

Recent Publications -- March 1999

Exotic Pests of Eastern Forests

The USDA Forest Service and the Southeast Exotic Pest Plant Council (SE-EPPC) present **Exotic Pests of Eastern Forests**, which focuses on invasive exotic pest plants and insects and diseases. Kerry Britton, project leader and research plant pathologist for the Insects and Disease research work unit in Athens, GA, edited the 29 papers presented at the April 1997 conference in Nashville, TN. Sponsors of the Exotic Pests of Eastern Forests conference aimed to enhance awareness of the many invasive exotic pests in eastern forests, the damage they have caused to the ecosystem, and the potential impact if prevention and control measures are not developed and utilized soon.

On February 3, President Clinton signed an Executive Order to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. In September 1998, USDA Forest Service Chief Mike Dombeck introduced the Forest Service Strategy for Noxious and Nonnative Invasive Plant Management. When implementing the program, Chief Dombeck emphasized the devastating effects of invasive plants: reducing biological diversity, impacting threatened and endangered species and wildlife habitat, modifying vegetative seral stages, changing fire and nutrient cycles, and degrading soil structure. Considering the ecological and economic effects of the chestnut blight, the rapid spread of the gypsy moth, and kudzu's alteration of the southern landscape, the invasion of exotic pest plants, insects, and diseases clearly have dramatically impacted the health, composition, and productivity of eastern forests.

James H. Miller, research forest ecologist in the Vegetation Management Research and Loblolly Pine Ecosystems research work unit in Auburn, AL, contributed **Exotic invasive plants in southeastern forests** to **Exotic Pests of Eastern Forests**. In this chapter, Miller brings attention to the problem of exotic plants in the sub-tropical part of the southeastern forest region and to mobilize support for organizing integrated weed management programs. The Southern Weed Science Society honored James Miller as the 1999 Weed Scientist of the Year, the first forestry member of the society to receive this prestigious award. Miller's outstanding achievements in research and technology transfer relate to forest vegetation management science. His accomplishments include basic science and applied technology for the control and management of native and nonnative plants and shrubs in a forest setting using techniques that are ecologically sound, economically viable, and socially acceptable.

Paula Spaine, Southern Research Station research plant pathologist in the Insects and Disease research work unit, co-authored **Three American tragedies: chestnut blight, butternut canker, and Dutch elm disease**. Spaine collaborated with Scott Schlarbaum, Frederick Hebard, and Joseph C. Kamalay. Schlarbaum teaches in the Department of Forestry, Wildlife, and Fisheries at the University of Tennessee, Knoxville; Frederick Hebard conducts research with The American Chestnut Foundation; Kamalay is a Forest Service scientist at the Northeastern Forest Experiment Station. These scientists present brief accounts of the impacts of chestnut blight, butternut canker, and Dutch elm disease on their host species, examples of research approaches for disease control, and a prognosis for the future of each species. Spaine worked with scientists at the Forestry and Forest Product Research Institute in Tsukuba, Japan from 1990-1992. The Japanese International Science and Technology grant, awarded by the Japanese government, the National Science Foundation, and the Forest Service sponsored Spaine's sabbatical. She continues to collaborate with colleagues in Japan on whether specific introduced pathogens in the US have occurred in the Far East. Butternut canker, caused by a fungus believed to be an introduced pathogen, has not been reported in Japan. This type of global communication helps to trace the origin of exotic pests.

To view or download **Exotic Pests of Eastern Forests**, visit www.webriver.com/tn-eppc/ You can purchase a copy for \$5 by calling 800-449-6339; printed copies are extremely limited. Weed control programs operate in many States, and Colorado and Montana distribute noxious weed calendars loaded with graphics and information about those often enticing exotics. If you want to get involved with a weed control group in the Southeastern U.S., Steve or Lee (800-449-6339) would be willing to point you in the right direction.

In this catalogue, Gary L. DeBarr, research entomologist with the Athens Insects and Disease research work unit, contributes **Description of new primary parasitoid, *Zarhopalus* Ashmead (Hymenoptera: Encyrtidae), of *Oracella Acuta* (Homoptera: Pseudococcidae)**. DeBarr co-authored this publication with Jianghua Sun, Northeast Forestry University, Harbin, China; C. Way Berisford, University of Georgia, Athens; and Michael E. Schauff, USDA National Museum of Natural History. To learn about the discovery of *Zarhopalus debarr*, request number **39**.

Continuing the Southern Research Station's aggressive research against invasive species, Kerry Britton, Gary DeBarr, and Dave Orr, a collaborator from North Carolina State University, travel to China in April 1999 to work with Beijing scientists to control and eradicate kudzu.

Sustainability through Ecosystem Management

In charting the USDA Forest Service's path for conservation leadership in the 21st century, Chief Mike Dombek says ecological sustainability is "our essence – our reason for being." Dombek leads the Forest Service toward a new organizational direction based on outcomes on the landscape as opposed to outputs produced. He recognizes the economic and social value of timber and mineral production, livestock grazing, hunting, and fishing on the 191 million acres the Forest Service manages. Chief Dombek also realizes that the values most citizens appreciate from their national forests include clean air and water, open space and large unfragmented landscapes – forests that look like forests – wildness and naturalness that support diverse and abundant wildlife, fish, and plants. By conserving endangered species and managing for ecological sustainability, we will leave choices for future generations.

Kay Franzreb, research wildlife biologist and project leader for the Endangered Species research work unit in Clemson, SC, co-authored **The role of indicator species: Neotropical migratory song birds**. This publication focuses on the Neotropical migrants that predominate in the breeding bird community of eastern deciduous forests. In some parts of the Southern Appalachians, up to 80 percent of the breeding bird community is comprised of these species. These approximately 75 species use ground, shrub, and especially canopy nests, and about 80 percent of them are insectivores. Recent concern over the status these birds has been prompted by surveys showing widespread population declines. Franzreb collaborated with T. Simons, K. Rabenold, D. Buehler, and others on this chapter in **Ecosystem management for sustainability: principles and practices illustrated by a regional biosphere reserve cooperative**. Edited by John D. Peine, a scientist with the U.S. Geological Survey, this book is available through CRC Press, Lewis Publishers. To purchase a copy, call 800-272-7737 (<http://www.crcpress.com/>). To request **The role of indicator species: Neotropical migratory song birds**, select number **36**.

Mike Rauscher, research forester at Bent Creek Research and Demonstration Forest, Asheville, NC, contributes **Ecosystem management decision support for federal forests in the United States: a review** to the March catalogue of Recent Publications. Rauscher says ecosystem management has all the characteristics of a "wicked" problem – tricky, complex, and thorny: finding a sensible middle ground between ensuring long-term protection of the environment while allowing an increasing

population to use its natural resources for maintaining and improving human life. Rauscher states that managers need to use knowledge, organization, judicious simplification, and inspired leadership to implement ecosystem management – no small order even with such a well-stocked toolbox. Rauscher reviews decision support systems related to implementing ecosystem management. He presents a conceptual model of the context in which ecosystem management is expected to function, describe a candidate for an operational ecosystem management process, and reviews many existing systems. To learn more, request number **29**.

Rauscher is instrumental in presenting an international conference on Application of Scientific Knowledge to Decision Making in Managing Forest Ecosystems in Asheville, NC, May 3-6, 1999. The International Union of Forestry Research Organizations (IUFRO), the USDA Forest Service, Southern Research Station, and the Forest Resources Systems Institute, Clemson, SC, sponsor this conference to bring together the leading developers and users of decision support systems (DSS) in the world. Speakers and participants will discuss contemporary issues regarding the development and applications of DSS for managing forest ecosystems. To learn more about the conference, visit our web site at www.srs.fs.fed.us or contact Mike Rauscher at 828 667-5261, ext. 102; e-mail him at [mrauscher/srs_bentcreek@fs.fed.us/](mailto:mrauscher/srs_bentcreek@fs.fed.us)

Sustainability and air quality become real for many people when “ozone alerts” suggest limitation of outdoor activities, as could happen in Western North Carolina from May 1 through September 30. This topic will surely attract attention when North Carolina Governor James B. Hunt, Jr. hosts the Governors’ Summit on Mountain Air Quality April 6-7, 1999, in Asheville. Key participants figure to be the Governors and delegations from the Southern Appalachian Mountain States – Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. Air quality experts from the Forest Service and other government agencies, industry, academia, and environmental organizations are engaged in understanding the air problems of the southern mountains and crafting strategies to solve those problems. The Air Quality Summit will prepare State policy makers for the decisions they will face over the next few years. Developing equitable and effective solutions requires regional collaboration. To register, call Salli Gaddini at 828-232-5123 or e-mail her at sgaddini@unca.edu/

Outdoor Recreation: Assessment and Valuation

Outdoor recreation in American life: a national assessment of demand and supply trends presents the United States only ongoing, comprehensive assessment of the trends, current situation, and likely future of outdoor recreation demand and supply. Thirty-one contributors examine new and different aspects of national demand, resemblances to the past, and trends in the supply of outdoor recreation opportunities, both from the private and public sectors. Authors include academicians, Federal and State scientists and managers, and specialists representing recreation user groups, the recreation industry, and providers of recreation opportunities.

Chapters authored by Southern Research Station scientists include the following selections:

Outdoor recreation resources by Carter J. Betz, Donald B.K. English, and H. Ken Cordell; request number **2**

Projections of outdoor recreation participation to 2050 by J.M. Bowker, Donald B.K. English, and H. Ken Cordell; request number **3**

Framework for the assessment by H. Ken Cordell; request number **7**

Outdoor recreation participation trends by H. Ken Cordell, Barbara L. McDonald, Jeff R. Teasley, and others; request number

Implications of this assessment by Donald B.K. English, H. Ken Cordell, and J.M. Bowker; request number **11**

Recreation visitor preferences for and perceptions of outdoor recreation setting attributes by Micheal A. Tarrant, Erin Sm and H. Ken Cordell; request number **40**

Private lands and outdoor recreation in the United States by R. Jeff Teasley, John C. Bergstrom, H. Ken Cordell, and others; request number **42**

To purchase a copy of **Outdoor recreation in American life: a national assessment of demand and supply trends**, call Sagamore Publishing (800-327-5557) or visit the web site at www.sagamorepub.com/

Recent Publications -- March 1999

Achtemeier, Gary L.; Jackson, William; Hawkins, Bernie; and others. 1998. **The smoke dilemma: a head-on collision!** In: Wadsworth, Kelly G., ed. Transactions of the 63rd North American Wildlife and Natural Resources conference; 1998 March 20-2 Orlando, FL. Washington, DC: Wildlife Management Institute: 415-421.

A head-on collision is imminent! The drivers are people. The vehicles are special interests. The road is smoke! Those concerned about air quality ride in the first car; those concerned about natural resource management ride in the second. In this paper, the authors look at what smoke is and why it is sometimes dangerous, factors leading to a collision, and what can be done to avoid a collision. **(1)**

Betz, Carter J.; English, Donald B.K.; Cordell, H. Ken. 1999. **Outdoor recreation resources.** In: Cordell, H. Ken; Betz, Carter; Bowker, J.M.; and others. Outdoor recreation in American life: a national assessment of demand and supply trends. Champaign IL: Sagamore Publishing: 39-182.

The authors examine recreation resources and opportunities by the four types of providers: Federal, State, local governments, and the private sector. They discuss the trend of partnerships in the provision of outdoor recreation opportunities, especially two types that emerged in the 1990's: Scenic Byways and Watchable Wildlife opportunities. Where possible, the authors discuss the changes and trends in recreation resources since the mid-1980's. Those trends, in turn, point to anticipated future trends. Brief articles by 36 contributors from Government agencies, environmental organizations, and recreation industry groups address issues and trends that have emerged over the past decade and offer their outlooks for the future. The chapter provides indexes that describe categories of recreation resources and how they have changed over the past 10 years. The authors also present observations about the outdoor recreation resource base in the United States by summarizing the current status, trends, and future outlook. **(2)**

Bowker, J.M.; English, Donald B.K.; Cordell, H. Ken. 1999. **Projections of outdoor recreation participation to 2050.** In: Cordell, H. Ken; Betz, Carter; Bowker, J.M.; and others. Outdoor recreation in American life: a national assessment of demand and supply trends. Champaign, IL: Sagamore Publishing: 323-351.

The authors project future outdoor recreation participation and consumption, in days and trips, well into the next century, as mandated by the Renewable Resources Planning Act (RPA). The chapter begins with a brief description of the data and methods used. They report indexed projections of future recreation participation (by millions of participants aged 16 and over) and consumption (by millions of days annually and by millions of primary purpose trips taken) across the four assessment regions [North, South, Rocky Mountains/Great Plains, and Pacific Coast] at 10-year intervals beginning in 2000 and ending in 2050. For convenience, the authors place projections for specific activities in the following groups: winter, water, wildlife, dispersed land, and developed land. Finally, they discuss some important findings, implications, and limitations of the analysis. **(3)**

Brockway, Dale G.; Outcalt, Kenneth W. 1998. **Gap-phase regeneration in longleaf pine wiregrass ecosystems.** Forest Ecology and Management. 106: 125-139.

Naturally regenerated seedlings of longleaf pine are typically observed to cluster in the center of tree fall canopy gaps and be encircled by a wide zone from which they are generally excluded. Twelve representative canopy gaps distributed across 600 ha a naturally regenerated uneven-aged longleaf pine forest in the sandhills of north central Florida were examined to determine which aboveground and belowground factors are responsible for development of this seedling exclusionary zone. Within 12 m of adult trees growing along the gap edge, significantly fewer longleaf pine seedlings were present. The canopy of overstory trees, however, extended only 4 to 5 m into the gap. The relatively open structure of the longleaf pine canopy (57 percent cover) allowed photosynthetically active radiation (PAR) to be evenly distributed upon the forest floor across each canopy gap. Thus, light availability was not related to pine seedling clustering near gap centers. Significantly greater forest litter mass beneath adult trees (5 Mg ha⁻¹) could result in fires more intense than would be supported by the litter mass near gap centers (2.5 Mg ha⁻¹). However, litter mass was significantly elevated only within 4 m of the gap edge. The fine root biomass within 12 m of the gap edge (3 to 4.5 Mg ha⁻¹) was two to six times that measured near the gap center and most closely coincided with the width of the seedling exclusionary zone along the margin of each gap. Thus, while the canopy of adjacent adult trees may indirectly influence seedling mortality through deposition of needle litter and greater fire intensity within 4 m of the gap edge, the root systems of these adults also appear to directly compete with seedlings within 12 to 16 m of the gap edge for limited site resources. To effectively regenerate and sustain longleaf pine wiregrass ecosystems, caution should be used in prescribing single-tree selection harvest methods so as not to create gap openings so small (< 30 m diameter) that intraspecific competition from adult trees totally excludes seedlings. Group selection methods may prove more effective in creating canopy gaps of sizes suitable (≥ 40 m diameter) for ensuring that intraspecific competition from adults is maintained at a level which allows for survival and growth of seedlings. Shelterwood and deferment methods may also prove useful where more open canopy conditions are desired. However, the pine seedlings' need for light cannot be used as an appropriate rationale for application of clearcutting methods. **(4)**

Brockway, Dale G.; Outcalt, Kenneth W.; Wilkins, R. Neal. 1998. **Restoring longleaf pine wiregrass ecosystems: plant cover, diversity and biomass following low-rate hexazinone application on Florida sandhills.** Forest Ecology and Management. 103: 159-175.

A longleaf pine wiregrass ecosystem in the sandhills of north central Florida, upon which turkey oak gained dominance following wildfire, was treated with low rate (1.1 or 2.2 kg/ha) applications of the herbicide hexazinone during the 1991 growing season. All applications successfully reduced oak in the overstory and understory, mortality ranging from 83 to 93 percent. The declining competition from oaks was associated with progressive increases in foliar cover of wiregrass, all graminoids, and forbs over time. Plant species diversity declined in the initial year, but recovered by the second growing season. Species richness increased over time while evenness declined with the continuing expansion of wiregrass. Initial increases in the standing biomass of wiregrass did not persist beyond the second growing season. The broadcast application methods exposed a greater number of understory plants to contact with hexazinone, resulting in initial declines in forb cover, species richness, and diversity. Although recovery was noted in subsequent years, because of lower selectivity, this broadcast application method is not recommended as a restoration technique. Spot applications of liquid hexazinone were generally more selective in their effect upon the plant community. The 1.1 and 2.2 kg/ha application rates, while producing an initial year reduction in diversity and evenness, resulted in increases in the cover of all graminoids and forbs and the highest species richness. While both application rates are useful, the 2.2 kg/ha application is most effective in controlling woody plant competition and stimulating increases in wiregrass and is therefore recommended for restoring xeric sandhills and similar longleaf pine wiregrass ecosystems. **(5)**

Clinton, Barton D.; Vose, James M.; Swank, Wayne T.; and others. 1998. **Fuel consumption and fire characteristics during understory burning in a mixed white pine-hardwood stand in the Southern Appalachians.** Research Paper SRS-12. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 8 p.

The authors characterized fire behavior and fuel consumption resulting from an understory prescribed burn in a mixed eastern white pine-hardwood stand in the Southern Appalachians. Three stands were used for the treatment. Flame lengths, ranging from 0.3 to 1.5 meters (in) for backing fires and from 1.2 to 4.5 in for head fires, reached maximum heights where evergreen understory was found. Rates of spread ranged from 1.8 to 3.0 in per minute for head fires and 0.3 in per minute for backing fires. Fire intensity measured with ceramic tiles painted with heat-sensitive paint, varied across stands. Mean peak flame temperature ranged from 170 to 290°C. Pre-burn mass totals were similar among stands, except for stand 1, which had substantially greater humus mass than the other stands. Consumption of litter and humus layers in the forest floor was positively correlated with flame temperature. Small wood (< 8 cm diameter) consumption was not correlated with temperature. Over all stands, 50 percent of the mass in small wood and litter was lost during burning, and 20 percent of the humus layer was consumed. The losses in the humus layer represent about 40 percent more humus mass consumption than would have occurred in a fell-and-burn treatment. The humus layer is an important nutrient reservoir for plant growth. Maintaining this layer through careful selection of burning conditions will minimize losses during burning and maintain long-term site productivity. **(6)**

Cordell, H. Ken. 1999. **Framework for the assessment.** In: Cordell, H. Ken; Betz, Carter ; Bowker, J.M. and others. *Outdoor recreation in American life: a national assessment of demand and supply trends.* Champaign, IL: Sagamore Publishing: 31-38.

This chapter of **Outdoor recreation in American life: a national assessment of demand and supply trends** details the components of the assessment framework. In this chapter the author recounts the establishment of the process for assessing the state of the forest and range resources in this country through passage of the Forest and Rangeland Renewable Resources Planning Act (RPA) in 1974. He explains that the intention of the RPA assessment was and is to describe recent trends, current condition, and likely futures for timber, water, wildlife and fish, range, minerals, and outdoor recreation and wilderness in the United States. *Outdoor recreation in American life: a national assessment of demand and supply trends* represents the fourth of the outdoor recreation and wilderness studies done to meet the mandates of the 1974 RPA. In this assessment, the primary approach is to use the expert judgement of the assessment specialists to examine supply trends across the spectrum of opportunities the public and private sectors provide in light of demand trends and projections. From this less formal "gap analysis" and based on knowledge of issues in outdoor recreation and wilderness, authors of the assessment attempt to identify policy, management, and research implications for the country. It is the authors' opinion that this form of qualitative comparison can provide valid insights, just as the more quantitative econometric gap analysis does. **(7)**

Cordell, H. Ken; McDonald, Barbara L.; Teasley, R. Jeff; and others. 1999. **Outdoor recreation participation trends.** In: Cordell, H. Ken; Betz, Carter ; Bowker, J.M.; and others. *Outdoor recreation in American life: a national assessment of demand and supply trends.* Champaign, IL: Sagamore Publishing: 219-321.

As part of the national assessment of outdoor recreation trends, the authors have taken a look at participation patterns and levels of participation across activities and across segments of our society. The primary source of data is the National Survey on Recreation

and the Environment (NSRE). The NSRE is the latest in the continuing series of National Recreation Surveys conducted by the Federal Government since 1960. The NSRE covers participation in over 80 activities, ranging from casual walking outdoors to more challenging activities such as rock climbing and white water canoeing. This chapter looks at national participation in land-, water-, and snow-and ice-based recreation activities. Long-term trends are covered, tracking some activities back to the original national survey done in 1960. To examine geographic patterns, differences in population percentages across Census regions and divisions are explored, with a focus on activities with the greatest differences. To further explore geographic patterns, selected activities are mapped at county scale to show more detailed patterns of participation across and within regions. Intensity of participation is described using days and trips away from home as the measure of involvement in outdoor activities. Participation differences among social groups in American society are examined, and constraints to participation described. The closing sections of this chapter include descriptions of visits to Federal and State recreation areas, international tourism in the United States, outdoor recreation consumer spending trends, and economic effects of outdoor recreationists' spending. **(8)**

Dolloff, C. Andrew. 1995. **Impacts of historic land use on trout habitat in the Southern Appalachians.** In: Barnhart, Roger; Shake, Bill; Hamre, R.H., tech. eds. *Wild Trout V: wild trout in the 21st century*; Proceedings of the Wild Trout V symposium; 1995 September 26-27; Yellowstone National Park. [Place of publication unknown]: [Publisher unknown]: 121-124.

Land use has had a major impact on habitat structure in the Southern Appalachians. One of the most conspicuous changes has been the loss of large woody debris (LWD). Human use has so changed the structure and composition of most forested watersheds that is difficult for average citizens to understand why LWD matters. Research is underway to determine the effect of adding LWD on trout, trout habitat, and macroinvertebrates in two southwest Virginia streams. **(9)**

Elliott, Katherine J.; Hendrick, Ronald L.; Major, Amy E.; and others. 1999. **Vegetation dynamics after a prescribed fire in the southern Appalachians.** *Forest Ecology and Management.* 114: 199-213.

In April 1995, the USDA Forest Service conducted a prescribed burn along with a south-facing slope of Southern Appalachian watershed, Nantahala National Forest, western NC. Fire had been excluded for over 70 years and the purpose of the burn was to create a mosaic of fire intensities to restore a degraded pine/hardwood community and to stimulate forage production and promote oak regeneration along a hillslope gradient. Permanent plots were sampled at three locations along a gradient from 1500 to 1700 m. Plot locations corresponded to three community types: mesic, near-riparian cove (low slope); dry, mixed-oak (mid slope); an xeric, pine/hardwood (ridge). Before burning (1994-1995) and post-burn (summer 1995 and summer 1996) vegetation measurements were used to determine the effects of fire on the mortality and regeneration of overstory trees, understory shrubs, and herbaceous species. After the burn, mortality was highest (31 percent) at the ridge location, substantially reducing overstory (from 26.84 pre-burn to 19.05 m² ha⁻¹ post-burn) and understory shrub (from 6.52 pre-burn to 0.37 m² ha⁻¹ post-burn) basal area. At the mid-slope position, mortality was only 3 percent, and no mortality occurred at the low slope. Not surprisingly, percent mortality corresponded to the level of fire intensity. Basal area of *Kalmia latifolia*, *Gaylussacia baccata*, and *Vaccinium* spp. were substantially reduced after the fire, but density increased due to prolific sprouting. The prescribed fire had varying effects on species richness and diversity across the hillslope gradient. On the ridge, diversity was significantly increased in the understory herb-layer, but decreased in the overstory. On the mid slope, no change was observed in the overstory, but diversity significantly decreased in the understory. On the low slope, no change was observed in the overstory or understory. **(10)**

English, Donald B.K.; Cordell, H. Ken; Bowker, J.M. 1999. **Implications of this assessment.** In: Cordell, H. Ken; Betz, Carter ; Bowker, J.M. and others. 1999. Outdoor recreation in American life: a national assessment of demand and supply trends. Champaign, IL: Sagamore Publishing: 433-440.

Outdoor recreation is complex and difficult to summarize fully. It includes a wide variety of activities and interests, ranging from canoeing to watching wildlife. Many outdoor activities often occur in a variety of settings. These settings may have different characteristics and thus provide different kinds of recreation experiences. Similarly, one setting often supports an array of activities often at the same time. Having the opportunity to participate in a mix of activities and settings is important to people as they seek satisfying and varied recreation experiences. On any given day or recreation trip, a single individual or group may participate in a number of activities across more than one setting. A further complexity of outdoor recreation is that the meanings of and benefits from participating can be very different for different people who are doing the same activity in the same place at the same time. Differences in the benefits recreationists seek can translate into significant differences in their preferences for setting attributes, their perceptions of crowding or other conditions at the recreation site, their expectations about resource quality and service delivery, and their attitudes regarding management goals and methods. Different types of recreation users do share some of the same concerns about facilities and general perceptions about the quality of managed sites. However, research has indicated that segmenting user markets based on setting-specific preferences for recreation experiences, although difficult to do, may be a managerially useful way to understand recreation site users better. As a result of their differences in preferences, visitors to the same recreation site are likely to exhibit different reactions to management prescriptions or resource changes.

Over and above the direct benefits participants get from their recreation experience, there is mounting evidence of indirect benefit of wild areas, scenic amenities, and recreation itself. There is an expanding definition of outdoor recreation participation and the scope of people who benefit from someone else's participation. Beyond the direct benefits of actual participation, economists and other social scientists have identified benefits to persons other than the visitor when measuring the values of the natural resource that support recreation. It also recognized that visitors benefit not only at the time they are participating in recreation, but also before and sometimes long after their visit to a recreation area. In addition, maintaining the quality of [National Wilderness Preservation System-designated] wilderness and other undeveloped or unique natural or historic resources can provide benefits into the future for those who may make use of them. A growing class of beneficiaries of recreation, wildlife, and [National Wilderness Preservation System-designated] wilderness resources includes those who engage in sightseeing, wildlife viewing, nature study, or other activities in "virtual" settings. **(11)**

Flebbe, Patricia A. 1997. **Global climate change and fragmentation of native brook trout distribution in the southern Appalachian Mountains.** In: Gresswell, Robert E.; Dwyer, Pat; Hamre, R.H., eds. Wild Trout VI: putting the native back in wild trout. Proceedings of the Wild Trout VI Symposium; 1997 August 17-20; Montana State University, Bozeman, MT. [Place of publication unknown]: [Publisher unknown]: 117-121.

Current distributions of native brook trout (*Salvelinus fontinalis*) in the Southern Appalachians are restricted to upper elevations by multiple factors, including habitat requirements, introduced rainbow (*Oncorhynchus mykiss*) and brown (*Salmo trutta*) trout, and other human activities. Present-day distribution of brook trout habitat is already fragmented. Increased temperatures predicted by various global warming models are likely to further limit suitable brook trout habitat. Predicted changes in hydrologic cycles may exacerbate temperature effects, and hydrologic effects on trout may differ across the region. Models of present-day trout guild distribution were used in a Geographic Information System (GIS) to examine the changes in trout distribution that might occur with temperature increase. Both suitable area and stream length for trout decrease as suitable habitat is increasingly restricted to

mountaintops. Furthermore, the remaining trout habitat is likely to be even more fragmented than at present. If trout habitat becomes more fragmented under warming trends, common local extinctions may become irreversible as avenues for recolonization are eliminated. **(12)**

Foster, G.S.; Rousseau, R.J.; Nance, W.L. 1998. **Eastern cottonwood clonal mixing study: intergenotypic competition effects.** Forest Ecology and Management. 112: 9-22.

Intergenotypic competition of seven clones of eastern cottonwood (*Populus deltoides*) was evaluated in a replacement series experiment. A partial diallel competition design was used to choose pairs (binary sets) of clones for plot type treatments. Two separate treatments were established for each pair of clones, namely (1) 75 percent clone A: 25 percent clone B and (2) 25 percent clone A: 75 percent clone B. Twenty-one treatments were established in the study: seven pure clone treatments and 14 mixed treatments (seven pairs of clones each at two ratios). Two study sites (Vicksburg, Mississippi and Wickliffe, Kentucky) were used. Results are presented for stand ages two, three, and four years which corresponds to the lower to mid-length rotation for the species for a short rotation woody crop (either biomass for energy or fiber for pulp and paper). Average plot height at an age of 4 years was 13.23 m. Plot total yield was affected by intergenotypic competition. The type and level of response to mixing clones depended on the specific clones involved and the planting site. Usually, the most predictable opportunity for over- or underyielding when in binary mixture occurred for clones which differed substantially in pure plot growth and yield. The yield of mixtures of clones of more similar growth patterns sometimes differed significantly from that expected from an additive model, but this was less common. When significant differences did occur between pure clone yields and the yields of their binary mixtures, the plot yield was often a linear function of the proportion of the best clone. Overyielding of mixtures occurred, with additional yields of up to 27 percent of the mixture over the best clone's pure plot yield. **(13)**

Greenberg, Cathryn H.; Simons, Robert W. 1999. **Age, composition, and stand structure of old-growth oak sites in the Florida high pine landscape: implications for ecosystem management and restoration.** Natural Areas Journal. 19(1): 30-4

The authors sampled tree age, species composition, and stand structure of four high pine sites composed of old-growth sand post oak (*Q. margaretta* Ashe), old-growth turkey oak (*Quercus laevis* Walt.), and young longleaf pine (*Pinus palustris* Mill.) in north and central peninsular Florida. The oldest turkey oak sampled was 123 years old, and the oldest sand post oak was 230 years old. Turkey oak exhibited the greatest diameter variation in relation to age. The median number of rings found in rotten and/or hollow turkey oaks was 63 and the corresponding number for sand post oak was 105. Age reconstruction indicated that in 1900 minimum oak tree (≥ 5 cm diameter at breast height) density ranged from 10 to 60 trees ha^{-1} among sites. This study demonstrates that sandhill oak trees historically were an integral component of at least some phases of the high pine ecosystem. These data support the hypothesis that spatial patchiness and variability in fire frequency, season, and intensity historically permitted oaks to reach and maintain tree size in varying densities over time and across the high pine landscape. **(14)**

Haag, Wendell R.; Warren, Melvin L., Jr.; Shillingsford, Mahala. 1999. **Host fishes and host-attracting behavior of *Lampsilis altilis* and *Villosa vibex* (Bivalvia: Unionidae).** American Midland Naturalist. 141: 149-157.

Suitable host fishes were identified for two species of freshwater mussels (Unionidae) from the Coosa River drainage, Mobile Bay: *Lampsilis altilis*, the fine-lined pocketbook and *Villosa vibex*, the southern rainbow. Suitable hosts are defined as fishes that produce

juvenile mussels from glochidial infestations in the laboratory. Larvae of both *L. altilis* and *V. vibex* transformed successfully on five species of sunfishes (Centrarchidae): *Lepomis cyanellus*, *Micropterus coosae*, *M. punctulatus*, and *M. salmoides*. For both mussel species, transformation success on *L. cyanellus* was highly variable and generally lower than on *Micropterus* spp. Gravid female *altilis* and *V. vibex* display highly modified mantle margin lures in the early spring. In addition to displaying mantle lures, *L. altilis* produce superconglutinates, similar to those recently described for three other species of *Lampsilis* in the Southeastern U.S. **(15)**

Haywood, James D.; Martin, Alton, Jr.; Pearson, Henry A.; Grelen, Harold E. 1998. **Seasonal biennial burning and woody plant control influence native vegetation in loblolly pine stands.** Res. Pap. SRS-14. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 8 p.

This paper documents the results of a study to determine the effects of selected vegetation-management treatments in loblolly pine. Vegetation in precommercially thinned, 6-year-old stands was subjected to five biennial growing season burns in either early March, May, or July coupled with hand felling of residual woody stems. Using a randomized complete block design, the authors compared the vegetation-management treatments to an unthinned, unburned, and unweeded check. By stand age 17, intensive vegetation management increased pine diameter growth by 2 centimeters ($\alpha = .004$) and volume growth by 0.04 cubic meters (m³) per tree ($\alpha = .02$) when compared to the check. However, this was a small biological gain in growth. Among the burned treatment five burns in early March reduced average pine total height by 0.8 m ($\alpha = .004$), diameter at breast height by 1.5 cm ($\alpha = .03$), and volume per tree by 0.04 m³ ($\alpha = .06$) compared to burning in early May or July. Vegetation management significantly reduced the height of hardwood trees and shrubs ($\alpha = .0001$), but the number of trees and shrubs per hectare was not significantly affected. Vegetation management significantly increased total herbaceous plant production ($\alpha = .003$). Pinehill bluestem was not on the check plots, but it was the most productive herbaceous species on the vegetation-management treatments, composing 49 percent of the average total annual production of 457 kilograms per hectare. **(16)**

Hemingway, Richard W. 1998. **Opportunities to use bark polyphenols in specialty chemical markets.** In: Swanson, James S., ed. Wood residues into revenue: Proceedings, 2nd biennial residual wood conference; 1997 November 4-5; Richmond, BC. Richmond, BC: MCTI Communications, Inc.: 80-85.

Current forestry practice in North America is to transport pulpwood and logs from the harvest site to the mill with the bark on the wood. Approximately 18 percent of the weight of logs from conifers such as southern pine is bark. The majority of this bark is burned as hog fuel, but its fuel value is low. When compared with natural gas at an average of \$2.50/MBTU or electricity at 3.5 cents/KWH, burning wet bark has a gross fuel value of about 1.2 cents/lb on a dry weight basis. Considering the cost of transport as well as the capital and maintenance costs of boilers, processing bark for fuel is a costly business and seems to be practiced only to avoid a large solid waste management problem. One must not lose sight of the fact that one must handle nearly two lbs of wet bark to recover that 1.2 cents. In addition, concerns about air quality, especially increasingly stringent limits on particulate emissions, has stressed the ability of hog fuel boilers to meet regulatory requirements. The author explores options for producing high value products from bark. **(17)**

Johnston, Carol E.; Knight, Charles L. 1999. **Life-history traits of the bluenose shiner, *Pteronotropis welaka* (Cypriniformes Cyprinidae).** Copeia. 1999(1): 200-205.

Life-history aspects and behavioral ecology of the bluenose shiner (*Pteronotropis welaka*) were investigated from May 1993 to June 1994 in a small tributary of the lower Pearl River in Marion County, MS. Samples were taken monthly or biweekly to provide information about preferred habitat, reproductive biology, and demography. Observations were made during the breeding season to determine spawning strategy. Except during peak spawning periods, bluenose shiners were located in schools of more than 25 individuals in areas of sluggish flow (0-4 cm/sec) near submerged vegetation. Based on gonadal condition, bluenose shiners have a protracted breeding season, lasting from May to August and including two major spawning bouts. Although the spawning act was not observed, aggregations of adults over sunfish nests and the presence of bluenose shiner eggs and fry in nests indicates that this species is a nest associate. Unlike male bluehead shiners (*Pteronotropis hubbsi*), male bluenose shiners show an increase in gonadal weight and a gradual increase in the development of secondary sexual characteristics with increased length. Length frequency data and the absence of adults from the study site in the fall and winter indicate that adults die after the breeding. **(18)**

Kilgo, John C.; Labisky, Ronald F.; Fritzen, Duane E. 1998. **Influences of hunting on the behavior of white-tailed deer: implications for conservation of the Florida panther.** Conservation Biology. 12(6): 1359-1364.

The effects of deer hunting by humans on deer population dynamics and behavior may indirectly affect the population dynamics and behavior of deer predators. The authors present data on the effects of hunting on the behavior of white-tailed deer (*Odocoileus virginianus*) on the Osceola National Forest, a potential reintroduction site for the endangered Florida panther (*Felis concolor coryi*). The authors then use this information to formulate and recommend testable hypotheses to investigate whether these changes in deer behavior influence panther movements, mortality, and hunting success. The authors monitored 14 radio-collared deer from June 1990 through July 1991 to compare movement, activity, and habitat-use patterns between the hunting and non-hunting seasons. Mean distance of deer to the nearest road, mean distance of activity centers of diel home ranges to the nearest road, and mean nocturnal rate of activity were greater during the hunting than the nonhunting seasons. During the hunting season, deer avoided clearcuts, young pine plantations (4-10 years old), and other open habitats and preferred swamp and mature pine forests, both of which provided cover. These results suggest that deer responded to hunter disturbance by moving away from roads and increasing nocturnal activity. Although recreational deer hunting may reduce the prey base for panthers, the changes observed in deer behavior during the hunting season may benefit panthers in the following ways: (1) an increase in nocturnal activity and movement away from roads by deer into areas frequented by panthers may increase prey availability for panthers; (2) the movement of deer away from roads may in turn draw panthers away from roads, which may decrease the chance of panthers being killed by vehicular traffic or poachers. **(19)**

Knoepp, Jennifer D.; Swank, Wayne T. 1998. **Rates of nitrogen mineralization across an elevation and vegetation gradient in the Southern Appalachians.** Plant and Soil. 204: 235-241.

The authors measured nitrogen (N) transformation rates for six years to examine temporal variation across the vegetation and elevation gradient that exists within the Coweeta Hydrologic Laboratory. Net N mineralization and nitrification rates were measured using 28-day in situ closed core incubations. Incubations were conducted at various intervals, ranging from monthly during the growing season, to seasonally based on vegetation phenology. Vegetation types included oak-pine, cove hardwoods, low elevation mixed oak, high elevation mixed oak, and northern hardwoods. Elevations ranged from 782 to 1347 m. Nitrogen transformation rates varied with vegetation type. Mineralization rates were lowest in the oak-pine and mixed oak sites averaging $<1.2 \text{ mg N kg soil}^{-1} \text{ 28 day}^{-1}$. Rates in the cove hardwood site were greater than all other low elevation sites with an annual average of $3.8 \text{ mg N kg soil}^{-1} \text{ 28 day}^{-1}$. Nitrogen mineralization was greatest in the northern hardwood site averaging $13 \text{ mg N kg soil}^{-1} \text{ 28 day}^{-1}$. Nitrification

rates were typically low on four sites with rates $<0.5 \text{ mg N kg soil}^{-1} 28 \text{ day}^{-1}$. However, the annual average nitrification rate of the northern hardwood site was $6 \text{ mg N kg soil}^{-1} 28 \text{ days}^{-1}$. Strong seasonal trends in N mineralization were observed. Highest rates occurred in spring and summer with negligible activity in winter. Seasonal trends in nitrification were statistically significant only in the northern hardwood site. Nitrogen mineralization was significantly different among sites on the vegetation and elevation gradient. While N mineralization rates were greatest at the high elevation site, vegetation type appears to be the controlling factor. (20)

Kreibich, Roland E.; Steynberg, Petrus J.; Hemingway, Richard W. 1998. **End jointing green lumber with SoyBond**. In: Swanson, James S., ed. Wood residues into revenue: Proceedings, 2nd biennial residual wood conference; 1997 November 4-5 Richmond, BC. Richmond, BC: MCTI Communications, Inc.: 80-85.

The possibility of bonding green wood offers the prospect of substantially increasing high value product recovery while at the same time reducing drying costs in the manufacture of lumber. Alkaline hydrolysis of protein-rich fractions from soybeans provides a material that, when combined with phenol-resorcinol-formaldehyde resins, forms a strong gel within seconds and that further polymerizes at room temperature to provide bonds with the strength and durability required for use in structural lumber. Because end-jointing randomizes the strength and grain pattern in wood, this process is especially significant because it offers a way to upgrade plantation grown timber for use in high-value added lumber products rather than use as pulp chips.

This paper describes some of the more important advantages offered through end-jointing green lumber, soy protein hydrolysis conditions that have been successfully scaled up from laboratory to 378 liter (100 US gallons) reactions, and adhesive formulation that have been used to end-joint Douglas fir, Hem fir, and southern pine lumber with only minor alterations of conventional lumber end-jointing lines used in the U.S. The same adhesive formulation can be used to bond dry, wet, or green material (and, importantly, wood with widely varying moisture content). No heat is required to cure the adhesive. Results of both laboratory and mill trial scale tests show that the strength and durability of the adhesive bonds meet requirements for use in structural lumber for either dry or wet use applications. (21)

Kuehler, E.A.; Flagler, R.B. 1998. **The effects of sodium erythorbate and ethylenediurea on photosynthetic function of ozone-exposed loblolly pine seedlings**. Environmental Pollution. 105(1999): 25-35.

In an open-top chamber study in east Texas, ozone-sensitive loblolly pine (*Pinus taeda* L.) seedlings were treated with either the antioxidant Ozoban (74.5 percent sodium erythorbate active ingredient (a.i.)) at 0, 1030, or 2060 mg liter⁻¹ or ethylenediurea (EDU 50 percent a.i.) at 0, 150, or 300 ppm every 2 weeks while being subjected to a range of ozone exposures beginning in April 1994. The ozone exposures included sub-ambient ozone levels (CF), approximate ambient (NF), and 1.5, 2.0, and 2.5 times ambient ozone (1.5 \times , 2.0 \times , and 2.5 \times , respectively). The response variables included net photosynthesis (*A*), stomatal conductance (*g*), chloroplast pigment concentration, and total foliar N concentration. Foliar injury due to ozone was observed early in the growing season, but subsided over time. Ozoban did not have any consistent effects throughout the experiment on the response variable but did cause changes early in the study on gas exchange. Both *g* and *A* photosynthesis were greater at elevated ozone levels in seedlings treated with 1030 mg liter⁻¹ of Ozoban compared to those treated with either 0 or 2060 mg liter⁻¹ for the first sampling period in June. However, at CF, seedlings treated with 1030 mg liter⁻¹ of Ozoban showed signs of reduced *A* compared to the other antioxidant treatments. This indicates that sodium erythorbate may have a negative physiological effect on seedlings in a high ozone environment. For EDU-treated seedlings, no consistent antioxidant treatment effects were observed, but linear regression analysis indicates that EDU shows promise in providing protection from ozone injury. At 150 ppm, EDU may retard stomatal

closure in younger pine seedlings. No consistent benefit was afforded to chloroplast pigments for the study by either antioxidant. Ozoban at 2060 mg liter⁻¹ appeared to have phytotoxic effects with regards to chlorophyll a and total carotenoids in the latter stage of the experiment. No significant Ozoban or EDU effects were observed with respect to total foliar N concentration until the final sampling period in October, where foliage treated with 300 ppm of EDU displayed higher N concentration at all ozone levels except 1.5× ambient ozone. Foliage treated with 150 ppm EDU showed the lowest nitrogen concentration in CF and NF, but the highest 1.5×. Because of relatively low ozone exposures during the study year and the closeness with which the seedlings were grown, these results may not accurately represent the benefits of sodium erythorbate or EDU in reducing ozone stress in loblolly pine seedlings for field-grown trees. **(22)**

Lonzarich, David George; Warren, Melvin L., Jr.; Lonzarich, Mary Ruth Elger. 1998. **Effects of habitat isolation on the recovery of fish assemblages in experimentally defaunated stream pools in Arkansas.** Canadian Journal of Fisheries and Aquatic Sciences. 55: 2141-2149.

The authors removed fish from pools in two Arkansas streams to determine recolonization rates and the effects of isolation (i.e., riffle length, riffle depth, distance to large source pools, and location), pool area, and assemblage size on recovery. To determine pool-specific recovery rates, the authors repeatedly snorkeled 12 pools over a 40-day recovery period. Results indicated the effects of isolation on percent numerical recovery, but no effects of pool area or assemblage size. Numerical recovery of assemblages in pools separated from neighboring pools by short riffles occurred by day 30, whereas more isolated pools had not reached 70 percent numerical recovery by day 40. Recovery also was more rapid in downstream pools and in pools that were closer to large source pools. Finally, recovery patterns differed among species and size-classes, with large fish (<100 mm total length) recolonizing pools more rapidly than small fish. This is the first study to quantify species- and assemblage-level recolonization rates at the scale of individual pools and the effects of isolation on recovery. The findings of this study have potentially important implications for research aimed at understanding the ecology of stream fishes and predicting the consequences of land-use activities. **(23)**

McMahon, C.K.; Tomczak, D.J.; Jeffers, R.M. 1998. **Longleaf pine ecosystem restoration: the role of the USDA Forest Service.** In: Kush, John S., comp. Ecological restoration and regional strategies: Proceedings of the longleaf pine ecosystem restoration symposium; Society of Ecological Restoration, 9th annual international conference; 1997 November 12-15; Longleaf Alliance Report No. 3. Fort Lauderdale, FL: Longleaf Alliance: 20-31.

The greater longleaf pine ecosystem once occupied over 90 million acres from southeastern Virginia, south to central Florida, and west to eastern Texas. Today less than 3 million acres remain, with much of the remaining understory communities in an unhealthy state. A number of public and private conservation organizations are conducting collaborative longleaf pine ecosystem restoration activities throughout the South. The USDA Forest Service has three roles or program areas which are contributing to a regional restoration/conservation strategy for the longleaf pine ecosystem, including: (1) expansion of the longleaf pine forest type and fire dependent understory communities on the national forests of the South; (2) providing voluntary, non-regulatory incentives through State and Private Forestry programs; and (3) expansion of collaborative research programs. **(24)**

McNab, W. Henry; Browning, Sara A.; Simon, Steven A.; Fouts, Penelope E. 1999. **An unconventional approach to ecosystem unit classification in western North Carolina, USA.** Forest Ecology and Management. 114: 405-420.

The authors used an unconventional combination of data transformation and multivariate analyses to reduce subjectivity in identification of ecosystem units in a mountainous region of western North Carolina, USA. Vegetative cover and environmental variables were measured on 79 stratified, randomly located, 0.1 ha sample plots in a 4000 ha watershed. Binary transformation percent cover followed by direct and indirect ordination indicated the 185 inventoried species were associated primarily with soil A horizon thickness, soil base saturation, and aspect. Redundant cluster analyses, consisting of divisive and agglomerative methods for multivariate classification of core plots, followed by selective discriminant analysis of remaining non-core plots, indicated that a continuum of vegetation and environment could be grouped into five ecosystem units. Approximately 20 herbaceous, shrubs, an tree species and several soil and topographic variables were highly significant discriminators of ecosystem units. The authors also demonstrated that redundant cluster analysis may be used to subdivide ecosystem units into subunits of uniform understory composition and associated environment. Validation and refinement of classification units, linkage with faunal biological components, and arrangement into landscape areas suitable for resource management is needed before field application. **(25)**

Miller, J.H. 1997. **Basal streamline sprays for hardwood resprout control: herbicides, concentrations, and streaks per stem.** In: Dusky, Joan A., ed. Fifty years of weed science: foundation for the future; Proceedings, 50th annual Southern Weed Science Society meeting; 1997 January 20-22; Houston, TX. Champaign, IL: Southern Weed Science Society: 88-94.

Basal streamline sprays were tested to control sweetgum, water oak, and southern red oak that ranged from 0.5 to 2 inches groundline diameter. Primary test herbicides and mixtures were triclopyr (Garlon 4) at 20 and 40 percent mixed with 10 percent limonene (Cide-Kick) and the remainder diesel; and imazapyr (Chopper) at 5 and 10 percent mixed in only diesel. Primary herbicide mixtures were applied with three doses: (a) to one stem side using one streak; (b) to one side using two streaks; and (c) to two sides using two streaks per side. Secondary test herbicides were tested only using two streaks to one side. All applications were in April. Individual rootstocks were the experimental units and assessment was 18 months after application. Increasing doses of primary herbicides resulted in increasing control. Both triclopyr and imazapyr at the highest concentrations and doses yielded greater than 80 percent crown volume reduction for sweetgum and the oaks. Rootstock control was greatest for the highest concentration doses as well. Treatments to one stem side were most effective with imazapyr at the high concentration. Southern red oak was the most difficult species to control. In general, the secondary herbicides were less effective than the primary herbicides. **(26)**

Miller, James H. 1997. **Exotic invasive plants in southeastern forests.** In: Britton, Kerry O., ed. Proceedings, exotic pests of Eastern forests; 1997 April 8-10; Nashville, TN. [Place of publication unknown]: Tennessee Exotic Pest Plant Council: 97-106.

Invasive exotic plants usurp forest productivity, hinder forest-use activities, and limit diversity on millions of acres of forest land in the Southeast. Infestations of these plants and their range are constantly expanding. This paper examines the various aspects of the problem. Outlined are the biology, origin, range, uses, and herbicide control for 14 of the most prevalent exotic trees, shrubs, vines, and grasses. Losses on forest lands will continue to increase until importation of new exotic species is controlled, integrated weed management programs are organized, and effective control procedures are implemented. Biological control technology using insect and pathogenic predators from the plant's home country offers the best long-term solution for subduing exotic invasive species. **(27)**

Miller, J.H. 1998. **Primary screening of forestry herbicides for control of Chinese privet (*Ligustrum sinense*), Chinese wisteria (*Wisteria sinensis*), and trumpetcreeper (*Campsis radicans*) [Abstract]**. In: Proceedings, 51st annual Southern Weed Science Society meeting; 1998 January 26-28; Birmingham, AL. Champaign, IL: Southern Weed Science Society: 161-162.

Exotic and native invasive plants increasingly hinder land management, use, and restoration projects. Chinese and Japanese privet are rapidly becoming major threats to future hardwood culture and currently hinder ROW management throughout the southeastern region. Chinese wisteria occurs as severe, dense isolated infestations in forest stands. Native trumpetcreeper can form dense ground cover under plantations that will require control before reestablishment. The objective of this research was to perform primary screening of forestry herbicides as foliar sprays on these three invasive species to identify efficacious active ingredients for further developmental research and treatment refinement. **(28)**

Rauscher, H. Michael. 1999. **Ecosystem management decision support for federal forests in the United States: a review** Forest Ecology and Management. 114: 173-197.

Ecosystem management has been adopted as the philosophical paradigm guiding management on many Federal forests in the United States. The strategic goal of ecosystem management is to find a sensible middle ground between ensuring long-term protection of the environment while allowing an increasing population to use its natural resources for maintaining and improving human life. Ecosystem management has all the characteristics of "wicked" problems that are tricky, complex, and thorny. Ambiguities, conflicts, internal inconsistencies, unknown but large costs, lack of organized approaches, institutional shock and confusion, lack of scientific understanding of management consequences, and turbulent, rapidly changing power centers all contribute to the wickedness of the ecosystem management paradigm. Given that ecosystem management, like human survival and welfare, is a wicked problem, how can we proceed to tame it? Managers need to use the same tools that people have always used for handling such problems – knowledge, organization, judicious simplification, and inspired leadership. The generic theory decision support system development and application is well developed. Numerous specific ecosystem management decision support systems (EM-DSS) have been developed and are evolving in their capabilities. There is no doubt that given a set of ecosystem management processes to support and adequate time and resources, effective EM-DSS can be developed. On the other hand, there is considerable doubt that sufficiently detailed, explicitly described, and widely accepted processes for implementing ecosystem management can be crafted given the current institutional, educational, social, and political climate. A socio-political climate in which everyone wants to reap the benefits and no one wants to pay the costs, incapacitates the Federal forest management decision-making process. Developing a workable ecosystem management process and the decision-making tools to support it is probably one of the most complex and urgent challenges facing us today. This paper offers a concise review of the state of the art of decision support systems related to implementing ecosystem management. A conceptual model of the context in which ecosystem management is expected to function is presented. Next, a candidate for an operational ecosystem management process is described and others are referenced. Finally, a generic ecosystem management decision support system is presented and many existing systems briefly described. **(29)**

Reeve, John D.; Rhodes, Douglas J.; Turchin, Peter. 1998. **Scramble competition in the southern pine beetle, *Dendroctonus frontalis***. Ecological Entomology. 23: 433-443.

The nature of intraspecific competition was investigated in the southern pine beetle, *Dendroctonus frontalis*, a highly destructive pest of pine forests in the Southern U.S.A. Data were analyzed from an observational study of naturally-attacked trees, and from

field experiments where attack density was manipulated by adding different numbers of beetles to caged trees. The effect of attack density on gallery construction, oviposition, brood survival, and the overall rate of increase were examined, and a flexible model of intraspecific competition used to classify the type of competition (contest or scramble) at different points in the life cycle. The results of these analyses suggest that contest competition occurs during gallery construction and oviposition, in accord with previous work on *D. frontalis*. Strong scramble competition occurs later on in development, however, and the overall competitive process is better characterized as scramble competition, similar to other bark beetles. Trees with attack densities sufficiently high to produce significant competition are common in the field. **(30)**

Rudis, Victor; Thill, Ronald E.; Gramann, James H.; and others. 1999. **Understory structure by season following uneven-age reproduction cutting: a comparison of selected measures 2 and 6 years after treatment.** Forest Ecology and Management 114: 309-320.

Deciding among cutting practices requires knowledge of forest structure, understory vegetation change, rates of recovery, and resource impacts. The authors used two field devices (a screenometer and a density board) and digital images of 35 mm photographs to compare measures and document the change in understory vegetation structure in forests following reproduction cutting disturbances. The study area, mostly 70-year old second-growth shortleaf pine-oak (*Pinus echinata-Qercus* spp.) had an average basal area of 26 m²/ha. Treatments retained 13.8 m²/ha in pine and three levels of hardwood basal area. The 21 m²/ha treatment retained 33 percent hardwood basal area in a scattered condition. One 17 m²/ha treatment retained 20 percent hardwoods in a clustered or grouped pattern, and another treatment retained 20 percent hardwoods scattered throughout. A fourth treatment retained no hardwood basal area. When compared with untreated (control) plots, vegetative screening increased on treated plots relative to untreated plots by degree of initial cutting disturbance. Both the screenometer and the density board readings distinguished between control and treated plots, but significant differences occurred by season, year, and height above ground. Digital information from scanned images yielded promising results by detecting significant differences in the amount of blue color intensity and the proportion of line objects. Color intensities were significantly different by season and year after treatment, that is, lowest in summer and highest in spring, and greater 2 years after treatment rather than 6 years after treatment. Results indicated that detection of disturbed conditions and recovery following disturbance varied with the scale and type of measurement. Each device estimated different structural dimensions. The authors concluded that assessment and modeling of understory structure, change, and recovery depended strongly on the cell size of the device used. **(31)**

Schaefer, Richard R. 1998. **First county records of red crossbill in the pineywoods region of eastern Texas.** Bulletin of Texas Ornithological Society. 31(2): 63-64.

The red crossbill (*Loxia curvirostra*) is reported from western Texas as a scarce and sporadic breeder in the Guadalupe Mountains and a probable rare or irregular nester in the Davis Mountains. It is also a rare and irregular winter visitor in many parts of the State. Red crossbills invaded much of Texas during the 1972-1973 winter. This invasion missed the pineywoods region east of the Trinity River, with the exception of a single sight record in Polk County. Several northern, seed-eating bird species, including the red crossbill, are well known for their irregular, irruptive movements. These movements are believed to coincide with times of food shortages in the species' normal range. **(32)**

Schlarbaum, Scott E.; Hebard, Frederick; Spaine, Pauline C.; Kamalay, Joseph C. 1997. **Three American tragedies: chestnut blight, butternut canker, and Dutch elm disease.** In: Britton, Kerry O., ed. Proceedings, exotic pests of Eastern forests; 1997 April 8-10; Nashville, TN. [Place of publication unknown]: Tennessee Exotic Pest Plant Council: 45-54.

Three North American tree species, American chestnut (*Castanea dentata*), butternut (*Juglans cinerea*), and American elm (*Ulm americana*), have been devastated by exotic fungal diseases over the last century. American chestnut was eliminated from eastern forests as a dominant species by chestnut blight (*Cryphonectria parasitica*). Butternut is presently being extirpated, as butternut canker disease (*Sirococcus clavigigenti-juglandacearum*) spreads into northern populations. Urban and forest American elm populations have been decimated by Dutch elm disease (*Ophiostoma ulmi* and *O. nova-ulmi*). A combination of basic and applied research has been directed toward developing resistant trees of each species. Resistant American elms are now available for planting in urban settings. The prospects for reintroduction of resistant American chestnut, butternut, and American elm into eastern forests appear to be promising.

Forest ecosystems are subjected to many biotic and abiotic stresses. Native insects and diseases, droughts, windstorms, and wildfire periodically impact forests or specific tree species, leaving dead or weakened trees. The effects of these stresses may be manifested locally or over a large area, yet they do not cause species extinction. In contrast, exotic pests can threaten the continued existence of a species. Often host species have not evolved genetic resistance to exotic pests, as coevolutionary processes have not occurred.

Three prominent North American tree species, American chestnut (*Castanea dentata* ((Marsh.)) Borkh.), butternut (*Juglans cinerea* L.), and American elm (*Ulm americana* L.) have been severely impacted by three exotic fungal diseases, chestnut blight (*Cryphonectria parasitica* ((Murr.)) Barr), butternut canker (*Sirococcus clavigigenti-juglandacearum* Nair, Kostichka & Kuntz), and Dutch elm disease (*Ophiostoma ulmi* ((Buis.)) Nannf and *O. nova-ulmi*). The authors give a brief account of the impacts of these diseases on their host species, examples of research approaches for disease control, and a prognosis for the future of each species. **(33)**

Schmidting, R.C.; Hipkins, V. 1998. **Genetic diversity in longleaf pine (*Pinus palustris*): influence of historical and prehistorical events.** Canadian Journal of Forest Research. 28: 1135-1145.

Genetic diversity of allozymes at 24 loci was studied in 23 populations of longleaf pine (*Pinus palustris* Mill.), including three seed orchard populations and an old-growth stand. Overall, the mean number of alleles per polymorphic locus was 2.9, the percentage of polymorphic loci was 92 percent, and the mean expected heterozygosity was 0.105. These values are comparable with diversity measures found in a similar loblolly pine (*Pinus taeda* L.) study. Diversity measures of the seed orchard sources and the old-growth stand were similar to those in the other natural seed sources. F statistics indicate very little inbreeding overall ($F_{IS} = -0.002$) and low differentiation among populations ($F_{ST} = 0.041$). All measures of genetic diversity were significantly related to longitude; western sources tended to have more allozyme diversity. Since growth or survival are not related to longitude, and no important climatic variables are related to longitude within the natural range of longleaf, it is proposed that the east-west variation in longleaf pine is a result of migration from a single refugium, in the west (south Texas or northeastern Mexico) after the Pleistocene. **(34)**

Schmitt, Christopher J.; Lemly, A. Dennis; Winger, Parley V. 1993. **Habitat suitability index model for brook trout in streams of the Southern Blue Ridge Province: surrogate variables, model evaluation, and suggested improvements.** Biological Report 18: Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 43 p.

Data from several sources were collated and analyzed by correlation, regression, and principal components analysis to define surrogate variables for use in the brook trout (*Salvelinus fontinalis*) habitat suitability index (HSI) model, and to evaluate the applicability of the model for assessing habitat in high elevation streams of the southern Blue Ridge Province (SBRP). In all data sets examined, pH and alkalinity were highly correlated, and both declined with increasing elevation; however, the magnitude of the decline varied with underlying rock formations and other factors, thereby restricting the utility of elevation as a surrogate for pH. In the data sets that contained biological information, brook trout abundance (as biomass, density, or both) tended to increase with elevation and decrease with the abundance of rainbow trout (*Oncorhynchus mykiss*), and was not significantly correlated ($P > 0.05$) with the abundance of most benthic macroinvertebrate taxa normally construed as important in the diet of brook trout. Using multiple linear regression, the authors formulated an alternative HSI model – based on point estimates of gradient, pH, elevation, stream width, and rainbow trout density – which explained 40 to 50 percent of the variance in brook trout density in 256 stream reaches. Although logically developed, the present U.S. Fish and Wildlife Service HSI model, proposed in 1982, seems deficient in several areas, especially when applied to SBRP streams. The authors recommend that the water quality component in the model be updated and reevaluated, focusing on the differential sensitivities of each life stage, the stochastic nature of the water quality variables, and the possible existence of habitat requirements that differ among brook trout strains. **(35)**

Simons, T.; Rabenold, K.; Buehler, D.; and others. 1999. **The role of indicator species: Neotropical migratory song birds.** Peine, John D., ed. Ecosystem management for sustainability: principles and practices illustrated by a regional biosphere reserve cooperative. Boca Raton, FL: CRC Press, Lewis Publishers: 187-208. **(Editor's note: Kay Franzreb, Southern Research Station scientist and project leader, co-authored this chapter.)**

Southern Appalachian forests support some of the richest avian diversity in North America, including some 75 species of Neotropical migrants, birds that perform the remarkable feat of making much of the Western Hemisphere their home. This diverse group includes the swallows, kingbirds, and other flycatchers that feed in the air on flying insects. The Eastern kingbird is a typical species. It breeds in forested areas, primarily the Eastern U.S. and winters in Central America and Northern South America. Species such as tanagers glean insects from forest foliage and also feeds extensively on fruit. Other groups include the vireos, orioles, thrushes, and even the tiny hummingbirds.

But the largest and most striking members of this group of birds are the wood warblers, some 50 closely related species of what can best be referred to as “quintessential” songbirds. These brightly colored songsters occupy an astonishing diversity of habitats. The Blackburnian warbler inhabits the spruce-fir forests as far north as boreal Canada. Black and white warblers glean insects from branches of the tallest trees in mature deciduous forests but nest on the ground. Worm-eating warblers are specialists at prying insects out of the protective covering of curled up leaves, while Chestnut-sided warblers are shrub nesting specialists of disturbed sites and forest edges.

Neotropical migrants predominate in the breeding bird community of eastern deciduous forests. In some parts of the Southern Appalachians, up to 80 percent of the breeding bird community is comprised of these species. These approximately 75 species use ground, shrub, and especially canopy nests, and about 80 percent of them are insectivores. Recent concern over the status of these birds has been prompted by surveys showing widespread population declines. **(36)**

Spetich, Martin A.; Parker, George R. 1998. **Plot size recommendations for biomass estimation in a midwestern old-growth forest.** Northern Journal of Applied Forestry. 15(4): 165-168.

The authors examine the relationship between disturbance regime and plot size for woody biomass estimation in a midwestern old-growth deciduous forest from 1926 to 1992. Analysis was done on the core 19.6 ac of a 50.1 ac forest in which every tree 4 i d.b.h. and greater has been tagged and mapped since 1926. Five windows of time are compared—1926, 1976, 1981, 1986 and 1992. The most efficient plot sizes requiring measurement of the least total area range from 0.02 to 1.6 ac. A small plot size was recommended after grazing disturbance, and a large size was recommended when mortality was high and acceptable error was low. **(37)**

Stringer, Jeffrey W.; Loftis, David L., eds. 1999. **Proceedings, 12th Central Hardwood Forest Conference;** 1999 February 28 March 1-2; Lexington, KY. Gen. Tech. Rep. SRS-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 293 p.

There were 32 oral presentations, 11 abstracts, and 22 poster presentations presented at the 12th Central Hardwood Forest Conference. Presentation topics included wildlife management, nutrient dynamics, stand structure, reforestation/reclamation, timber harvesting, modeling and inventory, silviculture, disturbance effects, and genetics/tree improvement. **(38)**

Sun, Jianghua; DeBarr, Gary L.; Berisford, C. Wayne; Schauff, Michael E. 1998. **Description of new primary parasitoid, *Zarhopalus Ashmead* (Hymenoptera: Encyrtidae), of *Oracella Acuta* (Homoptera: Pseudococcidae).** The Canadian Entomologist. 130: 793-797.

Zarhopalus debarri Sun sp.nov. reared from the loblolly pine mealybug, *Oracella acuta* (Lobdell), in the Southeastern United States is described. **(39)**

Tarrant, Michael A.; Smith, Erin; Cordell, H. Ken. 1999. **Recreation visitor preferences for and perceptions of outdoor recreation setting attributes.** In: Tarrant, Michael A.; Bright, Alan D.; Smith, Erin; Cordell, H. Ken. 1999. Motivations, attitudes preferences, and satisfactions among outdoor recreationists; 403-431. In: Cordell, H. Ken; Betz, Carter; Bowker, J.M.; and other: Outdoor recreation in American life: a national assessment of demand and supply trends. Champaign, IL: Sagamore Publishing; 412-431.

Between 1990 and 1994, a comprehensive national survey was conducted by the USDA Forest Service (FS), Southern Research Station, to measure visitor preferences for, and perceptions of, setting attributes at a variety of outdoor recreation sites. Over 11,000 visitors at 31 outdoor recreation sites across the country were interviewed in this study. The study was entitled CUSTOMER which is an acronym for Customer Use and Survey, Techniques for Operations, Management, Evaluations, and Research. Sites included those managed by the FS, the Bureau of Land Management (BLM), and the Tennessee Valley Authority (TVA). This [chapter] section presents results of analysis of CUSTOMER data on visitor preferences for, and satisfaction with, site attributes corresponding to five specific recreation settings (developed, dispersed, water, roaded, and winter) and one general outdoor

setting. This [chapter] section provides an overview to visitor satisfactions with, and preferences for, attributes of specific and general outdoor recreation settings using an importance-performance framework. Three objectives were addressed to determine (1) specific setting attributes that outdoor recreation managers should target, i.e., the “concentrate here” quadrant of the importance-performance framework; (2) the effect of visitor demographic characteristics on their importance and performance ratings; and (3) the effect of trip characteristics on visitor importance and performance. **(40)**

Taulman, James F.; Smith, Kimberly G.; Thill, Ronald E. 1998. **Demographic and behavioral responses of southern flying squirrels to experimental logging in Arkansas.** *Ecological Applications*. 8(4): 1144-1155.

This study investigated responses of populations of southern flying squirrels to a range of experimental even-aged and uneven-aged timber-harvest practices along a gradient of increasing disturbance intensity. The goals were to determine whether measurable demographic parameters of squirrels in experimental forests would change after logging; whether a disturbance threshold existed within the range of harvest practices implemented beyond which squirrels would not nest on a stand; and whether squirrels would show selection in the use of nest boxes in logged and unlogged habitats.

Winter nest-box surveys were conducted in the Ouachita National Forest, AR, USA, in 21 15 ha stands representing three replicated groups of six silvicultural treatments (pine-hardwood single-tree selection; pine single-tree selection; pine-hardwood shelterwood; pine shelterwood; pine-hardwood seed tree; and pine seed tree), plus an unaltered control during 1993, prior to harvest, and after harvest in 1994-1996. Neither densities of nesting squirrels nor use of boxes for nests or feeding stations differ among treatment groups prior to harvests. Densities declined on all harvested stands after treatment in 1994; during the same period, population growth was observed on control stands. A partial rebound in squirrels' use of nest boxes in some harvested stands occurred in 1995 and 1996. Prior to harvest, squirrels used boxes in all habitats in similar proportions. After logging, frequency of box use in greenbelt habitat (unharvested buffer strips along intermittent streams) was significantly greater than in harvested areas. On control stands the ratio of boxes used to those available did not change throughout the study. The ratio of boxes used per squirrel increased on harvested stands, even as squirrel densities declined, indicating a reduction in natural nesting resources after logging. The presence of mature forests adjacent to harvested stands, as well as retention of greenbelt habitat, overstory hardwoods, and snags within harvested areas, reduced the severity of logging impacts on flying squirrels. The seed-tree harvest regime, particularly without retained overstory hardwoods, appears to produce a level of disturbance and resource depletion that is too severe for flying squirrel persistence. **(41)**

Teasley, R. Jeff; Bergstrom, John C.; Cordell, H. Ken; and others. 1999. **Private lands and outdoor recreation in the United States.** In: Cordell, H. Ken; Betz, Carter; Bowker, J.M.; and others. *Outdoor recreation in American life: a national assessment demand and supply trends.* Champaign, IL: Sagamore Publishing: 183-218.

Outdoor recreation on private land is influenced by myriad factors. To provide background and context on these factors, this chapter first overviews the private land situation in the United States and provides general information and discussion related to ownership and tenure, land-use patterns, legal restrictions, and economic conditions, including taxation issues. Implications of these factors with respect to use of private land for outdoor recreation are also discussed.

Overall, there is little extant information on recreational use and access to private land. To help fill this information gap, the National Private Landowners Survey (NPLOS) was recently conducted (1995-1996). A major focus of NPLOS was to obtain data

for estimating the amount of private land open for outdoor recreation in the United States and landowner practices and attitudes related to access to their lands for outdoor recreation. The NPLOS methodology, results, and the implications of these results are discussed after a brief review of recreation use of private land. This chapter ends by offering general conclusions about outdoor recreational use of private lands in the United States. **(42)**

Thompson, Michael T. 1998. **Forest statistics for Georgia, 1997**. Resour. Bull. SRS-36. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 92 p.

This report summarizes a 1997 inventory of the forest resources for the State of Georgia. Major findings are highlighted in text and graphs; detailed data are presented in 51 tables. **(43)**

Thompson, Michael T. 1998. **Forest statistics for North Central Georgia**. 1998. Resour. Bull. SRS-34. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 60 p.

This report summarizes a 1998 inventory of the forest resources of a 32-county area of Georgia. Major findings are highlighted in text and graphs; detailed data are presented in 51 tables. **(44)**

Thompson, Michael T. 1998. **Forest statistics for North Georgia, 1998**. Resour. Bull. SRS-35. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 59 p.

This report summarizes a 1998 inventory of the forest resources of a 21-county area of Georgia. Major findings are highlighted in text and graphs; detailed data are presented in 51 tables. **(45)**

Warren, Melvin L., Jr.; Pardew, Mitzi, G. 1998. **Road crossings as barriers to small-stream fish movement**. Transactions of the American Fisheries Society. 127: 637-644.

The authors used mark-recapture techniques to examine the effects of four types of road crossings on fish movement during spring base flows and summer low flows in small streams of the Ouachita Mountains, west-central Arkansas. The authors assessed movement for 21 fish species in seven families through culvert, slab, open-box, and ford crossings and through natural reaches. The authors detected no seasonal or directional bias in fish movement through any crossing type or the natural reaches. Overall fish movement was an order of magnitude lower through culverts than through other crossings or natural reaches, except no movement was detected through the slab crossing. In contrast, open-box and ford crossings showed little difference from natural reaches in overall movement of fishes. Numbers of species that traversed crossings and movement within three of four dominant fish families (Centrarchidae, Cyprinidae, and Fundulidae) also were reduced at culverts relative to ford and open-box crossings and natural reaches. In spring, retention of fishes was consistently highest in stream segments upstream of crossings and lowest in downstream segments for all crossing types, a response attributed to scouring associated with spring spates. Water velocity at crossings was inversely related to fish movement; culvert crossings consistently had the highest velocities and open-box crossings had the lowest. A key requirement for improving road crossing designs for small-stream fish passage will be determination of critical levels of water velocity through crossings. **(46)**

Wear, David N.; Bolstad, Paul. 1998. **Land-use changes in Southern Appalachian landscapes: spatial analysis and forecast evaluation.** *Ecosystems*. 1: 575-594.

Understanding human disturbance regimes is crucial for developing effective conservation and ecosystem management plans and for targeting ecological research to areas that define scarce ecosystem services. The authors evaluate and develop a forecasting model for land-use change in the Southern Appalachians. The authors extend previous efforts by (a) addressing the spatial diffusion of human populations, approximated by building density; (b) examining a long time period (40 years, which is epochal in economic terms); and (c) explicitly testing the forecasting power of the models. The resulting model, defined by linking a negative binomial regression model of building density with a logit model of land cover, was fit using spatially referenced data from four study sites in the Southern Appalachians. All fitted equations were significant, and coefficient estimates indicated that topographic features, as well as location, significantly shape population diffusion and land use across these landscapes. This is especially evident in the study sites that have experienced development pressure over the last 40 years. Model estimates also indicate significant spatial autocorrelation in land-use observations. Forecast performance of the models was evaluated by using a separate validation data set for each study area. Depending on the land-use classification scheme, the models correctly predicted between 68 percent and 89 percent of observed land uses. Tests based on information theory reject the hypothesis that the model has no explanatory power, and measures of entropy and information gain indicate that the estimated models explain between 4 percent and 66 percent of uncertainty regarding land-use classification. Overall, these results indicate that modeling land-cover change alone may not be useful over the long run, because changing land cover reflects the outcomes of more than one human process (for example, agricultural decline and population growth). Here, additional information was gained by addressing the spatial spread of human populations. Furthermore, coarse-scale measures of the human drivers of landscape change (for example, population growth measured at the county level) appear to be poor predictors of changes realized at finer scales. Simulations demonstrate how this type of approach might be used to target scarce resources for conservation and research effort into ecosystem effects. **(47)**

White, David L.; Lloyd, F. Thomas. 1998. **An old-growth definition for dry and dry-mesic oak-pine forests.** Gen. Tech. Rep. SRS-23. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 42 p.

Dry and dry-mesic oak-pine forests are widely distributed from New Jersey to Texas, but representative old-growth stands are rare. Historical accounts of composition, along with information from existing old-growth stands, were used to characterize this type. Shortleaf pine and white oak were the most widely distributed trees across all old-growth stands. Shortleaf was the primary pine species of the oak-pine type in the Piedmont, Gulf Coastal Plain, and Interior Highlands, while pitch pine was predominant in the mountainous regions. Scarlet and chestnut oaks were more prevalent in the Appalachians. Maximum age for pitch and shortleaf pines exceeded 200 and 300 years, respectively. Forests of this type do not adhere to the steady state or equilibrium concept of forest dynamics; rather old-growth oak-pine may be ephemeral on a given site. Disturbance by fire or other agents distributed through space and time is required for its maintenance on the broader landscape. Characteristics of the living and dead components of old-growth oak-pine are presented. **(48)**

Zutter, Bruce R.; Miller, James H. 1998. **Eleventh-year response of loblolly pine and competing vegetation to woody and herbaceous plant control on a Georgia flatwoods site.** *Southern Journal of Applied Forestry*. 22(2): 88-95.

Through 11 growing seasons, growth of loblolly pine (*Pinus taeda* L.) increased after control of herbaceous, woody, or both herbaceous and woody vegetation (total control) for the first 3 years after planting on a bedded site in the Georgia coastal flatwoods. Gains in stand volume index from controlling either herbaceous or woody vegetation alone were approximately two-thirds that from controlling both types of vegetation. Pine response through age 11 was approximately equal for herbaceous control alone and woody control alone, whereas response through age 5 was greater with control of only herbaceous vegetation. The impact of woody vegetation should continue to have a strong effect on pine growth through midrotation because of its continued development. This is in contrast to herbaceous weeds that have greatly decreased in abundance since age 6. **(49)**