

COMPASS

Recent Publications  
of the Southern Research Station

Spring 2003

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.usda.gov](http://www.srs.fs.usda.gov)**) 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.

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## Roads Connect and Disconnect

Ecological impacts from roads may be the rule rather than the exception for most of the United States, according to **Kurt Riitters**, deputy program manager of the Southern Research Station's Forest Health Monitoring unit in Research Triangle Park, NC. Riitters teamed up with U.S. Environmental Protection Agency (EPA) scientist James Wickham to measure just how close land in the United States is to the nearest road. In *How Far to the Nearest Road?* the authors state that in 2001, according to U.S. Department of Transportation (DOT) data, the continental United States contained approximately 6.3 million kilometers of public roads, nearly a quarter of which were classified as non-local roads in rural areas. For the same year, the EPA estimated that the same area contained 5.3 million kilometers of streams and rivers.

"The comparison of these two sets of data begins to give you an idea of the potential influence of roads on forest ecosystems," said Riitters. "Effects of roads—what we call influence zones—extend tens to hundreds of meters from the roads themselves, altering habitats and water drainage patterns, disrupting wildlife movement, introducing exotic plant species, and increasing noise levels."

The land development that follows roads out into rural areas usually leads to more roads, an expansion process that only ends at natural or legislated barriers. Unlike streams, which shape and are shaped by the land, roads are shaped by economic demands. "The road network is designed to connect places efficiently in human terms," said Riitters. "Roads often cross

natural boundaries rather than going around, creating new patterns of movement within ecosystems. Though there is extensive research on how roads impact ecosystems at the site level, there is not much information about roads in relation to ecosystems at the regional level.”

To analyze nearness of roads at the regional scale, Riitters and Wickham used four different maps of landcover, roads, watersheds, and ecoregions. After converting the road map to generate a road-distance grid, they prepared data summaries by overlaying the road-distance grid with the other three maps and tabulating road distances by landcover type, watershed, or ecoregion. The researchers made separate estimates for total land area and for forest land area, in recognition that roads play a key role in forest fragmentation in the United States. Results showed that 20 percent of all land area was located within 127 meters (417 feet) of the nearest road, and 50 percent was within 382 meters (1253 feet). Only 18 percent of United States land area was more than 1000 meters (0.6 mile) from a road, and only 3 percent was more than 5000 meters (3.1 miles) away. Overall, forest land was slightly more remote than other landcover types, but the data followed similar trends.

“Imagine that the United States has been divided into 8.6 billion parcels the size of a baseball diamond infield, and that you could stand on home plate in each of these parcels,” said Riitters. “According to our model, in one out of every 22 cases there would be a road no further away from you than second base. In one in five cases, the road is no further away than the

center field fence. While the actual size of a road influence zone depends on local circumstances, the sheer pervasiveness of roads means that few places in the United States are immune to their influences.”

**Johnny Grace**, Southern Station research engineer, examines forest roads’ contribution to erosion and stream sedimentation and how to minimize these problems. Grace, a member of the Forest Operations unit in Auburn, AL, identifies concentrated flow, reduced infiltration, increased slopes, removal of surface cover, and interception of subsurface flow as factors that contribute to increased erosion potential of forest roads. In *Sediment Movement from Forest Road Systems*, Grace recommends planning as perhaps the most important way to decrease erosion and sedimentation. Grace says, “Based on what we know about the accelerated erosion potential of roads, minimizing road construction should be a major consideration in forest management. The planning process should consider all possible alternatives to road construction. Environmentally sensitive road designs plan for water quality by considering removing runoff from the road surface at a non-erosive velocity.”

In the late 1950s, the forest floor was recognized as a filter of sediment-laden runoff by virtue of increased filtration rates, infiltration capacity, and surface roughness, factors which reduce the erosive energy of storm runoff. The forest floor can provide a buffer zone (filter strip) to minimize sediment delivery to streams. Downslope gradient, soil erosive hazard, and obstructions influence the capacity of the forest floor to act as a filter. Grace notes that a gap exists in the understanding of how factors influence sediment travel distances downslope and, more importantly, the

influence of time on sediment travel distances. The bulk of work investigating sediment travel distances and minimum filter strip widths considers only short-term effects. Forest best management practices (BMPs) relative to roads assume that the forest floor efficacy in filtering road runoff never diminishes. As sediment deposition accumulates, however, these areas lack the ability to adequately filter and detain road runoff. State forestry programs often effectively use BMPs to protect stream water quality. Applying BMPs to watershed protection proves more challenging, and Grace recommends alternative approaches to reducing sediment transport to downslope streams.

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- 14** Grace, Johnny McFero III. 2002. **Sediment movement from forest road systems—roads: a major contributor to erosion and stream sedimentation.** American Society of Agricultural Engineers : 13-14.

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- 33** Riitters, Kurt H.; Wickham, James D. 2003. **How far to the nearest road?** *Frontiers in Ecology and the Environment*. 1 (3): 125-129.

## Southern Station Time Capsule

*Forest Science in the South* summarizes the Southern Station's accomplishments, emerging research issues, products, and collaborative efforts for the period October 1, 2001 to September 30, 2002. Our scientists created opportunities to deliver and exchange



knowledge through presentations at professional meetings and refereed and Station publications, the Southern Appalachian Hypertext Encyclopedia debuted on our Web site, and conservation education intern contacts reached 3,000. The Station distributed more than \$9,000,000 in research awards and grants to universities, States, and other Federal agencies. Our long-term collaboration with Alabama A&M University for the Forest Service's multicultural recruitment initiative brought unique reward—the Society of American Foresters accredited the University's forestry program. Alabama A&M is the first historically black university to achieve this standing.

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- 39** USDA Forest Service, Southern Research Station. 2003. **Forest science in the South.** Science Update SRS-004. Asheville, NC: USDA Forest Service, Southern Research Station. 121 p.

## Station News

### **Taking Control of Invasive Plants**

The invasion of exotic plants presents one of the greatest challenges to the Southern landscape. Jim Miller, Southern Research Station research ecologist, and Larry Nelson, Clemson University, present *Terrestrial Plant Invasions in the Temperate South: the Problem, Consequences, and Taking Control*. The two day workshop tackles these issues:

- Defining roles and responsibilities of Federal and State governments and the horticulture and arboriculture industries
- Identifying prevalent invasive species and associated problems and consequences
- Developing vegetation management strategies
- Monitoring and mapping invasive plant infestations
- Planning and enacting a control-restoration program
- Establishing information networks to share knowledge

Miller and Nelson organized the workshop to appeal to a wide audience, including landowners, land managers and administrators, Extension specialists, plant science educators and researchers, landscape architects, and policy regulators. *Terrestrial Plant Invasions in the Temperate South: the Problem, Consequences, and Taking Control* meets June 4-5 in Greenville, SC. For more information, go to [www.clemson.edu/extfor](http://www.clemson.edu/extfor). Call 864-656-4842 or 864.656.0606 for more information.

## Changing Places

Paula Spaine serves as acting project leader for the Insects and Diseases of Southern Forests unit in Athens, GA. A plant pathologist, Paula's research interests include population studies of fusiform rust and spore morphogenetic studies of fusiform rust. Her hardwood research focuses on butternut disease resistance screening and nutrient recycling in dogwood populations. Kerry Britton, former project leader for the Athens unit, has accepted the position of plant

pathologist for the Forest Health Protection program in the Forest Service's Washington office.  
Congratulations, Paula and Kerry!



## Southern Pine Ecosystems

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- 1 Berisford, C. Wayne; Grosman, Donald M., eds. 2002. **The Nantucket pine tip moth: old problems, new research.** Proceedings of an informal conference, the Entomological Society of America, annual meeting. 1999 December 12-16. Gen. Tech. Rep. SRS-51. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 68 p.

The Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock), has become a more prevalent pest in the South as pine plantation management has intensified. The Pine Tip Moth Research Consortium was formed in 1995 to increase basic knowledge about the moth and to explore ways to reduce damage. A conference was held in 1999 at the Entomological Society of America annual meeting in Atlanta, GA to review recent research on the moth. Papers presented at the conference included work on damage assessment (impact) and a review of previous attempts to quantify tip moth damage; interactions of the moth with different forest management practices and the relationship with intensive management; effects of herbicide and insecticide use on tip moth parasitoids; evaluations of different types of insecticides for tip moth control; methods for optimizing chemical control through more precise timing; potential for augmenting tip moth egg parasites by releases of laboratory-reared parasitic wasps; a review of the potential opportunities for using pheromone traps to predict tip moth infestation density and damage; and evaluations of different pheromone trap designs and lures.

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- 2 Brockway, Dale G.; Lewis, Clifford E. 2003. **Influence of deer, cattle grazing, and timber harvest on plant species diversity in a longleaf pine bluestem ecosystem.** *Forest Ecology and Management*. 175: 49-69.

Despite a recent slowing in the negative historical trend, losses of naturally-regenerated longleaf pine forests currently continue, largely as a result of conversion to plantations of faster growing pine species. Comparing the impacts of type conversion with silvicultural approaches that maintain longleaf pine and ascertaining their interaction with the influence of other resource management practices, such as grazing, on plant species diversity are essential in discerning the effects of these activities on the long-term sustainability of these ecosystems. A flatwoods longleaf pine bluestem ecosystem, which naturally regenerated following timber harvest during the early 20th century, on the Coastal Plain of Southern Alabama was thinned to a residual basal area of 17 m<sup>2</sup>/ha or clearcut, windrowed, and planted with slash pine (*Pinus elliottii*) seedlings in 1972 and then fenced in 1977 to differentially exclude grazing by deer and cattle. Neither grazing by deer alone nor deer in combination with cattle significantly altered vascular plant cover or species diversity; however, substantial differences were noted between the understory plant communities in the thinned forests and clearcut areas. Woody understory vegetation steadily increased through time, with woody plant cover in clearcuts (41 percent) dominated by the tree seedlings of *Pinus elliottii* and *Quercus* spp. being greater than that in thinned forests (31 percent) which were dominated by shrubs, principally *Ilex glabra*. While grass cover

dominated by *Schizachrium scoparium* and *Andropogon* spp. remained stable (~81 percent), the foliar cover of all forbs declined through time (from 42 to 18 percent) as woody plant cover increased. Although the overall species richness and diversity declined and evenness increased through time, understory species richness and diversity were consistently higher in thinned forests than in artificially-regenerated clearcuts. Despite a modest short-term decline in this differential, indicating a partial recovery of the clearcut areas over time, the disparity in understory plant diversity between thinned forests and clearcuts persisted for at least a decade. Whether grazing includes domestic cattle or is limited to native ungulates, such as white-tailed deer, we recommend that longleaf pine forests *not* be clearcut and replaced by plantations of other pines, if the ecological diversity is to be conserved, high quality habitat is to be maintained, and longleaf pine ecosystems are to be sustained.

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- 3 Cain, Michael D.; Shelton, Michael G. 2003. **Effects of alternative thinning regimes and prescribed burning in natural, even-aged loblolly-shortleaf pine stands: 25 year results.** Southern Journal of Applied Forestry. 27 (1): 18-29.

In Southeastern Arkansas, pine growth was monitored for 19 years after mechanically strip thinning a dense, naturally regenerated, even-aged stand of 6-year-old loblolly pines (*Pinus taeda* L.) and shortleaf pines (*P. echinata* Mill.) that averaged 16,600 stems/ac. Prescribed winter burns were conducted biennially between ages 9 and 20 years and at 24 years. Commercial thinnings during the 17th and 23rd

growing seasons left a residual stocking of either 85 ft<sup>2</sup>/ac or 200 crop trees/ac (7.5 ft<sup>2</sup>/ac) in merchantable-sized (>3.5 inches d.b.h.) pines on plots that were precommercially thinned and on plots that were not. Precommercial thinning enhanced pine growth in d.b.h. and sawlog volume through 25 years. Because of increased sawlog production, present net value averaged highest on plots that were precommercially thinned at age 6, then commercially thinned during the 17th year to 200 crop trees/ac, and during the 23rd year to 7.5 ft<sup>2</sup>/ac. In the year following prescribed winter burns, both d.b.h. growth and volume growth were reduced by about one-half when crown scorch was 75 percent.

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- 4 Conner, Richard N.; Shackelford, Clifford E.; Schaeffer, Richard R. [and others]. 2002. **Avian community response to southern pine ecosystem restoration for red-cockaded woodpeckers.** *Wilson Bulletin*. 114 (3): 324-332.

The effects of red-cockaded woodpecker (*Picoides borealis*) management on nontarget birds is not widely known. Intensive management for pine specialists such as the red-cockaded woodpecker may negatively impact both Nearctic-Neotropical and temperate zone migrants associated with hardwood vegetation. To evaluate possible positive and negative associations, we surveyed cavity tree clusters and mature forest control sites in longleaf pine (*Pinus palustris*) and loblolly (*P. taeda*)-shortleaf (*P. echinata*) pine habitats. In general, sites managed for red-cockaded woodpeckers supported more diverse and numerous bird populations than mature forest control sites.



During the breeding season in loblolly-shortleaf and longleaf pine habitats, respectively, species richness was 47 percent and 23 percent greater, avian abundance was 57 percent and 65 percent greater, and bird species diversity was 25 percent and 21 percent greater within managed red-cockaded woodpecker cluster sites than within control sites. During winter, species richness and avian abundance each were 52 percent higher within managed red-cockaded woodpecker cluster sites than control sites in loblolly-shortleaf pine habitat.

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- 5 Fraedrich, Stephen W.; Dwinell, L. David. 2003. **An evaluation of dazomet incorporation methods on soil-borne organisms and pine seedling production in southern nurseries.** Southern Journal of Applied Forestry. 27 (1): 41-51.

The use of dazomet as a fall and spring fumigant for pine seedling production and control of soilborne pests was evaluated at two southern nurseries. Dazomet was applied at low (280-325 kg/ha) and high (493-560 kg/ha) rates and incorporated with a rototiller or spading machine. Comparisons were made with methyl bromide/chloropicrin (MBC) fumigation and nonfumigated control treatments. Dazomet incorporation method had no effect on seedling density at either nursery, and often did not affect seedling morphological characteristics. At the Georgia (GA) nursery, seedling density and morphological characteristics did not differ among fumigant treatments, except in the spring study area where shoot weight was greater in the MBC treatment than the dazomet or nonfumigated control treatments. In

the study area at the North Carolina (NC) nursery, seedling density was greater in the high-rate dazomet treatment than the nonfumigated control. Seedlings were generally larger in MBC and dazomet treatments than the control. Seedling density and morphological characteristics did not differ among fumigation treatments in the spring study area. Fumigation with MBC or dazomet generally reduced the percentage of roots with *Pythium* and *Fusarium* spp. compared to controls at the GA nursery and the fall fumigation area in the NC nursery. Plant parasitic nematodes were found infrequently at both nurseries and did not differ among treatments. Nutsedge (*Cyperus* spp.) was the major problem at the GA nursery and was effectively controlled only with MBC. Compared to the MBC treatment, the abundance of soilborne fungi and the association of certain types of Trichoderma with roots was often lower in the dazomet treatments. The importance of these differences for long-term seedling production and management of soilborne diseases is not known at this time.

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- 6 Greenberg, Cathryn H.; Neary, Daniel G.; Harris, Larry D. 1994. **A comparison of herpetofaunal sampling effectiveness of pitfall, single-ended, and double-ended funnel traps used with drift fences.** Journal of Herpetology. 28 (3): 319-324.

We assessed the relative effectiveness of pitfalls, single-ended, and double-ended funnel traps at 12 replicate sites in sand pine scrub using drift fence arrays. Pitfalls captured fewer species but yielded more individuals of many species and higher average species richness than funnel traps. Pitfalls and funnel traps exhibited

differential capture bias, probably due to differences in behavior or morphology. More surface-active lizards, frogs, and small semifossorial herpetofaunal species were captured in pitfalls, whereas captures of large snake species were restricted to funnel traps. Double-ended funnel traps captured twice as many large snakes as single-ended funnel traps. All three trap types yielded similar estimates of relative abundance of lizards and frogs but not snakes. Estimates of relative abundance of large snakes were higher for double-ended funnel traps than pitfalls or single-ended funnel traps. Pitfall and funnel traps yield complementary results, and choice of type(s) depends on target species and sampling goals.

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- 7 Greenberg, Cathryn H.; Neary, Daniel G.; Harris, Larry D. 1994. **Effect of high-intensity wildfire and silvicultural treatments on reptile communities in sand-pine scrub.** *Conservation Biology*. 8 (4): 1047-1057.

We tested whether the herpetofaunal response to clearcutting followed by site preparation was similar to high-intensity wildfire followed by salvage logging in sand-pine scrub. Herpetofaunal communities were compared in three replicated 5- to 7-year post-disturbance treatments and mature sand-pine forest. The three disturbance treatments were (1) high-intensity wildfire, salvage-logging, and natural regeneration; (2) clearcutting, roller-chopping, and broadcast-seeding; and (3) clearcutting and bracke-seeding. Animals were trapped over a 14-month period using pitfall traps with drift fences. Microhabitat features were measured along line transects. Because

amphibian (frog) occurrence appeared to be unaffected by treatment, this paper focuses only on reptile communities. Six species of lizards and one snake species were numerically dominant. Reptile species richness, diversity, and evenness did not differ among treatments or mature forest. Species composition differed markedly, however, between mature forest and disturbance treatments. Typical open scrub species such as *Cnemidophorus sexlineatus*, *Sceloporus woodi*, and *Eumeces egregius* were dominant in high-intensity burn, roller-chopped, and bracke-seeded stands but scarce in mature forest; they were positively correlated with bare sand and other microhabitat features typical of open scrub. Conversely, *Eumeces inexpectatus* was most abundant in mature forest and was correlated with ground litter and other features typical of mature forest. With respect to the species sampled, especially the lizards (including endemic species) of open scrub, clearcutting appeared to mimic high-intensity wildfire followed by salvage-logging by creating microhabitat features such as bare sand. In a mirror image of the usual concept, forest maturation historically served as the fragmenting agent of an extensive open-scrub landscape matrix that was maintained by high-intensity wildfire. Hence, the patchwork of age classes created by current clearcutting patterns could serve as a barrier to lizard dispersal and impede metapopulation dynamics. The absence of a true control (unsalvaged burns) suggests caution in interpreting the results of this study.

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- 8 Greenberg, Cathryn H.; Neary, Daniel G.; Harris, Lawrence D.; Linda, Steven P. 1995. **Vegetation recovery following high-intensity wildfire and**

**silvicultural treatments in sand pine scrub.** American Midland Naturalist. 133: 149-163.

We hypothesized that clear-cutting mimics natural high-intensity disturbance by wildfire followed by salvage logging in sand pine scrub, and tested whether vegetation adapted to recovery from fire would respond similarly to another type of biomass removal. We measured plant community composition and structural characteristics in three replicated disturbance treatments and in mature sand pine forest (MF). Treatments were: (1) high-intensity burn, salvage logged, and naturally regenerated (HIBS); (2) clear-cut, roller-chopped, and broadcast-seeded (RC); and (3) clear-cut and bracke-seeded (BK). All treatments were sampled 5-7 years post disturbance. Nonwoody plant species richness and diversity were significantly lower in MF than in disturbance treatments. Ruderal species were more abundant in HIBS and RC, but not to the exclusion of the characteristic suite of native scrub species. Shrub richness and diversity did not differ, but some species responded differently among treatments. Differences may be due to season of disturbance or rhizome depth (e.g., *Serenoa repens* (Bartr.) Small vs. *Sabal etonia* Swingle ex Nash.). Oak stem density was significantly lower in HIBS and RC. Most structural characteristics were similar in HIBS, RC, and BK but differed from MF. Results suggest that many scrub species responded similarly to aboveground biomass removal and the consequent structural and microclimatic conditions across these disturbance types. We suggest that plant resiliency traits, which evolved in response to the selective pressures of high-intensity disturbance and harsh environmental conditions, confer resiliency to human-caused disturbance as well. Mechanical

biomass removal may be a suitable ecosystem management practice where burning is impractical. Due to the absence of a “virgin” (unsalvaged) burn treatment or pretreatment data and the short-term scope of this study, interpretation of results should be made with caution.

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- 9 Greenberg, Cathryn H.; Thomas, Michael C. 1995. **Effects of forest management practices on terrestrial coleopteran assemblages in sand pine scrub.** Florida Entomologist. 78 (2): 271-285.

Coleopteran assemblages were sampled monthly for one year using pitfall traps in replicated sites of three 5- to 7-year-old disturbance treatments and mature forested sand pine scrub in the Ocala National Forest, Marion County, Florida. Disturbance treatments were (1) burning at high-intensity and salvage-logging; (2) clearcutting, roller-chopping, and broadcast seeding; and (3) clearcutting and bracke-seeding. Community similarity of coleopterans was high. No differences in species richness, diversity, density, or evenness were detected. Of 40 species captured, only seven were common ( $n > 50$ ). Predaceous beetles were numerically dominant, followed by scavengers. Few xylophagous or herbivorous coleopterans were captured, probably due to trap bias. Peaks of annual above-ground terrestrial activity varied among species. An absence of differences among treatments may reflect similar plant communities or structural habitat features. Additionally, a dearth of mature forest specialists might be predicted in systems where mature forest was historically rare due to large-scale, high-intensity, and low-frequency wildfire.

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- 10 Horn, Scott; Hanula, James L. 2002. **Life history and habitat associations of the broad wood cockroach, *Parcoblatta lata* (Blattaria: Blattellidae) and other native cockroaches in the Coastal Plain of South Carolina.** *Annals of Entomological Society of America*. 95 (6): 665-671.

Wood cockroaches (Blattaria: Blattellidae) are important prey of the red-cockaded woodpecker, *Picoides borealis* Wilson (Piciformes: Picidae), an endangered species inhabiting pine (*Pinus* spp.) forests in the Southern United States. These woodpeckers forage on the boles of live pine trees, but their prey consists of a high proportion of wood cockroaches, *Parcoblatta* spp., that are more commonly associated with dead plant material. Consequently, we sampled large woody debris, logs, and standing dead trees (snags), in a South Carolina pine forest to determine densities of wood cockroaches in these habitats. Nearly 50 percent of the 662 wood cockroaches we collected from woody debris were found in snags. However, when we estimated the number of wood cockroaches per hectare, we found that the two habitats contained approximately equal numbers because logs are more abundant than snags. The broad wood cockroach, *Parcoblatta lata* Brunner, was the most common cockroach on live pine boles, constituting 46 percent of the wood cockroaches. Males were present from late April to late July in field studies, suggesting that *P. lata* has only one generation per year, which is consistent with laboratory studies in which males lived an average of 91.3 days. Female *P. lata* lived almost twice as long (158.2 days) and produced an average of 12.6 oothecae/female (SE = 3.4) or  $\approx 517$  offspring/female. Although *P. lata* were common on boles of live trees,

our results show that snags and logs also are important habitats of these wood cockroaches in pine forests.

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- 11** Klepzig, Kier D.; Walkinshaw, Charles H. 2003. **Cellular response of loblolly pine to wound inoculation with bark beetle-associated fungi and chitosan.** Res. Pap. 30. Asheville, NC: USDA Forest Service, Southern Research Station. 9 p.

We inoculated loblolly pines with bark beetle-associated fungi and a fungal cell wall component, chitosan, known to induce responses in some pines and many other plants. Trees in Florida were inoculated with *Leptographium procerum*, *L. terebrantis*, *Ophiostoma minus*, or chitosan. Trees in Louisiana were inoculated with *O. minus*, *Entomocorticium* sp. A, or *Ceratocystiopsis ranaculosus*. In both Florida and Louisiana, mechanical wounds served as controls. Treatment responses were sampled after 3 weeks, and all produced uniform responses across trees. Inoculations with *E. sp. A* and *C. ranaculosus* appeared similar to controls. Inoculations with *L. procerum* produced slightly higher levels of host damage. Loblolly pine responded similarly to chitosan and pathogenic bark beetle-associated fungi (*O. minus* and *L. terebrantis*), producing high levels of phenolic compounds and cell hydrolysis in the callus. In addition, callus inoculated with *O. minus* appeared extremely disrupted and “stringy.” Chitosan inoculations resulted in no hydrolysis, but produced extremely high levels of phenolics deposition, as well as noticeable periderm formation. Our results reveal possible morphological mechanisms for pine secondary response to these fungi and suggest that chitosan may



have potential as a stable material for testing variability in this response.

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- 12** Miller, Daniel R. 2002. **Short-range horizontal disruption by verbenone in attraction of mountain pine beetle (Coleoptera: Scolytidae) to pheromone-baited funnel traps in stands of lodgepole pine.** Journal of Entomological Society of British Columbia. 99: 103-105.

Verbenone interrupted the attraction of mountain pine beetle, *Dendroctonus ponderosae* Hopkins, to baited multiple-funnel traps at a distance of <4 m. Catches of beetles in traps placed  $\geq 4$  m from traps with verbenone were not significantly lower than catches in control traps. These results are consistent with the short-range phenomenon of “switching” exhibited by mountain pine beetle in the formation of a spot infestation in stands of lodgepole pine.

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- 13** Rideout, Sandra; Rickard, James K.; Wade, Dale D. 2003. **Preliminary response of herbaceous plants to biennial burning cycles applied at different dates during the growing season.** Natural Areas Journal. 23: 38-42.

The increase in acreage treated with growing-season fire during the past decade indicates that there has been increased interest in burning to enhance southern pine forest health and diversity. Information on how burn dates within the growing season can be manipulated to vary the mix of species is of practical

importance. The objective of this study was to determine the response of herbaceous and woody plants to eight 3-week treatment application windows during a biennial growing-season burn cycle at the Piedmont National Wildlife Refuge in Georgia, USA. Early results indicate other environmental factors, particularly lack of precipitation, had a greater impact on vegetation than prescribed burning.

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- 14** Saenz, Daniel; Conner, Richard N.; McCormick, James R. 2002. **Are pileated woodpeckers attracted to red-cockaded woodpecker cavity trees?** *Wilson Bulletin*. 114 (3): 291-296.

Pileated woodpeckers (*Dryocopus pileatus*) cause damage to red-cockaded woodpecker (*Picoides borealis*) cavity trees in the form of cavity enlargement or other excavations on the surface of the pine tree. However, it is not known whether pileated woodpeckers excavate more frequently on red-cockaded woodpecker cavity trees than on noncavity trees or how stand structure is related to the frequency of pileated woodpecker excavation. Also, it is unclear whether the cavity itself provides the stimulus to pileated woodpeckers to excavate or whether the presence of red-cockaded woodpeckers and their activities are attracting them. We surveyed all of the red-cockaded woodpecker cavity trees (n = 202) and 110 control trees in the loblolly (*Pinus taeda*)-shortleaf (*P. echinata*) pine habitat on the Angelina National Forest for recent pileated woodpecker excavation and found that approximately 7.4 percent of all cavity trees were damaged, while no control trees showed any evidence of pileated woodpecker damage. The rate of

piledated woodpecker excavation was negatively associated with hardwood midstory height and density. Piledated woodpeckers appeared to focus most of their excavations on red-cockaded woodpeckers cavity entrances. We suggest that piledated woodpeckers may be attracted to red-cockaded woodpecker cavity trees, especially the cavity, and that midstory removal used to improve red-cockaded woodpecker habitat may increase the incidence of damage to the cavity trees by piledated woodpeckers in the current fragmented landscape.

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- 15** Strom, B.L.; Clarke, S.R.; Roton, L.M. 2003. **Attraction of *Ips avulsus* (Eichoff) to varying enantiomeric composition of ipsdienol in commercially available lures.** Journal of Entomological Society. 38 (1): 137-139.

Three major species of *Ips* bark beetles (Coleoptera: Scolytidae) in the Southeastern United States, *I. avulsus* (Eichoff), *I. calligraphus* (Germar), and *I. grandicollis* (Eichoff), attack all species of pines in their range, sometimes causing significant tree mortality.

Coincident with region-wide drought, pine mortality due to *Ips* has been severe throughout the Southeastern United States in recent years. For example, losses in 1999 were estimated at about U.S. \$13 million dollars, second only to the southern pine beetle in value lost from insect-caused mortality.

Before effective monitoring, management, or research programs can be developed and implemented for *Ips* beetles in the Southeast, effective lures must be identified for each species. Ipsdienol has been identified as an aggregation pheromone for *I. avulsus*.

In addition, the enantiomeric composition of ipsdienol

appears to be important. The primary aggregation pheromone for *I. avulsus* was identified as (-)-ipsdienol, while its antipode was found to be an antiaggregant. Managers and researchers alike are uncertain about which lures should be used to trap this species. An experiment was conducted in Florida, Louisiana, and Texas, so the results could be generalized at least across the southern geographic range of *I. avulsus*. The experiment demonstrates that *I. avulsus* is attracted to the racemic ipsdienol lures in combination with lanierone. When using commercial products, monitoring of this species should proceed with the racemic lure, saving money from the more enantiomerically pure 97 percent (-) lure while capturing far more individuals. Further experiments must be done to elucidate the relative importance of the (+) enantiomer as an aggregant versus its (-) antipode as an antiaggregant. The notion that the (-) enantiomer of ipsdienol is the active aggregation component for *I. avulsus* and that the (+) enantiomer is an antiaggregant is apparently incorrect when deployed in combination with lanierone.

## Wetlands, Bottomlands, and Streams

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- 16** Baker, Terrell T., III; Lockaby, B. Graeme; Conner, William H. [and others]. 2001. **Leaf litter decomposition and nutrient dynamics in four southern forested floodplain communities.** Soil Science Society of America Journal. 65 (4): 1334-1347.

Decomposition of site-specific litter mixtures was monitored for 100 weeks in four floodplain

communities: (1) a mixed oak community along the Cache River in Central Arkansas; (2) a sweetgum (*Liquidambar styraciflua* L.)-cherrybark oak (*Quercus falcata* var. *pagodaefolia* Ell.) community along Iatt Creek in Central Louisiana; (3) a sweetgum-swamp tupelo (*Nyssa sylvatica* var. *biflora* (Walt.) Sarg.) community; and (4) a laurel oak (*Quercus laurifolia* Michx.) community along the Coosawhatchie River in Southeastern South Carolina. Soil temperature, hydroperiod, and litter quality (C:N, C:P, N:P, lignin:N) were used to interpret differences in the rates of mass loss and nutrient dynamics. After 100 weeks, litter mixtures retained 33, 18, 8, and 5 percent of original mass on the Cache, Coosawhatchie (laurel oak community), Coosawhatchie (sweetgum-swamp tupelo community), and Iatt floodplains, respectively, and these differences appeared related to hydroperiod. Decay rates were comparable to rates reported in similar floodplain environments. Net mineralization of both N and P was observed after 100 weeks, but both elements accumulated in litter mixtures periodically. Differences in hydroperiod were observed among the four floodplain communities and decomposition of and nutrient mineralization from litter among them appeared to be inversely related to the number and duration of flood events. Litterbags containing leaf litter of a single-species (i.e., cherrybark oak) were also monitored on three of the four sites to compare decay rates and nutrient dynamics with the litter mixtures. On the Cache River floodplain, slower decay of poorer quality cherrybark oak litter suggested that litter quality drove decomposition under similar edaphic conditions.

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- 17 Burke, Marianne K.; Chambers, Jim L. 2003. **Root dynamics in bottomland hardwood forests of the Southeastern United States Coastal Plain.** Plant and Soil. 250: 141-153.

Effects of flooding on root dynamics appear nonlinear and therefore difficult to predict, leading to disparate and often contradictory reports of flooding impacts on production in bottomland hardwood forests. We explored root dynamics in two adjacent wetland habitats by comparing results obtained from several methods of estimating root processes. Also, we tested the influence of flooding on root dynamics of cherrybark, overcup, water, and swamp chestnut oaks. Fine root biomass in the laurel oak habitat was greater ( $\alpha < 0.05$ ) than in the swamp tupelo habitat (5.7 vs. 2.4 Mg ha<sup>-1</sup>), as was fine root necromass (2.4 vs. 1.3 Mg ha<sup>-1</sup>), productivity (2.3 vs. 0.3 Mg ha<sup>-1</sup> yr<sup>-1</sup> when the sum of significant increments method was used, 5.6 vs. 2.5 Mg ha<sup>-1</sup> yr<sup>-1</sup> when the maximum minus minimum method was used, and 1.2 vs. 1.0 Mg ha<sup>-1</sup> yr<sup>-1</sup>, when the root screen method was used), and turnover (40 percent and 12 percent per year). Mortality estimates were lower in the laurel oak habitat (1.3 and 1.2 Mg ha<sup>-1</sup> yr<sup>-1</sup>) than in the swamp tupelo community (2.8 and 2.1 Mg ha<sup>-1</sup> yr<sup>-1</sup>) when significant increment and maximum minus minimum methods were used, respectively. This apparent contradiction between estimates of production and mortality may be due to more rapid decomposition rates in the more aerated soil of the laurel oak than in the swamp tupelo forest type. Roots in the swamp tupelo habitat appeared to be longer lived than in the laurel oak habitat. We concluded that there was greater investment in roots in the laurel oak habitat,

where a shallow rooting zone and episodes of flooding and drought required drastic changes in root structure and physiology. In contrast, the swamp tupelo habitat had a deeper rooting zone and more consistently moist-to-flooded hydroperiod, allowing flood-adapted roots to persist. The four oak species varied in their phenology of root production and response to flooding, from no difference among treatments for overcup oak to dramatic reductions in root growth during and after flooding for cherrybark oak. Flooding enhanced or at least did not negatively influence root growth in overcup oak, but seriously impacted root growth and survival of cherrybark oak and swamp chestnut oak. Different responses were attributed to the timing of root production: root growth began early for cherrybark oak so spring flooding severely affected this species. Growth in overcup oak began later and ended earlier than the other species tested, allowing the species a means of avoiding flood stress.

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- 18** Grace, Johnny McFero III. 2002. **Sediment movement from forest road systems—roads: a major contributor to erosion and stream sedimentation.** American Society of Agricultural Engineers : 13-14.

Nonpoint source pollution is a major concern related to natural resource management throughout the United States. Undisturbed forest lands typically have minimal erosion, less than 0.13 ton/acre (0.30 ton/hectare), due to the increased cover and surface roughness found in these areas. However, disturbances caused by forest management practices can result in accelerated erosion losses and stream sedimentation. Forest management activities were identified by the

Clean Water Act of 1977 as source activities for nonpoint source pollution. Soil erosion and sedimentation resulting from forest operations remain a concern in forest management. Activities with the potential to have detrimental impacts on water quality due to soil erosion and sediment delivery to stream systems are road activities, harvesting, site preparation, fertilization and fire management.

Environmentally sensitive road designs are designs that plan for water quality by considering removing runoff from the road surface at non-erosive velocity. A gap exists in the understanding of how factors influence sediment travel distances of downslope and, more importantly, the influence of time on sediment travel distances. Perhaps the most effective manner to reduce the impact of road systems on water quality is increasing the detention time for road runoff, allowing soil particles time to drop out of suspension. Two types of information are critical to further development of environmentally acceptable road systems: (1) factors influencing sediment travel distances downslope of forest roads; and (2) determination of the portion of sediment leaving road systems actually delivered to downslope streams.

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- 19** Haag, Wendell R.; Warren, Melvin, L., Jr. 2003. **Host fishes and infection strategies of freshwater mussels in large Mobile Basin streams, USA.** Journal of North American Benthological Society. 22 (1): 78-91.

We investigated host fishes, timing, and modes of glochidial release, and host-attraction strategies for 7 species of freshwater mussels from the Buttahatchee



and Sipsev rivers (Mobile Basin), Alabama and Mississippi, USA. We determined hosts as fish species that produced juvenile mussels from laboratory-induced glochidial infections. We established the following primary mussel/host relationships: *Elliptio arca* with *Etheostoma artesiae* and *Percina nigrofasciata*; *Fusconaia cerina* with 6 species of minnows (Cyprinidae); *Lampsilis ornata* with *Micropterus salmoides*; *Medionidus acutissimus* with 8 species of darters (Percidae); *Obovaria unicolor* with *Ammocrypta beani*, *A. meridiana*, and *Ethoeostoma artesiae*; *Pleurobema decisum* with *Cyprinella venusta*; and *Quadrula asperata* with *Ictalurus punctatus*. For most mussel species, host use was similar to that of closely related species, indicating that, in general, this trait is highly conserved at the generic level. Four mussel species used host-attraction strategies that targeted their specific host fish. *Fusconaia cerina* and *P. decisum* released glochidia in conglutinates that elicited feeding responses from fishes in the field and in the laboratory. Gravid female *Lampsilis ornata* and *M. acutissimus* displayed mantle lures. Host-attraction strategies were less apparent for *E. arca* and *Q. asperata* but these species released glochidia in association with copious mucous secretions, which may serve to entangle fishes, facilitating host infection. No host-attraction strategy was apparent for *O. unicolor*.

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- 20** Michael, J.L. 2003. **Environmental fate and impacts of sulfometuron on watersheds in the Southern United States.** Journal of Environmental Quality. 32: 456-465.

Dissipation of sulfometuron (SM), methyl 2-[[[(4,6-dimethyl-2 pyrimidinyl)amino]carbonyl]amino]sulfonyl] benzoate, in streamflow, sediment, plant tissue, litter, and soil following operational forestry applications at the target rate of 0.42 kg a.i. ha<sup>-1</sup> was monitored. Streamflow samples were collected at a weir on the perimeter and 30, 60, and 150 m downstream from the perimeter of the application site. Sulfometuron was detected in streamflow at low levels up to 29 days after treatment (DAT) on the watershed treated with the 75 percent dispersible granule formulation (Oust; DuPont Chemical Company, Wilmington, DE) and less than 53 DAT on the watershed treated with the experimental formulation (1 percent pellet). Twenty-four-hour average SM concentration in water ranged from not detected to a maximum of 49.3 µg L<sup>-1</sup>. Sulfometuron was not detected at quantifiable levels (1 µg L<sup>-1</sup>) 150 m downstream. Stream sediment, vegetation, litter, and soil were sampled periodically up to 180 DAT. All samples were analyzed for SM by high performance liquid chromatography. Sulfometuron dissipated from these watersheds with half-lives that ranged from 4 days in plant tissues to 33 days in soil. Acidic soil solution on these treated watersheds contributed to their rapid dissipation. Environmental impacts are discussed for these watersheds in the context of available toxicological data.

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- 21** 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 postevent population densities of brook trout *Salvelinus fontinalis* and instream habitat conditions; and (2) postevent 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 preevent 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 postevent 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 preevent 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.

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- 22** Smith, Freese; Brown, Arthur V.; Pope, Misty; Michael, Jerry L. 2001. **Benthic meiofauna responses to five forest harvest methods.** *Hydrobiologia*. 464: 9-15.

Benthic meiofauna were collected from the pools of minute (0 order) streams in the Ouachita National Forest, Arkansas during March 21-23, 1996 to see if benthic communities responded to forest harvest methods in a similar manner as plankton communities collected two years prior. The study streams and their watersheds (2-6 ha) were located in 14-16 ha forest stands that were selected for comparability of stands. Five treatment stands were paired with adjacent undisturbed reference stands (10 total). Treatment stands were subjected to one of five harvest methods listed in order of decreasing severity of harvest disturbance to the stands: (1) clearcut; (2) pine seed-tree; (3) pine shelterwood; (4) pine-hardwood group selection; and (5) pine single-tree selection. The mean number of taxa per site was 14 with a range of 9-20 taxa including rotifers, copepods, nematodes, dipterans, ostracods, and "other" meiofauna. Densities of total meiofauna (mean = 2449 No. l<sup>-1</sup>) were significantly higher ( $p = 0.002$ ) in treated sites. Highest densities occurred in single-tree and clearcut treatments. Rotifers were significantly more numerous at the single-tree treatments ( $p = 0.03$ ) and nematodes were significantly greater at the clearcut treatments ( $p = 0.03$ ). We conclude that benthic meiofauna in

these headwater streams are sensitive to silviculture practices and that the impact of forest harvest persists for at least 2.5 years.

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- 23** Trettin, Carl C.; Jurgensen, Martin F. 2003. **Carbon cycling in wetland forest soils.** In: Kimble, J.M.; Heath, Linda S.; Birdsey, Richard A.; Lal, R., eds. The potential of U.S. forest soils to sequester carbon and mitigate the greenhouse effect. New York: CRC Press: 311-331.

Wetlands comprise a small proportion (i.e., 2 to 3 percent) of Earth's terrestrial surface, yet they contain a significant proportion of the terrestrial carbon (C) pool. Soils comprise the largest terrestrial C pool (ca. 1550 Pg C in upper 100 cm), and wetlands contain the single largest component, with estimates ranging between 18 and 30 percent of the total soil C. In addition to being an important C pool, wetlands contribute approximately 22 percent of the annual global methane emissions. Despite the importance of wetlands in the global C budget, they are typically omitted from large-scale assessments because of scale, inadequate models, and limited information on C turnover and temporal dynamics.

Forests are recognized for their considerable potential to sequester C and their ability to affect carbon budgets at both the regional and global scales. However, the role of forested wetlands is typically not partitioned from upland forests. This distinction is important because of the inherently high plant diversity and productivity and the unique biogeochemistry of forested wetlands, which make them an important C sequestration pathway with a disproportional

influence on terrestrial C storage. In the United States, forests comprise approximately 51 percent ( $20.5 \times 10^6$  ha) of the total wetland area. These wetland forests comprise approximately 16 percent of the nonfederal forestland in the United States and are therefore integral to supplying both commodity and noncommodity uses. The forested wetland resource is not static; it is often managed; and while some lands are converted to upland or nonwetland uses, others are restored. Accordingly, soil C pools contained in wetland forests are a function of complex interactions of inherent soil processes, climate, vegetation, time, and disturbance regimes.

Forested wetlands are usually not considered when assessing opportunities for managing ecosystems to enhance terrestrial C storage. It is our hope that this chapter will provide a foundation for new work that is needed to realize the potential for effectively managing C pools in forested wetlands. Our objectives for this chapter are to (1) characterize the C cycle in wetland forests; (2) review the morphological and taxonomic basis for defining soil C status in forested wetlands; (3) review the morphological and taxonomic basis for defining soil C status in forested wetlands; (4) summarize soil properties and processes that regulate the soil C cycle in wetland forests. We focus on forested wetlands in North America while drawing on the international literature when discussing wetland soil processes.

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- 24** White, David A.; Skojac, Stephanie A. 2002. **Remnant bottomland forests near the terminus of the Mississippi River in Southeastern Louisiana.** *Castanea*. 67 (2): 134-145.

The woody communities of seven of the most intact bottomland hardwood forests of Southeastern Louisiana are described. The seven forests are on old levee ridges associated with past distributaries of the Mississippi River. The communities were divided by diameter size class into overstory ( $\geq 10.0$  cm d.b.h.) and understory ( $3.0$  cm  $\geq 10.0$  cm d.b.h.). The overstory (27 species) and understory (24 species) shared 18 species out of a total of 33. The understory stratum in these forests was not as uniform as the overstory across the forests in both dominants and subdominants. The forests were divided into two groups based upon size and abundance of two dominant overstory trees, live oak (*Quercus virginiana*) and sugarberry (*Celtis laevigata*). Other important overstory taxa were water oak (*Quercus nigra*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and elm (*Ulmus* spp.). The average total overstory density for the forests was 358.5 stems/ha and the average total overstory basal area was 30.5 m<sup>2</sup>/ha. The effect of microtopography, with its impact on hydroperiod, along and across the levee ridges was likely the principal variable impacting species dominance and diversity across the forests. These forests are under severe threat and conservation of those still remaining is a priority.

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- 25 Williams, Lance R.; Taylor, Christopher M.; Warren, Melvin L., Jr. 2003. **Influence of fish predation on assemblage structure of macroinvertebrates in an intermittent stream.** Transactions of the American Fisheries Society. 132: 120-130.

Despite considerable investigation of stream systems, the influence of fish predation on macroinvertebrate assemblages is still poorly understood and remains a controversial subject. We conducted a field experiment in an intermittent reach of Alum Creek in the Ouachita Mountains, Arkansas, to examine the effects of predatory fish on macroinvertebrate assemblages. We tested the prediction that with pool isolation, fish would have a top-down influence on macroinvertebrate assemblages. Overall, fish had a significant effect on both the density and assemblage structure of the macroinvertebrates in isolated stream pools. Assemblage effects may be linked to a feeding preference for relatively rare food items. These patterns were evident despite the loss of replicates (i.e., the drying of individual pools), indicating a strong short-term predator effect. We suggest that the use of different methodologies among studies makes it difficult to determine the influence of fish predation on macroinvertebrate assemblages in stream systems. Furthermore, we suggest that more realistic field experiments (i.e., with natural stream setting, hydrology, and substrata) must be conducted to fully understand and adequately address the question of the effects of fish predation on macroinvertebrates.



## Mountain and Highland Ecosystems

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- 26** Bragg, Don C. 2002. **Reference conditions for old-growth pine forests in the Upper West Gulf Coastal Plain.** *Journal of the Torrey Botanical Society*. 129 (4): 261.288.

Ecosystem restoration has become an important component of forest management, especially on public lands. However, determination of manageable reference conditions has lagged behind the interest. This paper presents a case study from pine-dominated forests in the Upper West Gulf Coastal Plain (UWGCP), with special emphasis on Southern Arkansas. Decades of forest management, fire exclusion, exotic species invasion, and other ecological changes have converted the small remnants of mature shortleaf (*Pinus echinata* Mill.) and loblolly pine (*Pinus taeda* L.) stands into ineffectual models for restoring presettlement-like conditions. However, sufficient information can be gathered from available references to more reliably describe the boundaries of the desired reference environment. Early explorer accounts, maps, survey records, historical trade and technical publications, and modern scientific journals were consulted to reconstruct presettlement (pre-1900) forest conditions for pine-dominated landscapes of the UWGCP. On average, virgin UWGCP pine forests had considerably more shortleaf pine (especially in the uplands) than contemporary natural stands, with relatively low basal area and standing volume concentrated in large trees. Presettlement pine timber also had less uniform structural and spatial patterns than modern examples of mature pine. Assuming most of the critical processes

are still present, it appears possible to recreate the compositional and structural attributes of virgin pine forests.

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- 27** Bragg, Don C. 2003. **Natural presettlement features of the Ashley County, Arkansas area.** *American Midland Naturalist*. 149: 1-20.

The General Land Office (GLO) survey records of the Ashley County, Arkansas area were analyzed for natural attributes, including forest composition and structure, prairie communities, and aquatic and geomorphological features. Almost 13,000 witness trees from at least 23 families were extracted from the surveys. Most (68 percent of the total) witness trees were black oak (*Quercus velutina*), pine (*Pinus* spp.), post oak (*Q. stellata*), white oak (*Q. alba*), hickory (*Carya* spp.) and sweetgum (*Liquidambar styraciflua*), with 60 percent of the taxa having fewer than 20 individuals, and 26 percent represented by a single tree. Witness trees were usually moderate sized with very few small or large individuals noted. The distribution of presettlement grasslands, bottomland forests, and upland mixed pine/hardwood forests was approximately mapped across the study area. Catastrophic disturbances mentioned in the GLO records included windthrow, floods, fire, timber harvest, and earthquakes. Even during this early period, European settlers were altering the Ashley County landscape with trails, homes, farms, cotton gins, and small-scale land clearing. Other notable ecological features in these survey records included large woody debris, wetlands, unique terrain conditions, and wild game.

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- 28** Bragg, Don C. 2003. **Optimal diameter growth equations for major tree species of the Midsouth.** Southern Journal of Applied Forestry. 27 (1): 5-10.

Optimal diameter growth equations for 60 major tree species were fit using the potential relative increment (PRI) methodology. Almost 175,000 individuals from the Midsouth (Arkansas, Louisiana, Missouri, Oklahoma, and Texas) were selected from the USDA Forest Service's Eastwide Forest Inventory Database (EFIDB). These records were then reduced to the individuals growing at the fastest rate given their species and size, and nonlinear ordinary least squares regression was used to fit equations to a subset of points with maximal increment. Sugarberry is provided as an example of the PRI derivation process.

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- 29** Greenberg, Cathryn H.; Rossell, C. Reed, Jr.; Johnson, David B. 2002. **Predation on artificial nests in hurricane-created gaps and adjacent forest of the Southern Appalachians.** Journal of the North Carolina Academy of Science. 118(3): 181-188.

Predation rates were compared during three 7-day trials on 742 artificial ground nests located in 10 hurricane-created canopy gaps and 10 adjacent closed-canopy controls in the Southern Appalachian Mountains of North Carolina. White northern bobwhite (*Colinus virginianus*) eggs were used in trials 1 and 2, but brown-speckled Japanese quail (*Coturnix coturnix*) eggs were used in trial 3 to determine: (1) whether artificial ground nests were at a greater risk of predation in gaps than in adjacent closed-canopy

forest; (2) whether predation rates increased with successive trials; and (3) whether egg color affected predation rates. Horizontal shrub cover and vertical shrub density up to 1.5 m were greater in gaps than in controls. Seventy percent of artificial nests were depredated, but predation rates ranged from 0-100 percent among sites and trials in both gaps and controls. Predation rates did not differ between gaps and controls. However, predation rate increased from trial 1 to trials 2 and 3. Egg color did not influence predation rates of artificial nests. Vertical shrub density deterred nest predation in gaps (but not controls) in trials 1 and 2, but had little effect by trial 3. Forest fragmentation by canopy gaps did not adversely affect nesting success of ground-nesting birds, as measured by predation rates of artificial ground nests.

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- 30** Lichstein, Jeremy W.; Simons, Theodore R.; Shriner, Susan A.; Franzreb, Kathleen E. 2002. **Spatial autocorrelation and autoregressive models in ecology.** *Ecological Monographs*. 72 (3): 445-463.

Recognition and analysis of spatial autocorrelation has defined a new paradigm in ecology. Attention to spatial pattern can lead to insights that would have been otherwise overlooked, while ignoring space may lead to false conclusions about ecological relationships. We used Gaussian spatial autoregressive models, fit with widely available software, to examine breeding habitat relationships for three common Neotropical migrant songbirds in the Southern Appalachian Mountains of North Carolina and Tennessee, USA. In preliminary models that ignored space, the abundance of all three species was correlated with both local- and

landscape-scale habitat variables. These models were then modified to account for broadscale spatial trend (via trend surface analysis) and fine-scale autocorrelation (via an autoregressive spatial covariance matrix). Residuals from ordinary least squares regression models were autocorrelated, indicating that the assumption of independent errors was violated. In contrast, residuals from autoregressive models showed little spatial pattern, suggesting that these models were appropriate.

The magnitude of habitat effects tended to decrease, and the relative importance of different habitat variables shifted when we incorporated broadscale and then fine-scale space into the analysis. The degree to which habitat effects changed when space was added to the models was roughly correlated with the amount of spatial structure in the habitat variables.

Spatial pattern in the residuals from ordinary least squares models may result from failure to include or adequately measure autocorrelated habitat variables. In addition, contagious processes, such as conspecific attraction, may generate spatial patterns in species abundance that cannot be explained by habitat models. For our study species, spatial patterns in the ordinary least squares residuals suggest that a scale of 500-1000 m would be appropriate for investigating possible contagious processes.

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- 31** Walker, John T.; Geron, Christopher D.; Vose, James M.; Swank, Wayne T. 2002. **Nitrogen trace gas emissions from a riparian ecosystem in Southern Appalachia.** *Chemosphere*. 49: 1389-1398.

In this paper, we present two years of seasonal nitric oxide (NO), ammonia (NH<sub>3</sub>), and nitrous oxide (N<sub>2</sub>O) trace gas fluxes measured in a recovering riparian zone with cattle excluded and adjacent riparian zone grazed by cattle. In the recovering riparian zone, average NO, NH<sub>3</sub>, and N<sub>2</sub>O fluxes were 5.8, 2.0, and 76.7 ng N m<sup>-2</sup> s<sup>-1</sup> (1.83, 0.63, and 24.19 kg N ha<sup>-1</sup> y<sup>-1</sup>), respectively. Fluxes in the grazed riparian zone were larger, especially for NO and NH<sub>3</sub>, measuring 9.1, 4.3, and 77.6 ng N m<sup>-2</sup> s<sup>-1</sup> (2.87, 1.35, and 24.50 kg N ha<sup>-1</sup> y<sup>-1</sup>) for NO, NH<sub>3</sub>, and N<sub>2</sub>O, respectively. On average, N<sub>2</sub>O accounted for greater than 85 percent of total trace gas flux in both the recovering and grazed riparian zones, though N<sub>2</sub>O fluxes were highly variable temporally. In the recovering riparian zone, variability in seasonal average fluxes was explained by variability in soil nitrogen (N) concentrations. Nitric oxide flux was positively correlated with soil ammonium (NH<sub>4</sub><sup>+</sup>) concentration, while N<sub>2</sub>O flux was positively correlated with soil nitrate (NO<sub>3</sub><sup>-</sup>) concentration. Ammonia flux was positively correlated with the ratio of NH<sub>4</sub><sup>+</sup> to NO<sub>3</sub><sup>-</sup>. In the grazed riparian zone, average NH<sub>3</sub> and N<sub>2</sub>O fluxes were not correlated with soil temperature, N concentrations, or moisture. This was likely due to high variability in soil microsite conditions related to cattle effects such as compaction and N input. Nitric oxide flux in the grazed riparian zone was positively correlated with soil temperature and NO<sub>3</sub><sup>-</sup> concentration. Restoration appeared to significantly affect NO flux, which increased ≈600 percent during the first year following restoration and decreased during the second year to levels encountered at the onset of restoration. By comparing the ratio of total trace gas flux to soil N concentration, we show that the restored riparian zone is likely more efficient than the grazed riparian zone at diverting upper-soil N from the

receiving stream to the atmosphere. This is likely due to the recovery of microbiological communities following changes in soil physical characteristics.

## Large-scale Assessment and Modeling

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- 32** Betz, Carter J.; Bergstrom, John C.; Bowker, J.M. 2003. **A contingent trip model for estimating rail-trail demand.** *Journal of Environmental Planning and Management.* 46 (1); 79-96.

The authors develop a contingent trip model to estimate the recreation demand for and value of a potential rail-trail site in Northeast Georgia. The contingent trip model is an alternative to travel cost modeling useful for *ex ante* evaluation of proposed recreation resources or management alternatives. The authors estimate the empirical demand for trips using a negative binomial regression specification. Their findings indicate a per-trip consumer surplus ranging from US \$18.46 to US \$29.23 and a price elasticity of -0.68. In aggregate, they estimate that the rail-trail would receive approximately 416,213 recreation visits per year by area households and account for a total consumer surplus in excess of US \$7.5 million.

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- 33** Riitters, Kurt H.; Wickham, James D. 2003. **How far to the nearest road?** *Frontiers in Ecology and the Environment.* 1 (3): 125-129.

Ecological impacts from roads may be the rule rather than the exception in most of the conterminous

United States. We measured the proportion of land area that was located within nine distances from the nearest road of any type, and mapped the results for 164 ecoregions and 2108 watersheds nationwide. Overall, 20 percent of the total land area was within 127 m of a road, and the proportion increased rapidly with distance, so that 83 percent was within 1061 m of a road, and only 3 percent was more than 5176 m away. For forest land area only, the proportions differed by less than 2 percent for all distances. Regions with more than 60 percent of their total land area within 382 m of a road may be at greatest risk of cumulative ecological impacts from roads. These regions include nearly all coastal zones, as well as substantial portions of the Southeastern United States and the basins of the Ohio, Brazos, Colorado, Sacramento, and San Joaquin Rivers.

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- 34** Zarnoch, S.J.; Kocis, S.M.; Cordell, H.K.; English, D.B.K. 2002. **A pilot sampling design for estimating outdoor recreation site visits on the national forests.** Res. Pap. SRS-29. Asheville, NC: USDA Forest Service, Southern Research Station. 20 p.

A pilot sampling design is described for estimating site visits to National Forest System lands. The three-stage sampling design consisted of national forest ranger districts, site days within ranger districts, and last-exiting recreation visitors within site days. Stratification was used at both the primary and secondary stages. Ranger districts were stratified based on Bailey's ecoregions, while site days were stratified based on site type, season, and day type. Statistical methodology is presented to derive site-visit estimates



at the site day, ranger district, and national levels. Results are presented to illustrate the magnitude of the site-visit estimates, their variability, and confidence intervals. With such information, an evaluation of the stratification variables is presented using the design effect and the relative hypothetical efficiency. Sample size analysis is performed to provide recommendations for future sample surveys to meet specified levels of precision.

## Inventory and Modeling

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- 35** Bentley, James W.; Howell, Michael; Johnson, Tony G. 2002. **Louisiana's timber industry—an assessment of timber product output and use, 1999**. Resour. Bull. SRS-81. Asheville, NC: USDA Forest Service, Southern Research Station. 9 p.

In 1999, industrial roundwood output from Louisiana's forests totaled 802 million cubic feet, 28 percent more than in 1996. Mill byproducts generated from primary manufacturers increased 50 percent to 285 million cubic feet. Almost all plant residues were used primarily for fuel and fiber products. Pulpwood was the leading roundwood product at 349 million cubic feet; saw logs ranked second at 269 million cubic feet; veneer logs were third at 148 million cubic feet. The number of primary processing plants decreased from 92 in 1996 to 57 in 1999. Total receipts increased 29 percent to 890 million cubic feet.

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- 36** Conner, Roger C. 2003. **Forest statistics for the Northern Coastal Plain of North Carolina, 2000.** Resour. Bull. SRS-83. Asheville, NC: USDA Forest Service, Southern Research Station. 59 p.

This report summarizes a 2000 inventory of the forest resources of a 23-county area of North Carolina. Major findings are highlighted in text and graphics; detailed data are presented in 49 tables.

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- 37** Howell, Michael; Johnson, Tony G. 2002. **Oklahoma's timber industry—an assessment of timber product output and use, 1999.** Resour. Bull. SRS-82. Asheville, NC: USDA Forest Service, Southern Research Station. 28 p.

In 1999, roundwood output from Oklahoma's forests totaled 120 million cubic feet. Mill byproducts generated from primary manufacturers totaled 51 million cubic feet. Almost all plant residue was used primarily for fuel and fiber products. Pulpwood was the leading roundwood product at 54 million cubic feet; saw logs ranked second at 52 million cubic feet. There were 67 primary processing plants operating in Oklahoma in 1999. Receipts totaled 151 million cubic feet.

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- 38** Rudis, Victor A. 2003. **Fresh ideas, perspectives, and protocols associated with Forest Inventory and Analysis surveys: graduate reports, 1974 to July 2001.** Gen. Tech. Rep. SRS-61. Asheville, NC: U.S.

Department of Agriculture, Forest Service, Southern Research Station. 49 p.

Graduate M.S. theses and Ph.D. dissertations were searched to provide a body of information associated with the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) database. Authors' abstracts were included if available in electronic form and published since 1974. Novel technical and nontraditional FIA data uses, as well as the geographic region of the reported studies, were highlighted in keywords and annotations. The search yielded the 103 citations included in this report. Dominating efforts were in economics, Geographic Information Systems, timber production, and selected States with a broadening array of subjects in more recent years. Research institutions in States with regional FIA survey unit offices granted one-third of the graduate degrees. Providing an overview of the uses of FIA data in student research, the results show that a body of knowledge based on the data is evolving, whereas the distribution of subjects and study regions has been somewhat limited.

## Foundation Programs

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- 39** USDA Forest Service, Southern Research Station. 2003. **Forest science in the South.** Science Update SRS-004. Asheville, NC: USDA Forest Service, Southern Research Station. 121 p.

**Forest Science in the South** includes the Southern Station's accomplishments, emerging research priorities, and products—journal articles, books,

Station publications, presentations, and Web postings. This report details budget allocations, highlights collaborative research, includes a directory of research units and experimental forests, and summarizes administrative functions.

## 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.usda.gov/bentcreek">www.srs.fs.usda.gov/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.usda.gov/disturbance">www.srs.fs.usda.gov/disturbance</a></b>	706-559-4315
Athens, GA Paula Spaine	4505	Insects and Diseases of Southern Forests <b><a href="http://www.srs.fs.usda.gov/4505">www.srs.fs.usda.gov/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.usda.gov/trends">www.srs.fs.usda.gov/trends</a></b>	706-559-4264
Auburn, AL Charles McMahan	4105	Vegetation Management Research and Longleaf Pine Research for Southern Forest Ecosystems <b><a href="http://www.srs.fs.usda.gov/4105">www.srs.fs.usda.gov/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.usda.gov/forestops">http://www.srs.fs.usda.gov/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.usda.gov/charleston">www.srs.fs.usda.gov/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.usda.gov/4201">www.srs.fs.usda.gov/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.usda.gov/4106">www.srs.fs.usda.gov/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.usda.gov/wildlife">www.srs.fs.usda.gov/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.usda.gov/4802">www.srs.fs.usda.gov/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.usda.gov/4111">www.srs.fs.usda.gov/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.usda.gov/4501">www.srs.fs.usda.gov/4501</a></b>	318-473-7232
Pineville, LA Les Groom	4701	Utilization of Southern Forest Resources <b><a href="http://www.srs.fs.usda.gov/4701">www.srs.fs.usda.gov/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.usda.gov/soils/soilhome.htm">www.rtp.srs.fs.usda.gov/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.srs.fs.usda.gov/econ">www.srs.fs.usda.gov/econ</a></b>	919-549-4093
Saucier, MS Floyd Bridgwater	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.usda.gov/termites">www.srs.fs.usda.gov/termites</a></b>	662-338-3100
Stoneville, MS Ted Leininger	4155	Center for Bottomland Hardwoods Research <b><a href="http://www.srs.fs.usda.gov/cbhr">www.srs.fs.usda.gov/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.

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