

For many of us, the term "forested wetlands" conjures images of cypress knees and Spanish moss, and sounds of birds, frogs, and crickets, either from personal experience or courtesy of movies or music. Naturally, the complexity of the forested wetlands ecosystem extends much wider and goes much deeper. Definitions of forested wetlands can vary considerably. Measuring carbon storage below ground requires a different model from those used in other forested areas. Southern Station scientists and colleagues explore these and other issues in four *Compass* publications.

Forested Wetlands of the Southern United States: A Bibliography describes forested wetland as a variety of habitat types ranging from bottomland hardwood forests to alluvial swamp forests that occur on river floodplains. *Wetland Forest Statistics for the South Atlantic States* presents information about timberland with hydric vegetation, hydric soil, and a wetland hydrology. Mark J. Brown, resource analyst, Greg M. Smith, forester, and Joseph McCollum, mathematical statistician, present findings about area, distribution, and ownership; stand size and age structure; forest management types and detailed forest types; physiography; volume, growth, removals, and mortality; and disturbances, condition, and opportunities.

The authors of *Existing Soil Carbon Models Do Not Apply to Forested Wetlands* evaluated 12 modeling simulations. According to authors C.C. Trettin, B. Song, M.F. Jurgenson, and C. Li, these models fail to assess accurately the cycling of nutrients and elements or carbon dynamics with respect to global change. Although wetlands occupy a relatively small proportion of Earth's terrestrial surface (less than 3 percent), they contain a disproportionate share of the terrestrial carbon pool (15 to 22 percent). Only 3 of 12 models evaluated allow for anaerobic conditions; none contains components for anoxia, ground

water hydrology, multiple organic and physical soil layers, or a daily time-step, all of which are necessary when modeling soil carbon (C) in wet soils. Southern Station scientist Trettin and his co-authors present a wetland soil C model framework. Their proposed synthesis would be appropriate when considering soil C dynamics at multiple spatial scales and where the land area considered includes both wetland and upland ecosystems.

The Southern Research Station published *Forested Wetlands of the Southern United States: A Bibliography*. This comprehensive list of references to varied studies conducted in these forest types could benefit researchers, students, managers, and other interested people. Citations date from 1923 to 2001.

Allen, J.A.; Keeland, B.D.; Stanturf, J.A.; and others. 2001. **A guide to bottomland hardwood restoration.** U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD/ITR–2000-0011; Gen. Tech. Rep. SRS-40. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. 132 p. **(10)**

Brown, Mark J.; Smith, Greg M.; McCollum, Joseph. 2001. **Wetland forest statistics for the South Atlantic States.** Resour. Bull. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 52 p. **(20)**

Conner, William H.; Hill, Nicole L.; Whitehead, Evander M.; and others. 2001. **Forested wetlands of the Southern United States: a bibliography.** Gen. Tech. Rep. SRS-43. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 133 p. **(11)**

Trettin, C.C.; Song, B.; Jurgensen, M.F.; Li, C. 2001. **Existing soil carbon models do not apply to forested wetlands**. Gen. Tech. Rep. SRS-46. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 10 p. **(14)**

Inventorying Southern Forests

The intense national pressure on forests to provide benefits for competing uses exerts its force most heavily in the South. Concern for the sustainability of resources and comparability of data across regional lines factored into the USDA Forest Service’s development of the annual inventory system. Mandated by the Farm Bill of 1998, the Forest Inventory and Analysis (FIA) nationwide program requires the Forest Service to estimate and maintain current forest resources information to provide real-time monitoring of forest ecosystems. The Southern FIA program joins the Southern Research Station and the 13 Southern States’ forestry associations in a strong partnership to survey plots, manage data, perform statistical analyses, and publish reports. *Compass* publications that address Forest Inventory and Analysis include:

Bechtold, William A.; Zarnoch, Stanley J. 1999. **Field methods and data processing techniques associated with mapped inventory plots.** In: Aguirre-Bravo, Celedonio; Franco, Carlos Rodriguez, comp. North American science Symposium: toward a unified framework for inventorying and monitoring forest ecosystem resources. Proceedings RMRS-P-12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 421-424. **(18)**

Brown, Mark J.; Sheffield, Raymond M. 2001. **Forest statistics for North-central Alabama, 2000.** Resour. Bull. SRS-63. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 53 p. **(19)**

Brown, Mark J.; Smith, Greg M.; McCollum, Joseph. 2001. **Wetland forest statistics for the South Atlantic States.** Resour. Bull. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 52 p. **(20)**

Hartsell, Andrew J.; Vissage, John S. 2001. **Forest statistics for North Alabama, 2000.** Resour. Bull. SRS-64. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 50 p. **(21)**

Johnson, Tony G., ed. 2001. **United States timber industry—an assessment of timber product output and use, 1996**. Gen. Tech. Rep. SRS-45. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 145 p. **(22)**

Looking at the Big Picture: the National Assessment and Projection of Forest Resources

You can get a copy of ***Forest Resources of the United States, 1997*** from the USDA Forest Service, North Central Research Station. Research foresters W. Brad Smith, John L. Vissage, David R. Darr, and Raymond Sheffield wrote this document, better known as the forest resources section of the RPA Assessment. Highlights in the ***Forest Resources of the United States, 1997*** include forest land area; timberland area; timber inventories; mortality; growth and removals; removals; and ownership and removals. The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) mandates the periodic assessment of our Nation’s resources managed by the Forest Service.

To request a print version of ***Forest Resources of the United States, 1997*** (GTR NC-219), call 608.231.9237 or send a message to sparisi@fs.fed.us. Mail a written request to Forest Products Laboratory, North Central Distribution Center, USDA Forest Service, One Gifford Pinchot Drive, Madison, WI 53705. If you want to print or review the document, visit http://www.ncrs.fs.fed.us/pubs/gtr/gtr_nc219.pdf.

Co-authors Smith and Darr work in the Forest Service's Washington Office. Smith is with the Science, Policy, Information, and Inventory Staff. Darr is a member of the Resource Valuation and Use Staff. Though John Vissage was a Southern Station scientist for many years, the North Central Station now claims him. Ray Sheffield leads the Resource Analysis Unit of the Southern Station. The authors, all research foresters, acknowledge the contributions of numerous team members who made the ***Forest Resources of the United States, 1997*** such a comprehensive document.

On the Bookshelf

Valuing Wildlife in Southern Forests: Species, Habitat, Culture, and Management

James Dickson, Southern Research Station scientist emeritus, enlisted the help of land managers, field experts, and research scientists to assemble a wealth of knowledge about wildlife on southern forests. ***Wildlife of Southern Forests: Habitat and Management*** addresses the history of the South's natural resources, forest types and physiographic regions, plant and wildlife communities, and management options. The chapters devoted to wildlife species cover the gamut: game species, large carnivores, furbearers, and non-game communities. Contributors provide details about species description, distribution and abundance, population ecology, habitat use, and management. One chapter addresses conflicts between wildlife and humans, and among humans pursuing their wildlife interests. A second chapter discusses wildlife recreation opportunities and preferences.

Two hundred and fifty-one color and black-and-white photos grace the pages of **Wildlife of Southern Forests: Habitat and Management**. The picture of the sandhill crane chick plopped on the ground beside an egg calls for action—you want to help that other little one whose still-encased beak barely pokes out! **Wildlife of Southern Forests: Habitat and Management** includes lists of common and scientific names for the animals and plants in the text, and an index helps guide you. To purchase a copy for $50, visit http://www.hancockhouse.com, send an e-mail to sales@hancockhouse.com, or call 800.938.1114.

Station News

Susan Fox joins the SRS Leadership Team as assistant director for planning and applications. Susan's position includes working with policy and budget leaders in the Forest Service. The responsibility for scientific staff work essential to the long-range planning and application of the Southern Station's multifunctional resource programs rests with Susan. As assistant director for planning and

applications, Susan works with policy and budget leaders in the Forest Service. Her position links her closely to research unit project leaders. Susan's scientific credentials complement her field experience and management skills.

Susan began working in forestry in 1977 in Sewanee, TN, assisting in a soils research project with the USDA Forest Service research work unit. She earned her B.S. degree in forestry from the University of the South. She received her M.S. in forestry from the Albert-Ludwigs University in Freiburg, Germany. While living in Germany, Susan worked in a wide range of jobs, planting and felling trees, conducting forest inventory and marking timber, laying out roads, and conducting deer browse surveys. Susan began her Forest Service career in 1985, as a research assistant to the spruce-fir forest research cooperative in Broomall, PA. She spent three years establishing a quality assurance program as a part of the multi-agency acid rain research program. From 1988 until 1997 she served first as deputy program manager and then as program manager for the Southern Commercial Forest Research Cooperative that shifted focus into the Southern Global Change Program. For the past five years, Susan pursued graduate studies at Duke University and completed a study of long-term effects of agriculture on Southern Piedmont forest soils. Welcome, Susan!

Clark Baldwin, Jr., a research forester with the Southern Research Station and the former Southern Forest Experiment Station, joined the Forest Service's Washington Office as lead silviculturist. Clark served as section head of Information Management for the Southern Station's Forest Inventory and Analysis research unit. He conducted research in Pineville, LA as a member of the Ecology and Management of Even-aged Southern Pine Forests unit. Clark's research produced Forest Service "best sellers" over the years. His focus includes modeling growth and yield of pine trees and stands; understanding and modeling trees and stand structure, especially crown structure in pine stands; linking a process model (MAESTRO) and a growth and yield model (PTAEDA2); and wood quality in managed pine stands. Two of Clark's most recent publications appear in this issue of *Compass*:

Leduc, Daniel J.; Matney, Thomas G.; Belli, Keith L.; Baldwin, V. Clark, Jr. 2001. **Predicting diameter distributions of longleaf pine plantations: a comparison between artificial neural networks and other accepted methodologies.** Res.Pap. SRS-25. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. 18 p. **(2)**

Newbold, Ray A.; Baldwin, V. Clark, Jr.; Hill, Gary. 2001. **Weight and volume determination for planted loblolly pine in North Louisiana.** Res. Pap. SRS-26. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 19 p. **(4)**

Southern Pines Research

Johnsen, K.H.; Butnor, J.R.; Maier, C.; and others. 2001. **Fertilization increases below-ground carbon sequestration of loblolly pine plantations.** In: Proceedings: First national conference on carbon sequestration [CD-ROM]. [Place of publication unknown]. http://www.netl.doe.gov/publicatins/proceedings/01/carbon_seq/carbon_seq01.html. [Date accessed unknown].

The extent of fertilization of southern pine forests is increasing rapidly; industrial fertilization increased from 16,200 ha per year in 1988, to 344,250 ha in 1998. Fertilization increases stand productivity and can increase carbon (C) sequestration by: (1) increasing above-ground standing C; (2) increasing C stored in forest products; and (3) increasing below-ground C pools. This talk will concentrate on the latter and will present summary data from five experiments spatially ranging from the Virginia Piedmont to the Alabama Coastal Plain, and ranging in age from one to 17 years. Fertilization has increased pine growth in all of these studies. In two other studies, fertilization has significantly decreased C losses from the soil as measured via an automated CO_2 efflux system using an infrared gas analyzer. In two more of these studies, soil CO_2 efflux did not differ significantly between control and fertilized plots (means under fertilization were lower though), although below-ground biomass was increased. And in the last study, fertilization increased soil CO_2 efflux by approximately 18 percent; however, fertilization increased below-ground biomass by more than 250 percent. Combined, these studies indicate forest fertilization increases below-ground C sequestration. As forest industry is firmly established in the Southeastern United States, and since soil nutrition is a major limiting factor to tree growth, increasing forest fertilization represents a realistic method to sequester atmospheric C in the short- to long-term. **(1)**

Leduc, Daniel J.; Matney, Thomas G.; Belli, Keith L.; Baldwin, V. Clark, Jr. 2001. **Predicting diameter distributions of longleaf pine plantations: a comparison between artificial neural networks and other accepted methodologies.** Res.Pap. SRS-25. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. 18 p.

Artificial neural networks (NN) are becoming a popular estimation tool. Because they require no assumptions about the form of a fitting function, they can free the modeler from reliance on parametric approximating functions that may or may not satisfactorily fit the observed data. To date there have been few applications in forestry science, but as better NN software and fitting algorithms become available, they may be used to solve a wide variety of problems—particularly problems where the underlying relationship between predicted and predictors is unknown. We benchmark tested an

alternative to the traditional Weibulll probability distribution function, diameter-at-breast-height moment, and direct parameter prediction models for approximating stand-diameter distributions. Using a feedforward backpropagation network, we demonstrated that NN are a somewhat better option. Unlike Weibull approximations, NN solutions cannot easily be mathematically constrained to match known reality constraints, but this difficulty is easy to overcome in practice. **(2)**

Maier, Chris A. 2001. **Stem growth and respiration in loblolly pine plantations differing in soil resource availability.** Tree Physiology. 21: 1183-1193.

Stem respiration and growth in 10-year-old loblolly pine (*Pinus taeda* L.) plantations were measured monthly during the third year of fertilization and irrigation treatments to determine whether soil resource availability differentially altered growth and respiration in stem tissue. Fertilized trees had significantly greater stem biomass, stem nitrogen concentration ([N]) and growth rate than unfertilized trees. Stem respiration (R_t) was significantly greater in fertilized trees when expressed on a per unit surface area ($R_{t,a}$, μmol $CO_2 m^{-2} s^{-1}$), sapwood volume ($R_{t,v}$, μmol $CO_2 m^{-3} s^{-1}$), or mass ($R_{t,w}$, nmol $CO_2 g^{-1} s^{-1}$) basis; however, there was no difference between treatments when expressed as a function of stem N content ($R_{t,n}$, μmol $CO_2 (molN)^{-1} s^{-1}$). Irrigation had no significant effect on R_t, or annual stem growth. Daily total respiration (R_d, mol CO_2 m^{-2} day^{-1}) and stem diameter growth both had a seasonal bimodal pattern with peaks in early spring and midsummer. Stem [N] declined significantly during the growing season. Stem growth rate and [N] explained 75 percent of the seasonal variation in temperature-normalized $R_{t,a}$.

The mature tissue method was used to partition total stem respiration (R_t) into maintenance (R_m) and growth (R_g) components. There was a linear correlation between winter $R_{t,v}$, a measure of basal R_m, and sapwood N content; however, $R_{t,v}$ per unit N was greater in January before diameter growth started than in the following December after growth ceased, indicating that $R_{t,v}$ declined as stem diameter increased. Consequently, estimates of annual maintenance respiration (R_M) based on January data were 44 percent higher than estimates based on December data. Growth respiration was correlated with stem growth rate (r^2 = 0.55). The growth respiration coefficient (r_g)—the slope of the relationship between R_g and stem growth rate—was 0.24. Respiration accounted for 37 percent of annual stem carbon budget. Stem carbon-use efficiency (CUE)—the ratio of stem growth to stem growth plus respiration—averaged 0.63 and was unaffected by fertilization. **(3)**

Newbold, Ray A.; Baldwin, V. Clark, Jr.; Hill, Gary. 2001. **Weight and volume determination for planted loblolly pine in North Louisiana.**

Res. Pap. SRS-26. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 19 p.

The objective of this study was to assess the variability in weight-to-volume relationships in loblolly pine (*Pinus taeda* L.) plantations and to determine predictability based on stand age, site quality, and/or tree size. Tree ages ranged from 11 to 40 years, with diameters to 21 inches and heights to 91 feet. Measured site indices ranged from 45 to 72 at base age 25. A total of 75 planted loblolly pine trees were felled and processed to assess the variability in bole weight to volume relationships. Cubic volume, green weight, and dry weight relationships were investigated; and the predictability of these variables with respect to age, site index, and tree size was determined. **(4)**

Saenz, Daniel; Conner, Richard N.; Rudolph, D. Craig; Eengstrom, R. Todd. 2001. **Is a "hands-off" approach appropriate for red-cockaded woodpecker conservation in twenty-first century landscapes?** Wildlife Society Bulletin. 29(3): 956-966.

The endangered red-cockaded woodpecker *(Picoides borealis) is* well adapted to fire-maintained pine ecosystems of the Southeastern United States. Management practices vary greatly among land ownerships. In some wilderness areas and state parks, a "no management" policy has eliminated use of prescribed fire, artificial cavities, and woodpecker translocation, tools that have proved effective elsewhere in recovering woodpecker populations. We compared forests with essentially "no management" to actively managed forests of similar tree ages and similar red-cockaded woodpecker population demographics. We also compared sites that had received no management in the past to the same sites after management. In every case, populations in forests that did not use state-of-the-art management for woodpeckers declined severely compared to those in managed forests. Because managed forests typically used all available management techniques concurrently, it was not possible to separate and rank effectiveness of specific management activities. One exception was the Wade Tract in Georgia, where prescribed fire was the primary activity for herbaceous layer and hardwood management in a high-density, stable woodpecker population. Wilderness areas, which are intended to be pristine places that preserve biodiversity, are losing red-cockaded woodpeckers, a keystone species in the ecosystem, at an alarming rate. Collectively, 9 groups of red-cockaded woodpeckers were present in 4 wilderness areas in Texas national forests in 1983. At the close of the millennium, only one woodpecker group remained and its continued existence is unlikely without management. The very fragmented features of present-day landscapes and intervention by humans impair the effectiveness of natural disturbance processes, primarily growing-season fire, that historically produced and maintained open pine savannas with grass-forb herbaceous layers in the pre-Columbian forests of the southeastern U.S.; therefore, active management must be used if the red-cockaded woodpecker is to persist. **(5)**

Sanchez, Felipe G. 2001. **Loblolly pine needle decomposition and nutrient dynamics as affected by irrigation, fertilization, and substrate quality.** Forest Ecology and Management. 152: 85-96.

This study examined the effects of initial litter quality and irrigation and fertilization treatments on litter decomposition rates and nutrient dynamics (N, Ca, K, Mg, and P) of loblolly (*Pinus taeda* L.) pine needles in the North Carolina Sand Hills over 3 years. Litter quality was based on the initial C/N ratios, with the high-quality litter having a significantly ($P < 0.001$) lower C/N ratio (143 ± 2.5) compared with the low quality litter (172 ± 1.3). Initial litter quality and the irrigation treatment did not significantly affect decomposition rates but the fertilization treatment effects were significant. Low quality needles on fertilized plots had higher decomposition rates ($k = 0.36 \pm 0.01$ year 1 for the fertilized and irrigated + fertilized plots) than on unfertilized plots ($k = 0.26 \pm 0.01$ and 0.28 ± 0.01 $year^{-1}$ for the control and irrigated plots, respectively). The decomposing litter was a net sink for P and N and a net source of Mg, Ca, and especially K. Whereas initial substrate quality did not affect decomposition rates, it did affect the rate of release. Compared to the low quality litter, the high quality litter released K at a higher rate, released Mg at a lower rate, and accumulated N at a higher rate. Fertilization decreased the rate of release of Mg and K in high-quality litter and Mg and Ca in low quality litter. In addition, fertilization increased the rate of accumulation of P in both. **(6)**

Schmidtling, R.C. 2001. **Southern pine seed sources.** Gen. Tech. Rep. SRS-44. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. 25 p.

The selection of an appropriate seed source is critical for successful southern pine plantations. Guidelines for selection of seed sources are presented for loblolly (*Pinus taeda* L.) slash (*P. elliottii* Engelm.), longleaf (*P. palustris* Mill., Virginia (*P. virginiana* Mill.), shortleaf (*P. echinata* Mill.), and sand [*P. clausa* (Chapm. ex Engelm.) Vasey ex Sarg.] pines. Seed movement guidelines in this handbook are based on climatic similarities between the seed source origin and the planting site. Because yearly average minimum temperature is the most important climatic variable related to growth and survival, it has been used to define the rules of seed movement. This variable, which defines plant hardiness zones, has been used for many years by horticulturists to guide the transfer of plant materials. East-west movement to areas of similar climate is permissible, with the exception of loblolly pine. **(7)**

Strom, B.L.; Goyer, R.A. 2001. **Effect of silhouette color on trap catches of *Dendroctonus frontalis* (Coleoptera: Scolytidae).** Annals of the Entomological Society of America. 94(6): 948-953.

With the exception of responses to semiochemicals, host selection behaviors of *D. frontalis* are largely unstudied. To better understand the host finding behavior of *D. frontalis*, and to identify potential visual disruptants, we evaluated the response of *D. frontalis* to multiple-funnel traps of eight different colors. Multiple-funnel traps provide an attractive vertical silhouette, similar to a host stem, that aids in capturing bark beetles and allows for controlled evaluation of visual cues. Evaluation of mean trap catch of each color by analysis of variance (ANOVA) produced two separate groups: white and yellow traps caught significantly fewer *D. frontalis* than the other six colors tested (black, blue, brown, gray, green, red). Examination of spectral reflectance curves showed that the eight colors could be naturally placed into two groups, those with high peak reflectance (white and yellow) and those with low peak reflectance (black, blue, brown, gray, green, red). When high and low peak reflectance were substituted for color in a separate ANOVA, reflectance group was as good as color at explaining the variability in trap catch (r^2 = 0.88 versus 0.92). Therefore, hue (dominant wavelength) was unimportant in affecting *D. frontalis* host finding behavior at the reflectance levels we tested and, thus, we found no strong evidence that differential wavelength sensitivity affected the response of *D. frontalis*. These results show that dark colored silhouettes (those with low reflectance values), regardless of hue, are best for capturing *D. frontalis*, while white or yellow are the best candidate colors for disrupting host finding. **(8)**

Waldrop, Thomas A.; Welch, Nicole Turrill; Brose, Patrick H.; and others. 2000. **Current research on restoring ridgetop pine communities with stand replacement fire.** In: Yaussy, Daniel A., comp. Proceedings: workshop on fire, people, and the central hardwoods landscape; 2000 March 12-14; Richmond, KY. Gen. Tech. Rep. NE-274. Newton Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 103-109.

Ridgetop pine communities of the Southern Appalachian Mountains historically have been maintained by lightning- and human-caused fires. With fire suppression for several decades, characteristic stands are entering later seral stages. They typically have an overstory of Table Mountain (*Pinus pungens*)and/or pitch pine (*P. rigida*), a midstory of chestnut oak (*Quercus prinus*), scarlet oak (*Q. coccinea*), and blackgum (*Nyssa sylvatica*), and a shrub layer of dense mountain laurel (*Kalmia latifolia*). Previous research suggests that restoration of these communities can be accomplished with the high-intensity fires that open the forest canopy and expose mineral soil. Three recent studies examined plant-community response to high-intensity prescribed fires. A series of corollary studies help to explain some of the results of these field studies. High and medium-

high intensity fires provided adequate sunlight for pines seedlings, whereas medium-low and low intensity fires did not. Post-burn duff was deep and did not vary by fire intensity. We observed sufficient seedling densities to restore pine-dominated stands after all but the highest intensity fires. Many seedlings survived the first growing season as their roots penetrated duff to reach mineral soil. Hardwood rootstocks resprouted on sites treated with all fire intensities and may outcompete pine seedlings for available resources. High-intensity fires may have reduced mycorrhizal abundance and moisture availability for new germinants. Fires of lower intensity than previously recommended or multiple fires of very low-intensity may best provide conditions for pine regeneration, but additional research is needed. **(9)**

Wetlands, Bottomland Hardwoods, and Streams Research

Allen, J.A.; Keeland, B.D.; Stanturf, J.A.; and others. 2001. **A guide to bottomland hardwood restoration.** U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD/ITR–2000-0011; Gen. Tech. Rep. SRS-40. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, NC. 132 p.

During the last century, a large amount of the original bottomland hardwood forest area in the United States has been lost, with losses greatest in the Lower Mississippi Alluvial Valley and East Texas. With a holistic approach in mind, this manual describes methods to restore bottomland hardwoods in the lower Midwest, including
The Lower Mississippi Alluvial Valley and the Southeastern United States. Bottomland hardwoods in this guide include not only the hardwood species that predominate in most forested floodplains of the area, but also
the softwood species such as baldcypress that often co-occur. General restoration planning considerations are discussed, as well as more specific elements of bottomland hardwood restoration, such as species selection, site preparation, direct seeding, planting of seedlings, and alternative options for revegetation. We recognize that
most projects will probably fall more within the realm of reforestation or afforestation rather than a restoration, as some site preparation and the planting of seeds or trees may be the only actions taken. Practical information needed to restore an area is provided in the guide, and it is left up to the restorationist to decide how complete the restoration will be. Postplanting and monitoring considerations are also addressed. Restoration and management of existing forests are included because of the extensive areas of degraded natural forests in need of rehabilitation. **(10)**

Conner, William H.; Hill, Nicole L.; Whitehead, Evander M.; and others. 2001. **Forested wetlands of the Southern United States: a bibliography.** Gen. Tech. Rep. SRS-43. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 133 p.

The term forested wetland covers a variety of forest types, including mangroves, cypress/tupelo swamps, bottomland hardwoods, pocosins and Carolina bays, flatwoods, and mountain fens. These forests are dominated by woody species that have morphological features, physiological adaptations, and/or reproductive strategies enabling them to achieve maturity and reproduce in an environment where the soils within the rooting zone may be inundated or saturated for various periods during the growing season. Although alluvial floodplains occur along most streams of the United States, they are most extensive in the Atlantic Coastal Plain, Gulf Coastal Plain, and Mississippi Alluvial Plain. Only about half of the original floodplain forests remained by the 1930s, and conversion to agriculture continued at an accelerated pace during the 1960s and 1970s. The purpose of this bibliography is to provide a detailed listing of references for students and researchers of the varied studies conducted in these forest types. **(11)**

Goelz, J.C.G.; Meadows, J.S.; Fristoe, T.C. 2001. **Development of water tupelo coppice stands on the Mobile-Tensaw River delta for five years after precommercial thinning and cleaning.** Southern Journal of Applied Forestry. 25(4): 165-172.

Three 4-yr-old stands (or locations) were selected for treatment. Treatment consisted of two components: (1) thinning water tupelo (*Nyssa aquatica* L.) stump sprouts and (2) cutting all stems of Carolina ash (*Fraxinus caroliniana* Mill.) and black willow (*Salix nigra* Marsh.) (cleaning). Contrary to results in other areas, survival of water tupelo coppice was very high and was not affected by the treatments. Cleaning had little or no positive effect on the individual tree or stand-level variables we measured. Thinning sprout clumps significantly increased diameter growth of water tupelo; the effect of thinning was considerably larger for one location. Stand basal area growth was decreased by thinning sprout clumps. However, quadratic mean diameter was increased by thinning, particularly at one location. Although thinning decreased basal area 5 yr after treatment, the increase in quadratic mean diameter was sufficient for there to be no significant effect of thinning on total volume 5 yr after treatment. Because of this, and in anticipation of imminent natural thinning of the unthinned plots, we suspect that the thinned plots will eventually have significantly greater standing volume than the unthinned plots, at least for the location where density of large sprouts was initially the highest. Rotation age will be decreased for that stand because stems will achieve merchantable size sooner. Thus we consider precommercial thinning of sprout clumps to be a potentially effective practice in stands with a high density of large water tupelo sprouts. **(12)**

Meadows, James S.; Burkhardt, E.C.; Johnson, Robert L.; Hodges, John D. 2001. **A numerical rating system for crown classes of southern hardwoods.** Southern Journal of Applied Forestry. 25(4): 154-158.

A numerical rating system to delineate crown classes of southern hardwoods is described. The system is based on four criteria: (1) amount of direct sunlight from above, (2) amount of direct sunlight from the sides, (3) crown balance, and (4) relative crown size. The total point value assigned places the tree within one of the four crown classes. The rating system can be used to train inexperienced hardwood foresters and
should give experienced foresters a better grasp of those factors important in hardwood crown classification. Time required to evaluate a tree varies by tree, by stand conditions, and by observer, but experienced users of the system can easily rate most trees in 30-45 seconds. The rating system is particularly useful in situations where an individual tree appears to be borderline between two crown classes. For researchers, the system provides: (1) an expression of individual-tree crown characteristics, and (2) documentation of changes in crown position and condition. In two tests comparing the numerical rating system with the conventional crown classification system, use of the rating system consistently improved the ability of participants to correctly identify crown classes. Dominant and suppressed trees were the easiest to assess with the numerical rating system, whereas codominant and intermediate trees were the most difficult. Agreement between participants and experts in identification of crown classes increased with the level of the participants' forestry knowledge and experience. In one test, a group of participants attending a continuing-education hardwood short course,
but with little to moderate hardwood experience, correctly identified the crown class of 78 percent of the trees after
only one hour of training. **(13)**

Trettin, C.C.; Song, B.; Jurgensen, M.F.; Li, C. 2001. **Existing soil carbon models do not apply to forested wetlands**. Gen. Tech. Rep. SRS-46. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 10 p.

When assessing the biological, geological, and chemical cycling of nutrients and elements—or when assessing carbon dynamics with respect to global change—modeling and simulation are necessary. Although wetlands occupy a relatively small proportion of Earth’s terrestrial surface (< 3 percent), they contain a disproportionate share of the terrestrial carbon pool (15 to 22 percent). Models that do not accurately represent wetland soil processes cannot, therefore, provide reasonable simulations. We evaluated 12 widely used soil C models to determine their applicability to wetland ecosystems: CANDY, CENTURY,

DAISY, DNDC, ITE, MBL-GEM, NCSOIL, QSOIL, ROTHC, SOMM, VVV, and WMEM. Only three (CENTURY, DNDC, and WMEM) allow for anaerobic conditions; none contains components for anoxia, ground water hydrology, multiple organic and physical soil layers, or a daily time-step, all of which are necessary when modeling soil C in wet soils. Accordingly, for any land area that includes wetlands, none of the individual models would produce reasonable simulations based on soil process. We present a wetland soil C model framework based on desired attributes, the DNDC model, and components of the CENTURY and WMEM models. Our proposed synthesis would be appropriate when considering soil C dynamics at multiple spatial scales and where the land area considered includes both wetland and upland ecosystems. **(14)**

Southern Appalachians Research

Greenberg, Cathryn H.; Lanham, J. Drew. 2001. **Breeding bird assemblages of hurricane-created gaps and adjacent closed canopy forest in the Southern Appalachians.** Forest Ecology and Management. 154: 251-260.

We studied breeding bird assemblages in forest gaps created in 1995 by Hurricane Opal at the Bent Creek Experimental Forest in Asheville, NC. We hypothesized that forest gaps and adjacent closed-canopy forest would differ in bird density, richness, diversity, and relative abundances of some species. To test this hypothesis we censused breeding bird assemblages for 2 years in 12 gaps (0.1-1.2 ha) and 12 adjacent closed canopy controls using strip transects. Gaps had more coarse woody debris, shrub cover, brush piles, and pit and mound microtopography than controls. Canopy cover was lower in gaps than controls, but remained high (69.4 ± 2.1 percent versus 89.6 ± 1.7 percent). Bird assemblage similarity was high. Total density and species richness of birds were higher in gaps than in controls, but species diversity did not differ between treatments. Shrub (primarily Carolina Wrens) and bark-foragers, and cavity shrub and canopy-nesters were more abundant in gaps than in controls. Densities of gap-associated (indigo bunting, hooded warbler, Carolina wren) and edge (eastern towhee) species were more abundant in gaps. Abundance of interior species including red-eyed vireo and scarlet tanager were about equal in gaps and controls. Only Ovenbirds were more abundant in controls than gaps. Species that require larger patches of young second-growth forest, such as prairie warbler, and yellow-breasted chat, did not occur in gaps; but neither are they abundant in the Asheville basin. No brown-headed cowbirds were observed in gaps or controls. Unpublished data indicate that parasitism of artificial ground nests did not occur, and predation rates did not differ between gaps and controls. Juvenile birds and other evidence of breeding were observed more often in gaps than in controls, suggesting that gaps attract bird families for foraging and provide microsites that attract breeding pairs. Gap size was positively correlated with bird density,

species richness, and diversity. This study suggests that small openings and interior edge habitat created by treefall gaps within a forested matrix do not adversely affect breeding birds as measured by the abundance of individual species or community indices. We suggest that canopy gaps increase avian diversity at a landscape scale by providing habitat patches for some species that require young, second-growth forest, and serve as magnets for recruitment and foraging. **(15)**

Interior Highlands Research

Burr, Brooks M.; Adams, Ginny L.; Krejca, Jean K.; and others. 2001. **Troglomorphic sculpins of the *Cottus carolinae* species group in Perry County, Missouri: distribution, external morphology, and conservation status.** Environmental Biology of Fishes. 62: 279-296. [Editor's note: Southern Research Station scientist Melvin L. Warren, Jr. co-authored this publication.]

The existence of cavernicolous sculpin (here allocated to *Cottus carolinae,* banded sculpin, and referred to as grotto sculpin), in the karst regions of Perry County, MO, first came to our attention in 1991. Examination of 35 caves in Missouri, 96 in Illinois, 17 in Tennessee, 2 in Indiana, and 11 in Arkansas revealed that banded sculpin are common in cave habitats; however, grotto sculpin are limited to two karst areas of Perry County, MO, where they are known from only six cave systems. These caves and their streams are extensive and apparently provide a unique habitat compared to other karst systems; this may be a critical factor in the present restricted distribution of the grotto sculpin. Grotto sculpin occupy pools and riffles of cave streams, and occur over a variety of substrates, from sediment to breakdown. Density estimates in Mystery and Running Bull caves were 0.29 and 0.63 individuals m^{-2}, respectively. Grotto sculpin have small eyes (1-6 percent SL vs. 6-10 percent SL in epigean samples), significantly reduced pigmentation (including nearly complete loss of dorsal saddles), a reduction in pelvic fin ray number (from 4 + 4 elements to often 4 + 3, or 3 + 3), and enlarged cephalic lateralis pores (e.g., mandibular pores of cavernicolous samples are 2-3 times those of epigean stream samples). Multivariate analyses of body shape revealed statistically significant separation of epigean and hypogean samples, with eye size highly variable, but smallest in the Running Bull Cave population. We interpret these results as representative of losses associated with long-term cave habitation. Caves of Perry County provide ample habitat for grotto sculpin, but because the caves are located downgradient of the city of Perryville and an intensively farmed landscape, point and non-point source pollution threaten their continued existence. Escape of farm-pond fishes through the extensive sinkhole network in Perry County has increased potential predation pressure on grotto sculpin by channel catfish, *Ictalurus punctatus,* and other species normally excluded from cave environments. **(16)**

Large Scale Assessment and Modeling Research

Yuancai, Lei; Parresol, Bernard R. 2001. **Remarks on height-diameter modeling.** Res. Note SRS-10. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 5 p.

Height-diameter model forms in earlier published papers are examined. The selection criteria used in height-diameter model forms are not reasonable when considering tree biological growth pattern. During model selection, forms for height-diameter relationships should include consideration of both data-related and reasonable biological criteria, not just data-related criteria. A reasonable model form should possess the S-shaped functional properties of monotonic increment ($dy/dt > 0$), inflection point ($d^2y/dt^2 = 0$), and asymptotical value ($y \rightarrow$asymptote as $t \rightarrow \infty$), rather than the concave shaped, functional properties. The S-shaped models are best when appropriate data are collected (data sets containing early growth). The Bertalanffy-Richards and Schnute functions are recommended for modeling height-diameter relationships, and an example contrasts the fit of the sigmoidal Schnute function against the concave Meyer function. **(17)**

Inventory and Monitoring Research

Bechtold, William A.; Zarnoch, Stanley J. 1999. **Field methods and data processing techniques associated with mapped inventory plots.** In: Aguirre-Bravo, Celedonio; Franco, Carlos Rodriguez, comp. North American science Symposium: toward a unified framework for inventorying and monitoring forest ecosystem resources; 1998 November 2-6; Guadalajara, Mexico. Proceedings RMRS-P-12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 421-424.

The U.S. Forest Inventory and Analysis (FIA) and Forest Health Monitoring (FHM) programs utilize a fixed-area mapped-plot design as the national standard for extensive forest inventories. The mapped-plot design is explained, as well as the rationale for its selection as the national standard. Ratio-of-means estimators are presented as a method to process data from mapped inventory plots.

It is particularly timely that we have convened to develop a sampling framework for forest ecosystems that is unified across the entire North American continent. In the United States we have been engaged in a similar effort to standardize our inventory system for the past decade. The purpose of this paper is to describe the sampling design

implemented nationally in the United States, provide background information about how this design evolved, explain how the resulting data can be processed, and describe our experience with this design since its implementation in 1991. **(18)**

Brown, Mark J.; Sheffield, Raymond M. 2001. **Forest statistics for North-central Alabama, 2000.** Resour. Bull. SRS-63. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 53 p.

This report summarizes a 2000 inventory of the forest resources of a 15-county area of Alabama. Major findings are highlighted in text and graphics; detailed data are presented in 49 tables. **(19)**

Brown, Mark J.; Smith, Greg M.; McCollum, Joseph. 2001. **Wetland forest statistics for the South Atlantic States.** Resour. Bull. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 52 p.

Twenty-one percent, or 17.6 million acres, of the timberland in the South Atlantic States was classified as wetland timberland. Sixty percent of the region's wetland timberland was under nonindustrial private forest ownership. Forty-eight percent of the region's wetland timberland was classified as sawtimber-sized stands. Lowland hardwood types made up 62 percent of the wetland timberland. Thirty-one percent of the wetland timberland occurred on a flatwoods physiography. Wetland timberland contained 30 billion cubic feet of growing-stock volume, 24 percent of the region's total. Removals from wetland timberland averaged 842 million cubic feet, 20 percent of the region's total. The two greatest impacts to wetland timberland were natural disturbance and final harvest, which averaged 375 and 295 thousands annually, respectively. **(20)**

Hartsell, Andrew J.; Vissage, John S. 2001. **Forest statistics for North Alabama, 2000.** Resour. Bull. SRS-64. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 50 p.

This report summarizes a 2000 inventory of a 10-county area of Alabama. Major findings are highlighted in text and graphics; detailed data are presented in 49 tables. **(21)**

Johnson, Tony G., ed. 2001. **United States timber industry—an assessment of timber product output and use, 1996**. Gen. Tech. Rep. SRS-45. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 145 p.

This report is a compilation of timber product output for the United States and the five Resources Planning Act regions for 1996, and is a companion report to the Forest Resources of the United States, 1997. Roundwood output from the Nation's forest totaled 16.4 billion cubic feet, 8 percent less than in 1991. Saw logs were the leading roundwood product at 7.1 billion cubic feet; pulpwood ranked second at 5.2 billion cubic feet; and veneer logs were third at 1.3 billion cubic feet. The South supplied 58 percent of the Nation's timber product output and had 7 of the top 10 producing States. Softwood species accounted for 61 percent of output, and nonindustrial private forest owners supplied 60 percent of the Nation's roundwood products. Mill byproducts generated from primary manufacturers totaled 6.1 billion cubic feet. Only 2 percent of the mill residues were not used. Mill residue was used primarily for fuel and fiber products. **(22)**

Foundation Programs Research

Butnor, J.R.; Doolittle, J.A.; Kress, L.; and others. 2001. **Use of ground-penetrating radar to study tree roots in the Southeastern United States.** Tree Physiology. 21: 1269-1278. [Editor's Note: Southern Research Station scientist Kurt Johnsen co-authored this publication.]

The objectives of our study were to assess the feasibility of using ground-penetrating radar (GPR) to study roots over a broad range of soil conditions in the Southeastern United States. Study sites were located in the Southern Piedmont, Carolina Sandhills and Atlantic Coast Flatwoods. At each site, we tested for selection of the appropriate antenna (400 MHz versus 1.5 GHz), determined the ability of GPR to resolve roots and buried organic debris, assessed root size, estimated root biomass, and gauged the practicality of using GPR. Resolution of roots was best in sandy, excessively drained soils, whereas soils with high soil water and clay contents seriously degraded resolution and observation depth. In the Carolina Sandhills, 161 x 1-m plots were scanned with the 1.5 GHz antenna using overlapping grids. Plots were subsequently excavated, larger roots (> 0.5 cm diameter) sketched on graph paper before removal, and all roots oven-dried, classified by size, and weighed. Roots as small as 0.5 cm in diameter were detected with GPR. We were able to size roots (0.5 to 6.5 cm in diameter) that were oriented perpendicular to the radar sweep (r^2 = 0.81, P = 0.0004). Use of image analysis software to relate the magnitude of radar parabolas to actual root biomass resulted in significant correlations (r^2 = 0.55, P = 0.0274). Orientation and geometry of the reflective surface seemed to have a greater influence on parabola dimensions than did root size. We conclude that the utility of current GPR technology for estimating root biomass is site-specific, and that GPR is ineffective in soils with high clay or water content and at sites with rough terrain (most forests). Under particular soil and site conditions, GPR appears to be useful for augmenting traditional biomass sampling. **(23)**

Butry, David T.; Mercer, D. Evan; Prestemon, Jeffrey P.; and others. 2001. **What is the price of catastrophic wildfire?** Journal of Forestry. (99)11: 9-17.

We modeled and analyzed the economic impacts of the six weeks of large, catastrophic wildfires in northeastern Florida in June and July 1998, among Florida's most devastating in recent history. The result of the unusually strong El Nino–Southern Oscillation (ENSO) in 1998, the Florida wildfires produced economic impacts of at least $600 million, similar in scale to recent category-2 hurricanes. Improved understanding of the interactions between management, wildfire, and its costs may yield large payoffs to society by identifying optimal intervention activities. **(24)**

Fonseca, Teresa J.F.; Parresol, Bernard R. 2001. **A new model for cork weight estimation in Northern Portugal with methodology for construction of confidence intervals.** Forest Ecology and Management. 152: 131-139.

Cork, a unique biological material, is a highly valued non-timber forest product. Portugal is the leading producer of cork with 52 percent of the world production. Tree cork weight models have been developed for Southern Portugal, but there are no representative published models for Northern Portugal. Because cork trees may have a different form between Northern and Southern Portugal, equations developed with southern data do not always predict well in the North. An analysis of eight tree variables revealed the interaction between tree circumference (outside bark at 1.3 m) (CSC) and debarking height (H_{DEB}) to be the best predictor variable. A nonlinear exponential function was chosen over a simple linear function due to a slight curvature exhibited in the plot of weight over CSC $\times$ H_{DEB}. The paper concludes with a section on construction and use of confidence intervals about the mean and individual predictions from the nonlinear regression, plus a method to place bounds on an aggregate estimate for a stand. **(25)**

Haines, Terry K.; Busby, Rodney L.; Cleaves, David A. 2001. **Prescribed burning in the South: trends, purpose, and barriers.** Southern Journal of Applied Forestry. 25(4): 149-153.

The results of a survey of fire management officials concerning historical and projected prescribed burning activity in the South are reported. Prescribed burning programs on USDA Forest Service and private and State-owned lands are described in terms of area burned by ownership and State, intended resource benefits, barriers to expanded burning, and optimum burning area needed to achieve resource management goals. More than 4.1 million ac/yr of pine-type forest were

burned between 1985 and 1994, about 6.5 percent of the area in pine-type forest per year. **(26)**

Hunter, William C.; Buehler, David A.; Canterbury, Ronald A.; and others. 2001. **Conservation of disturbance-dependent birds in eastern North America.** Wildlife Society Bulletin. 29 (2): 440-455. [Editor's note: Paul B. Hamel, Southern Research Station scientist, co-authored this publication.]

Populations of most bird species associated with grassland, shrub-scrub habitats, and disturbed areas in forested habitats (hereafter all referred to as disturbance-dependent species) have declined steeply. However, a widespread perception exists that disturbance-dependent species are merely returning to population levels likely found by the first European explorers and settlers. The fact that many disturbance-dependent bird species and subspecies are now extinct, globally rare, threatened, or endangered challenges that perception and raises the question of balance between conservation efforts for birds dependent upon disturbances and birds more closely associated with mature forests. An overall understanding of the status and trends for these disturbance-dependent species requires reconstruction of at least thousands of years of Native American land use followed by 500 years of post-European settlement. Interpretations herein on how to manage for these disturbance-dependent species should support efforts to conserve all landbirds in Eastern North America. **(27)**

Lee, Sang-Mook; Abbott, A. Lynn; Schmoldt, Daniel L. 2001. **Wane detection on rough lumber using surface approximation.** In: Kline, D. Earl; Abbott, A. Lynn., tech. eds. Proceedings: 4th international conference on image processing and scanning of wood; IPSW 2000; 2000 August 21-23; Mountain Lake, VA. Blacksburg, VA: Virginia Tech, Department of Wood Science and Forest Products: 89-96.

The initial breakdown of hardwood logs into lumber produces boards with rough surfaces. These boards contain wane (missing wood due to the curved log exterior) that is removed by edge and trim cuts prior to sale. Because hardwood lumber value is determined using a combination of board size and quality, knowledge of wane position and defects is essential for selecting cuts that maximize profit. We have developed a system that uses a structured-light system to obtain profile (thickness) images of unplaned boards, in addition to gray-scale images for defect detection. The focus of this paper is to describe a new approach for detecting wane boundaries through the analysis of these
profile images. The problem is difficult because bark and other debris adversely affect the laser-based imaging process, and because variations in surface reflectance also cause inaccuracies in the resulting images. The problem is compounded by the need to perform wane detection rapidly in a manufacturing environment. The method that we have developed relies on a combination of column-wise image

statistics, selective smoothing, and the analysis of surface shape. Initial wane edge estimates that are obtained using the smoothed image are then refined by analysis of the original image data. Based on visual assessment, the current method appears to improve dramatically on traditional thresholding techniques. **(28)**

Parresol, Bernard R. 2002. **Biomass.** In: El-Shaarawi, Abdel H.; Piegorsch, Walter W. Encyclopedia of Environmetrics. Chichester: John Wiley & Sons, Ltd.: 196-198.

Biomass, the contraction for biological mass, is the amount of living material provided by a given area or volume of the earth's surface, whether terrestrial or aquatic. Biomass is important for commercial uses (e.g., fuel and fiber) and for national development planning, as well as for scientific studies of ecosystem productivity, energy and nutrient flows, and for assessing the contribution of changes in forest lands (especially tropical) to the global carbon cycle. **(29)**

Selgrade, James F.; Roberds, James H. 2001. **On the structure of attractors for discrete, periodically forced systems with applications to population models.** Physica D. 158: 69-82.

This work discusses the effects of periodic forcing on attracting cycles and more complicated attractors for autonomous f systems of nonlinear difference equations. Results indicate that an attractor for a periodically forced dynamical system may inherit structure from an attractor of the autonomous (unforced) system and also from the periodicity of the forcing. In particular, a method is presented which shows that if the amplitude of the k-periodic forcing is small enough, then the attractor for the forced system is the union of k homeomorphic subsets. Examples from population biology and genetics indicate that each subset is also homeomorphic to the attractor of the original autonomous dynamical system. **(30)**

Trani, Margaret K.; Brooks, Robert T.; Schmidt, Thomas L.; and others. **Patterns and trends of early successional forests in the Eastern United States.** Wildlife Society Bulletin. 29 (2): 413-424. [Editor’s note: Victor A. Rudis, Southern Research Station scientist, co-authored this publication.]

We assessed the status of early successional forest conditions for 33 Eastern States within the New England, Middle Atlantic, Great Lakes, Central Plains, Coastal South, and Interior South subregions. We used Forest Inventory and Analysis surveys to analyze trends from 1946 to 1998. Dramatic regional differences occurred in distribution of early successional forests. The northeastern region had the least proportion of young forest (16 percent), followed by the north-central (24 percent), and southern (29 percent) regions. The least amount of young

forest occurred in the Central Plains (15 percent) and New England (16 percent), whereas the greatest occurred in the pine-dominated Coastal South (32 percent). Differences also existed among individual States, ranging from 3 percent (Illinois) to 38 percent (Alabama). Long-term declines also were evident within the northeastern and north-central regions. Selective harvesting, fire suppression, urban sprawl, and cessation of agricultural abandonment contributed to the present imbalance in distribution of young forests. Private ownership predominates in the East and presents a significant challenge to provide young forests. Absence of proactive management on private lands may promote continued declines in early successional forest within many eastern areas. **(31)**

Troggio, M.; Kubisiak, T.L.; Bucci, G.; Menozzi, P. 2001. **Randomly amplified polymorphic DNA linkage relationships in different Norway spruce populations.** Canadian Journal of Forest Research. 31: 1456-1461.

We tested the constancy of linkage relationships of randomly amplified polymorphic DNA (RAPD) marker loci used to construct a population-based consensus map in material from an Italian stand of *Picea abies* (L.) Karst. in 29 individuals from three Norwegian populations. Thirteen marker loci linked in the Italian stand did show a consistent locus ordering in the Norwegian population. The remaining 16 unlinked marker loci were spread over different linkage groups and (or) too far apart both in the population map and in this study. The limited validity of RAPD markers as genomic "hallmarks" resilient across populations is discussed. We also investigated the reliability of RAPD markers; only 58 percent of the RAPD markers previously used to construct the consensus map in the Italian population were repeatable in the same material. Of the repeatable ones, 76.3 percent were amplified and found polymorphic in 29 megagametophyte sibships from three Norwegian populations. **(32)**

Vose, James M.; Maass, Jose Manuel. 1999. **A comparative analysis of hydrologic responses of tropical deciduous and temperate deciduous watershed ecosystems to climatic change.** In: Aguirre-Bravo, Celedonio; Franco, Carlos Rodriguez, comp. North American science Symposium: toward a unified framework for inventorying and monitoring forest ecosystem resources; 1998 November 2-6; Guadalajara, Mexico. Proceedings RMRS-P-12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 292-298.

Long-term monitoring of ecological and hydrological processes is critical to understanding ecosystem function and responses to anthropogenic and natural disturbances. Much of the world's knowledge of ecosystem responses to disturbance comes from long-term studies on gaged watersheds. However, there are relatively few long-term sites due to the large cost and commitment required to establish and maintain them. Knowledge gained from these sites is also important for

predicting responses to future disturbances, such as climatic change, and these sites should be the focal point for the development and validation of predictive models. In this study, we apply a hydrologic model (PROSPER) using climate, vegetation, and soil parameters from watersheds in the mesic Southeastern United States and in the dry tropical forests of Western Mexico to assess the overall effects of climatic change (increased temperature and [CO_2]) on watershed hydrology. We found that evapotranspiration (ET) increased substantially in both ecosystem types, with increases ranging from 24 to 42 percent. These increases were directly attributable to changes in leaf energy balance and evaporative demand. Streamflow decreased more substantially, with virtually no streamflow under the greatest temperature increase scenario (+20 percent) at the site in Western Mexico. Decreased stomatal conductance was not sufficient to offset the effects of increased temperature. **(33)**