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Planting and Care of Fine Hardwood Seedlings

Hardwood Tree Improvement and Regeneration Center

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Poster Abstracts of the Central Hardwood Forest Conference

16th Central Hardwood Forest Conference — April 7-9, 2008

This publication includes the poster abstracts presented at the 16th Central Hardwood Forest Conference on April 7-9, 2008. The Central Hardwood Forest Conference is a series of biennial meetings that have been hosted by universities and research stations of the U.S. Forest Service in the Central Hardwood Forest region in the Eastern United States. The objective of the conference is to bring together forest managers and scientists to discuss research and issues concerning the ecology and management of forests in the Central Hardwood region.

The 2008 conference was co-hosted by the Purdue University Department of Forestry & Natural Resources and the Hardwood Tree Improvement and Regeneration Center. It was held in Lafayette, Indiana at the Holiday Inn Select City Centre near the Purdue University campus.

2008 Steering Committee:

Liz Jackson
Purdue University Department of
Forestry & Natural Resources
1007 North 725 West
West Lafayette, IN 47906-9431
Phone: (765) 583-3501
Fax: (765) 583-3512
jackson@purdue.edu

Douglass F. Jacobs
Associate Professor
Hardwood Tree Improvement and
Regeneration Center
Purdue University Department of
Forestry & Natural Resources
715 West State Street
West Lafayette, IN 47907
Phone: (765) 494-3608
Fax: (765) 494-9461
djacobs@purdue.edu

Charles H. Michler
Director, Hardwood Tree Improvement and
Regeneration Center at Purdue University
NSF I/UCRC Center for Tree Genetics
USDA Forest Service, Northern Research Station
715 W. State Street
West Lafayette, IN 47907-2061
Phone: 765-496-6016
Fax: 765-494-9461
michler@purdue.edu or cmichler@fs.fed.us
www.htirc.org

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Effects of Seasonal Prescribed Fire on Oak Reproduction in Stands Impacted by Oak Decline in the Ozark National Forest

Kathryn R. Booker,[1] Hal O. Liechty,[1] and Jamie L. Schuler[1]*

[1]School of Forest Resources, University of Arkansas at Monticello, AR 71656
[*]Author of Correspondence (email:booker@uamont.edu Phone: 870-460-1052)

Abstract — The Ozark and Ouachita Mountains of Arkansas have been impacted by oak decline, which has resulted in high mortality rates for several red oak species. During the decline, outbreaks of red oak borer (*Enaphalodes rufulus*) populations degraded over 300,000 acres in the Ozark National Forest. Recent studies conducted in a number of stands impacted by oak decline have indicated that non-oak regeneration composed 73% of all understory (1-4"dbh) and 82% of seedlings of advance regeneration (seedlings <1" dbh and >4.5' tall). White oak and red oak species comprised only 17 and 4 % of understory stems, indicating that the regeneration potential for oak species is poor in these degraded upland stands. Previous studies have illustrated fire can be used as an effective silvicultural tool to reduce the density of non-oak understory stems, promote sprouting from the base of oak stems, and alter environmental conditions to favor oak survival. Thus, recurrent, low-intensity fires could help to accumulate and enhance oak reproduction in these degraded stands thereby facilitating restoration of degraded or declining oak stands. This study was designed to evaluate the effects of dormant and growing season understory burns on oak reproduction in upland oak stands that have experienced elevated oak dieback and mortality.

The study is being conducted at three sites, each of which contains a control, dormant season, and growing season treatment. Currently, only one site has received all treatments. Overall density of seedlings and understory was respectively 1,411 and 362 stems/acre. Oak comprised 38% of the seedlings and 39% of the understory. Five months after the dormant season fire, the number of seedlings increased by 62% and the number of understory decreased by 23%. Prior to the dormant season burn, red and white oaks comprised 40 and 25 % of seedlings and 37 and 21 % of understory stems. At the end of the growing season, red and white oaks accounted for 40 and 7 % of the seedlings and 27 and 30 % of the understory respectively. A sub-sample of oaks, red maple, and blackgum seedlings were selected prior to the dormant season burn for monitoring. All of these seedlings were top killed by the dormant season fire. Five months after the dormant season fire 62% of the oak, 50% of the red maple, and 100% of the blackgum had produced a sprout at least 2' tall. A similar sub-sample of seedlings in the growing season fire treatment was also monitored. The growing season fire top killed 88% of these seedlings; however only a small proportion exhibited sprouts taller than 6" at the end of the growing season. A total of 66% of the measured saplings and midstory trees (0.6-4.5" dbh) were top killed by the dormant season fire and <1% by the growing season fire. Frequency of stump sprouting from the base of stems was highest in the 1 and 2" dbh classes. These trees had an average of 4.7 sprouts per stem and an average sprout height of 3.2'.

How Do Retailers Rate the U.S. and Canada as Wood Furniture Manufacturing Sources, Compared to China?

Matthew Bumgardner,[1] Urs Buehlmann,[1] Torsten Lihra,[1] and Mary Frye[1]*

[1]Northern Research Station, U.S. Forest Service, 241 Mercer Springs Road, Princeton, WV
[*]Author of correspondence (email: mbumgardner@fs.fed.us Phone: 740-368-0059)

Abstract — The decline in global competitiveness of North American wood furniture manufacturing, and the subsequent reduction in domestic market share, jobs, and lumber demand, continues to be widely reported and discussed. Less is known about the role of retailers in furniture importing. This study investigated the attitudes of U.S. furniture retailers toward China, Canada, and the United States as manufacturing sources for residential wood furniture, as well as their perceptions of consumer interest in country of origin for furniture manufacturing. The study was based on a nationwide survey in 2005 of the membership of a large U.S. home furnishings trade association. Over half of the retailers surveyed indicated that they did not always know where the products they sold were made, but reported that many consumers were asking about the country of origin of furniture products. Those retailers sourcing furniture from China were found to have more favorable perceptions of Chinese goods than those not sourcing from China; although both groups had equally favorable perceptions of the U.S. as a furniture source. Low price was the only attribute from a list of 16 for which China was rated higher than the U.S or Canada, even as Chinese firms have captured substantial U.S. market share. Opportunities for North American furniture manufacturers to compete on non-price factors are identified as priorities for development of competitive strategies.

A Landscape Analysis of Land Use Change Impacts on the Fragmented Forests of North-Central Indiana

Bogdan Chivoiu,[1] Guofan Shao,[2] Bryan Pijanowski,[2] Stephen Shifley,[3] and George Parker[2]*

[1]National Wetlands Research Center, USGS
[2]Department of Forestry and Natural Resources, Purdue University
[3] USFS North Central Research Station
[*]Author of correspondence (email: chivoiub@usgs.gov Phone: 337- 266-8669)

Abstract — The landscape of North-Central Indiana is predominated by farmland. Accounting for less than 10% of the total land area, forestland in North-Central Indiana is highly fragmented and mostly in private ownership. The major anthropogenic disturbance is land-use change and is primarily produced by urban sprawl. The purpose of this study is to quantify and characterize how land-use change affects forests in a fragmented landscape through the integration of LANdscape DIsturbance and Succession model (LANDIS) and the Land Transformation Model (LTM) on 25 sites in the Upper Wabash basin of Indiana. LANDIS has not been used in a fragmented landscape such as that of North-Central Indiana. LTM uses an artificial neural network and a set of drivers to estimate the pattern of urban growth and forecast urbanization under different scenarios, such as: the establishment of new forest patches, protection of small forest patches and of riparian buffers. LTM output is used to update the land-use map as input for LANDIS, and creates a dynamic spatial configuration of the forest patches for LANDIS simulations. The output of the coupled modeling project is a series of simulation maps of future forest landscapes as a result of interactions between forest processes and the land-use change. Analyzing these maps helps to identify the trends in forest succession, impacts of land-use change on forest dynamics, and effects of fragmentation (measured by landscape metrics) on the future forest structure and composition. These issues are essential for forest management on large spatial and temporal scales, landscape planning, natural resource conservation, and watershed management.

A Pilot Study to Predict Upland Hardwood Forest Site Quality and Productivity in the Southern Appalachians

C.A. Cotton[1] and T.R. Fox[1]*

[1]Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA
[*]Author of correspondence (email: ccotton9@vt.edu Phone: 540-552-4002)

Abstract — The forested ecosystems of the southern Appalachians are some of the most diverse in North America due to the variability in climate, soils, and geologic parent material coupled with the complex topography found throughout the region. These same characteristics cause upland hardwood stands to be extremely inconsistent with regard to site quality and productive capacity. Historically, the site index has been the most popular and simplest tool to quantify site quality but the model is not accurate at this point largely due to land-use and disturbance history. Research has shown that water availability, nutrient availability, disturbance, and elevation are important influences to site quality in the region, and that variables related to these key factors are the drivers of site productivity. In response to this, a pilot study of three sites in the southern Appalachians was performed based on biotic and abiotic stand conditions of upland hardwood forests with the goal of creating a more accurate approach to estimating site quality and productivity for these ecosystems. Data was obtained from the Allegheny Plateau (Fernow LTER), Cumberland Plateau (Robinson Forest), and Ridge and Valley (George Washington Jefferson National Forest) physiographic provinces. Site, vegetation, and plot location data were used to identify predictive variables of site productivity. A layered GIS was created for each site that depicted the climate, soils, geology, and topography. Using logistic regression and spatial analysis techniques to compare GIS-derived data to the actual inventoried vegetation, models were developed that classified site productivity into site quality classes for each dataset. This pilot study presents a method to increase the accuracy of site quality and growth and yield estimates for southern Appalachian upland hardwood forests.

Development of an Expert System for Assessing Woody Biomass for Bioenergy Production

Sabina Dhungana,[1] Jingxing Wang,[1] and Shawn Grushecky[1]*

[1]Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV 26506
[*]Author of correspondence (email: sdhungan@mix.wvu.edu Phone: 304 293 2941 x 2495)

Abstract — Biomass expert system was developed to identify the available wood residues and equivalent bioenergy in West Virginia. The system reflects the knowledge of experts in the related field of woody biomass utilization and industrial energy sectors. The knowledge base, an important component of the system, was developed and stored in a relational database. The system is designed using object oriented programming techniques and is built upon several interdependent and interrelated objects for modifiability and modularity, which can be run as a stand alone program as well as a dynamic web-based application. Graphical interface at the front-end and java at back-end with an integration of database enable user to make inquiry and obtain results without any complications. The system uses heuristic search technique and provides user with the information for the optimum biomass utilization for bioenergy production on the basis of information provided. This system proved to be a useful bio-energy production decision support and planning tool for industries seeking to use/produce bioenergy from woody biomass. The program is currently limited to data from the state of West Virginia. However, in future, the program can be enhanced to work with other states as well.

Spatial Structure of an Old-Growth Beech-Maple Forest of the Lower Great Lakes Region, USA

Igor Drobyshev,[1] Natalie Pinheiro,[1] Marie Semko-Duncan,[1] Kathryn Holmes,[1] David M. Hix[2], and Charles Goebel[1]

[1]School of Environment and Natural Resources, Ohio Agricultural Research and Development Center, The Ohio State University, 1680 Madison Ave., Wooster, OH 44691
[2]School of Environment and Natural Resources, The Ohio State University, 2021 Coffey Rd., Columbus, OH 43210-1085
[*]Author of correspondence (email: Drobyshev.1@osu.edu Phone: 330-263-3787)

Abstract — Analysis of the tree spatial structure in the closed-canopy forests helps deduce fine-scale stand dynamics, detect successional changes, and reveal regeneration patterns of canopy trees. Such knowledge should be of value in designing conservation management plans and in the spatially-explicit stand modeling. In this study we analyze spatial structure of a natural beech-maple forest in the Lower Great Lakes, which has largely escaped human-related influences. We quantified composition and mapped all canopy trees (>10 cm dbh) on six 2500 m^2 plots in a relatively undisturbed old-growth remnant and on two plots of the same size in the second-growth area of the forest (Crall Woods, Ashland County, Ohio). Two main questions for the study were

1. If species biology (shade tolerance and regeneration requirements) is consistently reflected in spatial pattern of its populations, and
2. Do different canopy trees show a pattern of association/segregation, which may be indicative of the similarities in species' traits, competition for resources, or/and ongoing successional dynamics.

We used second-order analyses of point patterns to evaluate how distribution of trees changes with scale. Our preliminary results indicate that spatial distribution of woody species may be representing a pattern connected to gap-associated tree regeneration. Specifically, spatial structure of the sub-canopy trees exhibits a regular pattern at the scale of 6 meters and less, and an aggregated pattern at larger scales. For trees with intermediate canopy positions a similar threshold is observed at 8 meters, and for dominant and co-dominant trees, at 14 meters. We will report results obtained with Clark and Evans' aggregation index *R* and segregation index *S* by Pielou to study spatial association/segregation among trees of both different species and strata. We will compare results of this study to the data from other temperate closed canopy forests to discuss the generality of our finding.

Site Productivity on Reclaimed Coal Mine Sites in Eastern Tennessee

Jennifer Franklin[1] and John Rizza*

[1]Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, TN
**Author of correspondence (email: jafranklin@utk.edu)*

Abstract — Growth rate of some important hardwood tree species is related to soil depth in the shallow soils in the southern Appalachians. We assessed sites in the Cumberland mountains of eastern Tennessee that were mined for coal 40-50 years ago, with loosely placed overburden, and either planted with pine or left to revegetate naturally. These were compared to adjacent forest that was not disturbed by mining. Field soil respiration rates, tree species composition, basal area, and understory perennial composition were measured. Site index for yellow poplar (*Liriodendron tulipifera*) was determined. Our results suggest that above-ground forest productivity is greater on mined sites than in the un-mined forest. However species composition differs from that of the un-mined area. Areas initially planted with pine have undergone succession, and pine now comprises less than 10% of the total basal area in areas in which it was planted. Field soil respiration rate in mined areas did not differ between planted and naturally regenerated areas, and both were significantly lower than in the un-mined area. Initial results suggest that above-ground productivity was not negatively impacted by coal mining over the long term, using reclamation techniques of that time period. However, recovery of below ground ecosystem processes occurs more slowly.

Growth of Young Populus Trees as Effected By Various Weed-Control Techniques in Kansas

W.A. Geyer[1] and C. J. Barden*

[1]Forestry Division, Throckmorton Hall, Kansas State University, Manhattan KS 66506
[*]Author of correspondence (email: wgeyer@ksu.edu Phone: 785-532-1409)

Abstract — Various synthetic mulches were tested on an alluvial site in three studies to examine survival and growth of cottonwood and hybrid poplar seedlings in central Kansas. Blue, clear, and yellow waste plastics; black, brown, and gray/black polyethylene; and polypropylene fabric weed barrier were compared with cultivation; sod; or isoxaben + orazalin (Gallery + Surflan) or sulfometron methyl (Oust) herbicide weed control treatments. After five years, cottonwood seedling survival was moderately high (50 to 91%) for all synthetic mulch types, whereas seedling survival with cultivation and Oust treatments ranged from 60 to 76%. Seedling growth was best with Oust herbicide, slightly less for cultivation, and nearly the same for all plastics. Planting in sod without weed-control or use of Gallery + Surflan is not advisable, as these treatments yielded the poorest results. Oust provided the best environmental conditions for growth. All the synthetic mulches tested seem to be practical for use in tree establishment under environmental conditions found in the central Great Plains.

Usage of Oak Species in Oriented Strand Board

Jody Gray[1] and Brian Cox*

[1]West Virginia University, P.O. Box 6125, Morgantown WV
[*]Author of correspondence (email: Jody.Gray@mail.wvu.edu)

Abstract — Oriented Strand Board (OSB) is a large consumer of small diameter, low quality timber and logging residue. One problem that was encountered with oak usage was to meet PS2 testing requirements for panel strength and stiffness the panel density had to be increased by more than one pound per cubic foot (pcf). It was undetermined though if the necessary increase in panel density was due to the poor strand quality or the higher density of the oak species. Higher density wood species will reduce the compaction ratio of the entire panel.

Through previous research we noted that we could dramatically increase the strand quality of the oak species. This poster will address the findings of the panel production using higher quality oak strands.

Panels were produced with oak contents of 0%, 25%, 50%, 75%, and 100%. Overall target panel density was held constant for all groups at 42.5 lbs/ft^3.

Results from the panel testing revealed that there were no significant differences between the 0% and 25% oak panels for max force (F_{max}) and MOE. However, there were differences between those two treatments in maximum moment (M_{max}) and MOR. Significant differences were found between the 0%, 50%, 75%, and 100% treatment groups for F_{max}, M_{max}, MOE, and MOR. The decline in mechanical properties may be attributed to the reduction in compaction ratio. Typical mixed hardwoods having an average density of 41.6 lbs/ft^3 and a target panel density of 42.5 lbs/ft^3 would result in a compaction ratio of 1.022. Using the more dense oak species reduces the compaction ratio to 0.906 for 100% oak panels. From these results it is obvious that in order to use even high quality oak strands in OSB production, the overall target panel density will have to be increased in order to maintain a compaction ratio closer to 1:1.

The Influence of Fire Suppression On Oak-Hickory Forests in Great Smoky Mountains National Park

Eric J. Holzmueller[1], Shibu Jose, and Michael A. Jenkins*

[1]Department of Forestry, Southern Illinois University Carbondale, Carbondale, IL 62901, USA
[*]Author of correspondence (email: eholzmue@siu.edu Phone: 618-453-3708)

Abstract — The oak-hickory (*Quercus –Carya*) forest type is one of the most common forest types in Great Smoky Mountains National Park (GSMNP). Historically, this forest type burned every 10-15 years. However, after the Park was established in 1934, fires were heavily suppressed. This shift in the disturbance regime may have altered the species composition of oak-hickory forests in GSMNP. We examined overstory and understory community composition to determine the effects of fire suppression on oak-hickory forests. We hypothesized that fire suppression has increased the abundance of fire intolerant species and decreased the abundance of fire tolerant species in oak-hickory forests. We compared overstory and understory species composition and abundance among four sampling categories: unburned stands; and stands that had burned once, twice, and three times over a 20-year period (late 1960s to late 1980s). Preliminary results indicate that fire suppression does promote fire intolerant species, particularly eastern hemlock and red maple. Both of these species had significantly higher densities in unburned areas compared to burned areas ($P < 0.05$). Fire tolerant species, such as oak and hickory, were more abundant in burned areas compared to unburned areas ($P < 0.05$). Our study demonstrates the important role of fire in the oak-hickory forest type of GSMNP and suggests that prescribed fire may be used to maintain this forest type in central hardwood forests.

Updating the Shade Tolerance Tables

Daniel J. Johnson[*1] *and Burnell C. Fischer*[2]

[1]*Assistant Instructor Department of Biology, Indiana University, Bloomington, IN 47405*
[2]*Clinical Professor, School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405*
[*]*Author of correspondence: (email: dj4@indiana.edu Phone: 812-855-1674)*

Abstract — The term shade tolerance has been around for nearly a century and today's foresters and ecologists often use the term when discussing a species and its relationship with light levels. Silvicultural prescriptions in the eastern hardwoods are often based around the shade tolerance category for desired species. Shade tolerance rankings are currently based on opinion (Baker 1949) and lack strong empirical underpinnings. Conflicting findings from empirical research suggest that the rankings are in need of an update (Pacala et al. 1994, Niinemets 2006). Tables can be developed to address species that co-occur regionally through the use of long term data sets and physical parameters to rank species in a relative way for shade tolerance. Regional tables would provide applicable relative rankings that could be defended scientifically and useful to practicing silviculturists. Utilizing the Forest Service Forest Inventory and Analysis (FIA) database for basic species measurements and presence or absence in differing light conditions, we propose a rank for each species in a region on a scale of 1-9 (1 being shade tolerant and 9 being shade intolerant). This scale allows species to better compare to the species index used in Europe (Ellenberg 1988) and would be a step toward developing the full suite of tolerance values (i.e. light, temperature, water, salinity, soil pH and nitrogen tolerances). These tables can be supplemented with data from the literature that address the physical traits that determine shade tolerance, such as leaf mass ratio, seed size and whole plant light compensation point (Walters and Reich 1999, Niinemets 2006). Regional tables of shade tolerance would serve to improve forest modeling, niche space understanding, regional forest succession, silvicultural prescriptions and communication between natural resource managers and the public.

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Regional Synthesis of Long-Term Findings From U.S. Forest Service Management Intensity Demonstrations

Laura S. Kenefic[1] and Thomas M. Schuler[2]*

[1]U.S. Forest Service, Northern Research Station, 686 Government Road, Bradley, ME
[2]U.S. Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV
**Author of Correspondence (email: tschuler@fs.fed.us)*

Abstract — Though the forests of central and northern United States have been repeatedly and often heavily cut since European settlement, the science of forestry did not take root in this country until the late 1800s. By the early 1900s concerns about past exploitive use and perceived timber shortages had motivated the creation of the U.S. Forest Service and the initiation of forest management research in commercially important forest regions. Installation of large-scale trials of cutting methods began in the 1920s and continued into the 1950s. The individual studies were often referred to in part as "cutting practice levels" or "management intensity demonstrations" and rated different practices as poor, fair, good, and high-order; these often-unreplicated studies were frequently accompanied by larger stand-level, replicated experiments. Specific characteristics of each practice varied to meet regional forest and market requirements, but treatments often included variations of clearcutting, diameter-limit cutting, and single-tree selection. In some cases, prescribed treatments have continued since inception with up to twelve uneven-age harvests, providing some of the longest continual records of forest harvesting in the central and northern United States. We provide the first comprehensive documentation of this pioneering effort to evaluate the effects of different forest management practices and include results from the Bartlett (New Hampshire), Dukes (Michigan), Fernow (West Virginia), Kane (Pennsylvania), Penobscot (Maine), and Vinton Furnace (Ohio) Experimental Forests. Initial ideas regarding the sustainability of different practices are reported and subsequent research is synthesized to support or reject these early concepts about forest management. There have been substantial changes in the consensus evaluation regarding each of the cutting practices since study inception. Photographs from permanent camera points associated with some of these studies provide remarkable evidence of changes in forest structure through time. Greater awareness of this region-wide set of related studies will facilitate increased use and potential collaborations to investigate forest management issues not envisioned by the original investigators.

How Fast Will the Trees Die? A Transition Matrix Model of Ash (*Fraxinus spp.*) Decline in Forest Stands Infested By Emerald Ash Borer (*Agrilus Planipennis*)

Kathleen S. Knight,[1] Robert P. Long,[1] Annemarie Smith,[2] Kamal Gandhi,[3] and Daniel A. Herms,[4]*

[1]USDA Forest Service Northern Research Station.
[2]Ohio Department of Natural Resources
[3]Department of Entomology, Ohio State University
[4]Department of Entomology, Ohio State University/ Ohio Agricultural Research and Development Center
[*]Author of correspondence (email: ksknight@fs.fed.us Phone: 740-368-0063)

Abstract — Emerald ash borer (EAB, *Agrilus planipennis*) is a serious threat to North American ash (*Fraxinus*) species and has already killed more than 20 million ash trees in Michigan, Ohio, and Indiana. We recorded ash tree health and other forest stand characteristics in 124 monitoring plots in 38 EAB-infested forest stands in Michigan and Ohio from 2004 to 2007. Ash was a dominant component of these stands, with green ash, white ash, and black ash represented at different sites. >2000 ash trees were monitored at infested sites. These data were used to create a transition matrix model of ash decline, where each transition probability was a function of stand characteristics such as ash density, ash species, stand size, and average ash health. A subset of the data from stands in Michigan, not used to create the model, was used to test the accuracy of the model in predicting ash decline. The model showed the potential for rapid decline of ash trees in infested stands with mortality increasing by 20-40% per year. Some of the stands in Michigan, which have been infested for at least 4 years, have reached 100% mortality while some of the Ohio stands, which have probably not been infested for more than three years, currently have <20% mortality. The transition matrix model can be used to predict the trajectory of ash decline in infested stands, which may be useful for planning management and restoration activities.

Sewanee's Split Creek Watershed: Hydrology, Water Quality, and Soil Characterization

*K. Kuers,[*1] M.A. Knoll, S.J. Torreano, and D.A. McGrath*

[1]Department of Forestry and Geology Sewanee: The University of the South, 735 University Ave, Sewanee, TN 37383

[*]Author of correspondence (email: kkuers@sewanee.edu Phone: 931-598-1421)

Abstract — Split Creek watershed, located atop the Mid-Cumberland Plateau near Sewanee, Tennessee, has been monitored since 2002 to establish baseline streamflow, water quality, soil parameters, and forest composition to serve as a benchmark for comparison of local Plateau watersheds subject to human or natural disturbance. The watershed is equipped with a Parshall Flume (Montana style) to gauge streamflow and a weather station to record precipitation, relative humidity, air and soil temperature, and PAR. The 55 acre upland hardwood watershed has an average basal area of 110 $ft^2\ ac^{-1}$, comprised of 60% oak (Quercus sp.), 8% hickory (Carya sp.), and 6% yellow-poplar (Liriodendron tulipifera), with 4.5 acres of the watershed in planted pine. Depth to bedrock, measured every 66 feet, is relatively shallow, averaging 41 inches, with 83% of the 583 samples less than 4.5 ft deep.

The stream, like most of those draining neighboring Plateau watersheds, is intermittent. For the 5 year period 2002 through 2006, there was no streamflow for an average of 57 days per year. In only one year (2004) was there flow throughout the year, while in the driest year (2006) there were 128 days without flow. Baseflow stopped as early as June 3 and resumed by November 13.

Beginning in 2004, grab samples were collected from the stream once or twice each month. Stream pH averaged 5.6 and overall ion content was quite low, with conductivity values averaging 12 $\mu S\ cm^{-1}$. Nitrate-N and ammonia-N concentrations averaged 0.1 ppm or less, sulfate 2.9 ppm, and phosphate less than 0.05 ppm. Cations (calcium, magnesium, sodium, and potassium) averaged 0.23, 0.24, 0.56, and 0.37 ppm, respectively, and soil lysimeter samples gave similar concentrations. Grab samples collected from adjacent forested watersheds were not statistically different, indicating that water quality in Split Creek is representative of other local Plateau watersheds.

Screening and Testing Phytochemicals in Eastern Redcedar (Juniperus Virginiana) For Development of Potential Entrepreneurial Opportunities

Chung-Ho Lin1[*], Michael A. Gold[1], Robert J. Kremer[2]
Amber L. Spohn[2], and Larry D. Godsey[1]

[1] Center for Agroforestry, University of Missouri, Columbia, MO 65211
[2] U.S. Department of Agriculture-Agricultural Research Service, Cropping Systems and Water Quality Research Unit, Columbia, Missouri 65211
[*]Author of correspondence (email: lincu@missouri.edu Phone: 573-882-7965)

Abstract — Eastern redcedar (*Juniperus virginiana*) is often considered a "trash or nuisance" tree. In some states, this species has been declared invasive and management strategies have been adopted to destroy it. However, value-added phytochemical products from eastern redcedar have the potential to create new industries in regions such as Missouri with an abundant redcedar resource. As a first step toward the development of such industries, it is essential to characterize, and quantify the composition of the individual phytochemicals within various redcedar tissues with modern chromatographic, spectroscopic and bioassay technologies, followed by an evaluation of their commercial applications in agricultural, pharmaceutical, and cosmetic industries. In this study, the distilled cedar oil, cedar sawdust and various tissues including roots, leaves, fruits, branches, sapwoods, and heartwood were collected and intensively extracted with solvents. Separation and fractionation of the phytochemicals with a range of polarity were performed by liquid/liquid extractions followed by a reverse-phase liquid chromatography. Bioassays will be performed to evaluate the potent biological activities (herbicidal, antifungal, antibacterial, antitermitic, pesticidal, antitumoral activities, etc.) in each fraction. The potent compounds in the extracts showing high bioactivities will be isolated and further purified for chemical characterization and structure elucidation purpose.

White Oak Decline at Two Southern Ohio State Forests

Robert P. Long,[1] Yilmaz Balci,[2] William MacDonald,[2] and Daniel Balser[3]*

[1]USDA Forest Service, Northern Research Station, Delaware, OH
[2]Division of Plant and Soil Sciences, West Virginia University
[3]Division of Forestry, Ohio Department of Natural Resources
[*]Author of correspondence (email: rlong@fs.fed.us Phone: 740-368-0052)

Abstract — Extensive white oak (WO = *Quercus alba* L.) decline and mortality has been observed since 2002 in oak forests across southern Ohio. The mortality was especially severe at the 3800 ha. Scioto Trail State Forest (STSF) in southern Ross County, and more recent mortality has occurred at Zaleski State Forest (ZSF) in Vinton County. A series of stressors including drought (1998 and 1999) and insect defoliators (forest tent caterpillar, *Malacosoma disstria;* common oak moth, *Phoberia atomaris;* half-wing geometer, *Phigalia titea*) adversely affected tree health through 2004. WO crown dieback and mortality initially developed as single trees or small groups of trees on lower slope and bottomland sites.

In 2006, WO mortality was assessed at STSF in seven severely affected bottomland stands using thirty-four 800 m^2 plots. Standing dead WO basal area ranged from 9 to 18 m^2 ha^{-1}, or 57% to 84% of total WO basal area. Sapling regeneration (stems <10 cm dbh and > 1.4 m in height) is dominated by maples (*Acer saccharum, A. rubrum*) that are poised to fill canopy gaps. Plots (n=103) were established in declining (n= 59) or non-declining (n=44) sites to evaluate soils and roots for the presence of *Phytophthora* spp. Among the species, *P. cinnamomi* was frequently isolated in 69% (n=41) in soils from declining trees and 57% (n=25) in soils from non-declining trees. Excess moisture in 2003 and 2004 may have favored development of *Phytophthora* spp. or other root pathogens and may have contributed to the WO decline at STSF.

At ZSF widespread overstory white oak mortality was not reported until 2005. A similar stress history of drought and defoliation occurred here, but mortality did not develop as early or as extensively as at STSF. Twenty four 800 m^2 plots were established at 12 locations across the forest in September 2006 and soil samples will be assessed in 2007 to determine the presence of *Phytophthora* organisms at these sites.

The Indiana Hardwood Ecosystem Experiment

Cortney J. Mycroft,[1] Virgil Brack, Jr.,[5] Benjamin J. Dolan,[1] John B. Dunning, Jr.,[1] Jeffery D. Holland,[1] Kamal Islam, [2] Brian J. MacGowan,[1] Charles H. Michler [3] George R. Parker,[1] Linda S. Prokopy,[1] Keith S. Summerville,[4] Harmon P. Weeks, Jr.,[1] Rod N. Williams,[1] and Robert K. Swihart[1]*

[1]Purdue University, West Lafayette, IN
[2]Ball State University, Muncie, IN
[3]USDA Forest Service, Northern Research Station, West Lafayette, IN
[4]Drake University, Des Moines, IA
[5]Indiana University, Terre Haute, IN
[*]Author of correspondence (email: mycroftc@purdue.edu Phone: 765-494-1472)

Abstract — The broad goal of the Hardwood Ecosystem Experiment is to understand ecological and social impacts of long-term forest management on public and private lands in Indiana and the Central Hardwood Region. Research objectives include efforts to develop a proven system of forest management prescriptions to maintain populations of desirable native plant and animal species and important communities such as those dominated by oak species. We will assess public attitudes towards forest management to develop new approaches for education of the general public and private landowners, and we will engage various interest groups in a discussion of effective land management. To reach these goals and objectives, we designed a long-term field experiment on forest management and its impacts. In collaboration with the Indiana Division of Forestry, we created a replicated series of study areas at Morgan-Monroe and Yellowwood State Forests, on which the most common forest management techniques will be implemented and monitored. The framework of study sites will be used to understand the response of selected species of invertebrates, vertebrates, and plants both within treated areas and in the surrounding forest. Simultaneously, we will conduct surveys of the landowners and general public in the immediate vicinity of the study areas to assess their attitudes towards active land management. Baseline sampling has been ongoing for two years, and harvest treatments will begin in the latter half of 2008.

Age Structure and Disturbance Patterns in an Oak - Beech Stand in Southern Sweden

Mats Niklasson,[1] Igor Drobyshev,[1] and Marcin Churski[2]*

[1]Southern Swedish Forest Research Centre, SLU, Box 49, Alnarp 230 53, Sweden
[2]Mammal Research Institute, Polish Academy of Sciences, ul. Waszkiewicza 1c, 17-230 Bialowieza, Poland
[*]Author of correspondence (email: Igor.Drobyshev@ess.slu.se Phone: +1.330.234.3015)

Abstract — Natural and human-mediated disturbances influence regeneration, age structure, and species composition, and in this way shape trees population dynamics. Understanding the disturbance history of the ecosystems is a crucial prerequisite in formulating and implementing conservation management programmes. In southern Sweden, oak (*Quercus* sp.) and beech (*Fagus sylvatica*) forests present one of the most species-rich, and therefore, biologically valuable ecosystems. Due to widespread human impact, very few natural old-growth oak-beech forests currently exist in the region. To provide further understanding of disturbance-related stand dynamics in such forests we studied age and spatial structure, disturbance patterns, and species regeneration patterns in an old-growth remnant oak-beech stand in Kvibille, Southern Sweden. Fire in 1843 and cutting dated back to 1920s were two disturbance events which likely had important implications for the regeneration dynamics of canopy dominants. All recorded oak trees which were alive at the time of fire (n = 8) survived this disturbance event. It was not possible to assess exact germination dates for the most of the oak trees due to wood rot and sampling at the height above germination point. However, among all oak trees which had their innermost tree-rings dating after fire (23 trees), 13 trees (57 %) were present on the site already 25 years after this disturbance event. No fire survivors among beech trees were found on the site. In the presentation we discuss role of different disturbance events in the population dynamics of different broadleaved species and possible management implications of our reconstruction.

Increasing Nitrogen Availability to Swamp White and Pin Oak Saplings Growing in Missouri River Floodplain Soils

Christopher J. Plassmeyer,[1] J. W. Van Sambeek,[1*] Frieda Eivazi, and Daniel C. Dey*

[1] USDA Forest Service, Northern Research Station, 202 Natural Resource Building, Columbia, MO 65211-7260

[*]Authors of correspondence (emails: cjpgg2@mizzou.edu, jvansambeek@fs.fed.us Phone: 573-875-5341 Ext 233)

Abstract — Public land managers and private landowners are interested in reforesting former agricultural bottomlands within the lower Missouri River and upper Mississippi River. Restoring hard-mast species can be problematic due to lack of seed sources for natural regeneration, competition from other vegetation, and altered soil properties. In fall1999, two 16.2 ha fields on two conservation areas in central Missouri were cultivated and one field at both areas seeded to a living mulch of redtop. The four fields were divided into eight plots each consisting of either five mounded or non-mounded rows. Plots were divided into a series of seven 30-tree plots on 9.1 m spacing within row and 9.1 m spacing between the five rows. Oak foliage nitrogen content in mid-August 2001 averaged 2.0% at Smoky Waters and 1.7% at Plowboy Bend suggesting low available soil nitrogen was limiting tree growth. Starting in spring 2004 and annually thereafter, each tree within one row of each plot was fertilized within the 1.3 m^2 area covered by a weed barrier mat. Treatments included applying 83 g 20-10-10 NPK as slow-release ammonium nitrate, 87 g 19-6-9 NPK as slow-release urea, interplanted with two nitrogen-fixing wild false indigos, interplanted with two buttonbushes, or left untreated. Foliage nitrogen content in late July 2006 still averaged 1.8% with no differences between Smoky Waters and Plowboy Bend, between the two ground covers, or among the five fertilizer treatments. In general, macro- and micro-nutrient content in the oak foliage was higher at Smoky Waters (silt loam or silty clay soils) than at Plowboy Bend (fine sand soils). No patterns for these nutrients existed between the ground cover or fertilizer treatments. We suspect the high pH's at both areas maybe limiting nutrient availability and uptake for both oak species.

Crown Conditions Among Red Oaks in Missouri: A Landscape-Scale Surrogate for Growth and Mortality

KaDonna C. Randolph,[1] W. Keith Moser, and Mark Hansen*

[1]US Forest Service, Southern Research Station FIA, 4700 Old Kingston Pike, Knoxville, TN
[*]Author of correspondence (email: krandolph@fs.fed.us Phone: 865-862-2024)

Abstract — The health and vitality of a tree is often discerned by observing the most visible part of the tree, that is, its crown. Since a tree's photosynthetic capacity is dependent upon the size and condition of the crown, trees with full, vigorous crowns are generally associated with more vigorous growth rates. Deterioration in crown condition is often the first visible symptom that a tree is in decline; therefore, the US Forest Service Forest Inventory and Analysis Program (FIA) measures a suite of crown condition indicators to monitor forest health.

A recent national summarization of crown conditions indicated relatively poor conditions among the red oaks in Missouri. Oak forests in the Ozark Plateau of Arkansas and Missouri have experienced severe droughts followed by unprecedented levels of insect and pathogen attack, components of the forest health complex known as "oak decline."

We will investigate the current crown conditions for major tree species in Missouri and seek to determine if the poor conditions noted among the red oaks are attributable to the ongoing decline of red oak stands documented across much of the State. Changes in crown condition over a five-year period will be presented with particular emphasis given to species in the Erythrobalanus (red oak) group. Since growth is a continuous process whereas mortality is a discrete event, this study will examine the relationship between declining plot-level growth, the preponderance of poor crown conditions, and (any) subsequent mortality.

Removal of the Shade-Tolerant Midstory Canopy to Release a New Cohort of Oak Seedlings in Three Mature Oak Forests in Southern Indiana

Ronald A. Rathfon[1]

[1]Purdue University, Department of Forestry and Natural Resources, 12000 Purdue Farm Rd., Dubois, IN 47527
Author of Correspondence (email: ronr@purdue.edu Phone: 812-678-5049)

Abstract — Entire cohorts of oak seedlings may be lost due to inadequate amounts of light reaching the forest floor. Many mature oak forests have mid- and understory crown layers composed of shade tolerant tree and shrub species. The timely removal of these sub-canopy layers may be crucial to the survival of new oak seedlings and their recruitment into established and competitive size classes. Three methods for controlling mid- and understory woody vegetation were tested for overall efficacy and the rate at which they produced mortality in one inch size classes from 1 inch to 9 inches and larger in three mature oak forests in southern Indiana. The three methods were 1) injection using an ax and applying undiluted picloram, 3 percent acid equivalent (ae) + 2,4-D, 20.9 percent ae, (Pathway) herbicide delivered to injections using a backpack sprayer and gunjet nozzle, 2) chainsaw girdle and felling with the application of Pathway herbicide to the girdle or cut stump, and 3) low volume basal bark using 20 percent triclopyr (0.8 lb ae/gal), 44.3 percent (4 lb/gal) ae (Garlon 4) in AX-IT oil-surfactant low volume basal oil. By the end of the first growing season, all three treatments controlled 90% or more of all stems in the 1 to 3 inch diameter classes. There was little difference between treatments applied to stems larger than 3 inches dbh with an overall reduction in control as stem diameter increased. Stem control ranged from 35% for 9 – 12 inch dbh stems to over 80% for 4 inch dbh stems. Injection and basal bark treatments produced gradual reductions in mid- and understory basal area throughout the first growing season for all diameter classes. The chainsaw girdle and felling treatment produced immediate removal of stems under 4 inches dbh. Treatment effects varied by species for stems greater than 3 inches dbh.

The Influence of Edaphic Factors on the Regeneration of Oaks and Their Principal Competitors in Central Missouri

Joshua H. Stevens,[1] John M. Kabrick,[2] David R. Larsen,[3] and Rose-Marie Muzika[3]*

[1]Resource Forester, Missouri Department of Conservation
[2]Research Forester, USDA Forest Service, Northern Research Station
[3]University of Missouri-Columbia, School of Natural Resources, Department of Forestry
[*]Author of correspondence (email: Josh.Stevens@mdc.mo.gov Phone: 573-592-1400)

Abstract — In the understory of oak (*Quercus spp.*) forests in the Outer Ozark Border ecological subsection of Missouri, the density of advance reproduction of sugar maple (*Acer saccharum*) is increasing while the density of advance reproduction of oaks (*Quercus spp.*) is decreasing. Accordingly, foresters are concerned that in the absence of adequate oak advance reproduction, oak regeneration failures are likely. In this study we examined the regeneration dynamics among oaks, maples, and other competitors along an edaphic gradient in a clearcut stand during a nine-year period to determine how site factors and pre-harvest stand conditions affect oak regeneration success. To do this, we monitored the reproduction in five permanent 0.1-acre plots with two, 0.01-acre nested subplots on different slope positions and soil environments. Prior to and immediately following harvesting, oak reproduction densities were considerably lower than those of sugar maple and white ash (*Fraxinus americana*) regardless of slope position. However, during the eight years following the harvest, the oak reproduction density has been increasing and sugar maple reproduction has been decreasing. There were slope- and soil-mediated differences in the reproduction composition and response to harvesting. In upper slope positions and particularly where soils were shallow to dolomite or contained clayey residuum, the reproduction densities of both oaks and sugar maples have increased. However, on lower slope positions, species other than oaks such as bitternut hickory (*Carya cordiformis*) and white ash have remained important competitors. These early results suggest that following clearcutting, oaks will likely recruit into the overstory perhaps along with sugar maple on the upper slope positions but will be non-existent on the lower slopes. Thus, regenerating oaks in the lower slope positions may require management interventions prior to harvesting to increase the density of oak advance reproduction and after harvesting to ensure its recruitment.

Herbaceous Layer Response to Thinning and Fire in the Bankhead National Forest, AL

Joel C.Zak,[1] Luben D. Dimov,[2] Callie J. Schweitzer[3] and Stacy L. Clark[3]*

[1]Center for Forestry and Ecology, Alabama A&M University, Normal, AL; CFE,
[2] Alabama A&M University, Normal, AL; USDA Forest Service,
Southern Research Station, Normal, AL;
[3]USDA Forest Service, Southern Research Station, Normal, AL
[*]Author of correspondence (email: joel.zak@gmail.com Phone: 256-372-4571)

Abstract — We studied the first-year effects of silvicultural treatments on herbaceous layer cover and diversity. The study was a stand-level replicated experiment involving dormant season prescribed burning, two levels of thinning, combinations of burning and thinning, and a control. The study was implemented at the William B. Bankhead National Forest (BNF) located on the southern end of the Cumberland Plateau. Stands are mixed conifer-hardwoods dominated by planted loblolly pine (*Pinus taeda* L.). Herbaceous layer cover and diversity were estimated in each stand prior to and during the spring and summer after treatment implementation. Average pretreatment stand scale cover was 38%, species richness was 59, and Shannon-Wiener Index (H') was 2.84. The changes in cover, richness, and diversity (H') will be used to determine if the treatments had any initial effects on the herbaceous layer and cover. These results can be used to predict the effects that prescribed burning and thinning will have in the short term on plant species cover, richness, and diversity in the herbaceous layer of the BNF.