POSTER ABSTRACTS

EFFECTS OF FIRE AND FERTILIZATION ON GIANT CANE: DEVELOPING MANAGEMENT TOOLS FOR CANEBRAKE

Margaret M. Anderson, James J. Zaczek, Jon E. Schoonover, and Sara Baer[1]

Giant cane (*Arundinaria gigantea* (Walt) Muhl.), a native bamboo, is an integral component of bottomland forests in the southeastern United States. Cane occurs as monodominant stands, also known as canebrakes, which historically covered vast areas of land. As a result of land conversion, overgrazing, and altered fire regimes, a 98 percent reduction of canebrakes has occurred. Interest in giant cane restoration has increased due to its ecological significance as wildlife habitat, a riparian buffer, its role in soil stabilization, and its potential as woody biomass. Research with planted cane indicates fertilization and burning have interacting effects on cane growth, however in remnant natural stands, the influence of burning and fertilization on canebrake growth and spread is unknown. This study examines the survival and growth response of cane to burning and fertilization in remnant stands to provide guidance for rehabilitation, restoration, and management.

Four treatment plots were replicated eight times across six sites in canebrakes growing in riparian zones adjacent to agricultural fields in the Cache River Watershed, Illinois. The four treatments were randomized factorial design of: (1) burning, (2) fertilization, (3) burning/fertilization, or (4) control. Within treatment plots, two interior and three exterior 1 m^2 sample plots were randomly established to measure culm density, height, diameter, and spread prior to treatment and after one and two growing seasons. Fertilization and burning/fertilization plots were treated in summers of 2011 and 2012 with a half corn rate of nitrogen (56 kg/ha), phosphorus (22 k/gha), and potassium (37 kg/ha). Prescribed burning took place in March 2012.

Data were analyzed using a repeated measures analysis ($\alpha = 0.05$) (SAS Institute Inc., Cary, NC). At year 0 (2011), culm density, height, and diameter were not significantly different among treatments. By year 2, live density in interior plots slightly increased, however density in exterior plots generally more than doubled, indicating canebrake expansion over time. Fertilization generally increased height but had little effect on cane diameter. Research suggests that cane typically increases in both height and diameter simultaneously, suggesting that fertilization only partially provides the resources needed to stimulate growth. Further analysis on fertilization application may be necessary to ascertain the efficiency of its role in culm growth and development.

Prescribed burning resulted in a decrease in height growth and diameter and consumed a portion of the existing culms. However, vigorous postfire resprouting of the canebrake resulted in an increase of culm density and appears to demonstrate the possible utility of fire as a tool for land managers to reduce competition and increase canebrake health and expansion.

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LAUREL WILT DISEASE AND FIRE: SHOULD THE CENTRAL HARDWOOD REGION TAKE NOTICE?

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Invasions of nonnative insects and pathogens into forest ecosystems have historically generated large economic and ecological impacts. Nonindigenous insects are often more problematic than native insects because host tree species have not had the opportunity to evolve natural resistance. The rate of introductions into naïve ecosystems has coincided with a near global increase in the frequency of a behavioral shift from targeting dead to targeting live trees. A recent nonnative species introduction is the redbay ambrosia beetle (*Xyleborus glabratus*), which transmits a fungal pathogen *Raffaelea lauricola* responsible for laurel wilt disease (LWD). *R. lauricola* blocks the xylem of redbay (*Persea borbonia*) and many other taxa in the Lauraceae family including avocado (*Persea americana*), sassafras (*Sassafras albidum*), swamp bay (*Persea palustris)*, silk bay (*Persea humilis)*, pondspice (*Litsea aestivalis)*, pondberry (also known as southern spicebush; *Lindera melissifolia)*, northern spicebush (*Lindera benzoin)*, camphortree (*Cinnamomum camphora)*, and California bay laurel *(Umbellularia californica)*, causing wilt symptoms that eventually lead to 90 to 100 percent mortality. Following mortality, dead redbay leaves are marcescent for 1 year or more; this phenomenon has been linked to increased crown ignition in several North American tree species. Accompanying leaf senescence, surface fire hazard may increase as the leaves, branches, and stems fall to the forest floor. Sassafras is capable of being the sole host of LWD in stands north of the originally predicted range of the redbay ambrosia beetle and may affect fuel loading in this area. The Central Hardwood Forest region may be subject to similar shifts in fire behavior as new nonnative pests continue to accumulate and alter the ecosystems at an ever-increasing rate.

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LANDSCAPE SCALE RESTORATION WITHIN THE CACHE RIVER JOINT VENTURE PARTNERSHIP

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Landscape-scale restoration measures in the Midwest typically require the formation of collaborative partnerships. The Cache River wetlands in southern Illinois, a designated Ramsar site[2], have been undergoing ecological restoration across multiple state, federal, and private ownerships. Although some aspects are coordinated under the Cache River Joint Venture Partnership (CRJVP), individual agencies and entities pursue specific ownership priorities and approaches to management. This case study explores the dynamics among land managers employed by federal agencies, state agencies, and nongovernmental organizations managing land and water resources in a hydrologically linked wetlands system within the CRJVP. Semi-structured interviews were conducted with 25 managers, including staff members who maintain active participation in restoration activities, and individuals who have worked closely with CRJVP. Triangulation of interview transcriptions, meeting observations, management plans, and other relevant agency/organization documents revealed emerging themes and patterns within the data. Grounded theory was applied to better understand how differences in institutional cultures, missions, and resources impact management practices across the landscape.

Results suggest that administrative processes, funding sources, policy and regulations, mission statements, specified objectives, and management goals within and between agencies and organizations determine how institutional priorities and capacity impact management decisions and on-the-ground implementation. Institutional structures influence decisionmaking power and grassroots capabilities. Incompletely defined management and decisionmaking criteria challenge compatibility among partners and the central mission of the CRJVP itself. There are implications of this research in the function of existing or future partnerships facing similar challenges.

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[2] Ramsar sites are wetlands of international importance, designated under the Ramsar Convention of 1971.

ALLOMETRIC EQUATIONS FOR ABOVEGROUND AND BELOWGROUND BIOMASS ALLOCATION OF AMERICAN CHESTNUT AND NORTHERN RED OAK REGENERATION

Ethan P. Belair and Mike R. Saunders[1]

Prior to the importation of chestnut blight (*Cryphonectria parasitica* [Murr.] Barr) in the early 1900s, American chestnut (*Castanea dentata*) was a dominant species in many hardwood forest types in the eastern United States. Based on their co-occurrence in many habitats, it is often assumed that chestnut and oak species (*Quercus* spp.) are similarly adapted to resist abiotic stresses. Specifically, it is well known that oak's preferential allocation of resources to root systems increases their tolerance of both drought and fire. However, the similarity of chestnut's biomass allocation to co-occurring oak species has not been formally tested using the seedlings and saplings that may be deployed during the impending American chestnut restoration efforts. Furthermore, to the author's knowledge, belowground structures of chestnut seedlings in natural conditions remain unstudied. We harvested aboveground structures and excavated roots from 29 American chestnuts and 47 northern red oaks (*Quercus rubra*) with ground line diameters between 0.5 and 5 cm at three sites in north central Indiana. All individuals were divided into four component parts: stem, branches, foliage, and coarse roots (>2 mm). Additive biomass equations were developed using nonlinear seemingly unrelated regressions with ground line diameter, total height, live crown length, number of first order lateral branches, crown diameter, and overstory canopy openness as independent variables. Leaf area allocation and specific leaf area were investigated using digital scans of a subset of the foliage from each individual. This information is of interest as it elucidates chestnut's stress tolerance adaptations and likely performance on various sites, as well as its suitability for carbon sequestration.

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DENDROHYDROLOGICAL ANALYSIS OF MISSISSIPPI RIVER FLOOD EVENTS IN A MIXED BOTTOMLAND HARDWOOD FOREST

Margaret B. Bialecki and Matthew D. Therrell[1]

Destructive flooding in 2011 highlights the dynamic nature of the Mississippi River, and the bottomland hardwood forest riparian ecosystem presents a unique opportunity to examine the history of the Mississippi River flood pulse and provide insight into the ecological effects of long-term hydrologic alterations in the river-floodplain system.

We collected tree ring samples in 2009 from 33 living and 2 dead oak (*Quercus* spp.) trees from Big Oak Tree State Park in Mississippi County, MO, to evaluate long-term yearly growth and response in floodplain trees. This site represents one of the few remaining stands of virgin wet-mesic bottomland hardwood forests within the lower Mississippi River (LMR) alluvial valley. We developed an annually resolved tree ring record of high magnitude flooding on the LMR based on anatomical signatures evident in the wood (flood rings). Flood ring years were determined by examining each tree series for evidence of flood injury and abnormalities consistent with previous flood ring studies. We found that the most pronounced characteristic of flood rings in the oaks sampled was a reduction in the cross-sectional area of the earlywood (EW) vessels during the year of inundation. Additional characteristics used for identification included narrow rings, irregular EW vessel distribution, reduced latewood fiber, and disorganized flame parenchyma.

The resulting flood ring record identified spring flood events on the LMR from 1694-2009 and included virtually all of the observed high magnitude spring floods of the 20th century occurring on the LMR adjacent to the Birds Point-New Madrid floodway, as well as similar flood events in prior centuries. A response index analysis for years 1770-2009 indicated that more than half of the floods identified caused anatomical injury to more than 50 percent of the sampled trees and many of the greatest flood events were recorded by 80 to 100 percent of the trees at the study site. A comparison of the response index with average daily river stage height values at New Madrid, MO (1879-2009) indicated that the flood ring record can explain significant portions of the variance in both stage height (30 percent) and number of days in flood (40 percent) during spring flood events. Preliminary analysis of EW vessel size revealed that median vessel diameter can also be a proxy for large-scale flooding. Vessel size appeared to be highly responsive to stream flow measures, in particular duration of spring flood events (r^2=0.82). The flood ring record also suggested that high-magnitude spring flooding is linked to regional climate variability.

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ANALYSIS AND IMPACT OF ENERGY RECOMMENDATIONS IN THE WOOD PRODUCTS INDUSTRY

Brian Bond, Henry Quesada-Pineda, and Janice K. Wiedenbeck[1]

Increasing manufacturing costs have contributed significantly to the decline of the forest products industry in the United States; increasing costs limit the ability of manufacturers to flourish against global competitors. While forest products companies in the United States are continually improving their products, processes, finances, and business practices, many have not seized upon opportunities to reduce energy consumption. Cutting energy costs remains a way that many wood products firms can trim operating expenses while developing new business prospects and serving existing customers. The goal of this project is to increase the competitiveness of the wood products industry by providing current information about the most beneficial energy saving opportunities. Methods include (1) data mining the implemented energy saving recommendations from the Industrial Assessment Center (IAC) collection for U.S. manufacturers, and (2) identifying lean management practices or principles that can be used to not only decrease energy consumption but also to increase productivity. Energy reduction recommendations based on lean principles can lead to greater savings and relative shorter payback times than will other common energy reduction recommendations.

Cluster analysis and statistical techniques will be used to identify the best energy recommendations for wood products sectors (primary and secondary). Those recommendations that have been successfully implemented by the industry will be classified as technical, administrative, or process improvement by using clustering techniques. Energy saving recommendations will be compared by different implementation criteria such as cost savings, payback period, and capital cost across different North American industry classification codes (NAICS) within the wood products industry. An example of this data for the pallet and skid-manufacturing sector includes an average savings per implementation of an estimated \$60.40/employee or \$0.09/ft^2, with an average payback period per implementation of 0.84 year. The most common implemented energy recommendation for this industry sector was the elimination of leaks in inert gas and compressed air lines/valves with an average payback of 0.23 year and annual savings of \$19.10 per employee or \$0.025/ft^2.

Work completed to date demonstrates that recommendations based on lean principles can lead to greater savings and relatively shorter payback times than other common energy reduction recommendations. For example, preliminary data analysis indicates that for 8 out of 10 cases, the payback period is less than 1 year. Data also indicate that for lean-based recommendations, the savings, based on the area (size) of the plant, ranges from \$0.08/ft^2 to \$1.92/ft^2. The underlying strength of lean-based recommendations is that while energy consumption is decreased, productivity is simultaneously improved.

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MAPPING TEMPORAL CHANGE IN OAK-DOMINATED ECOSYSTEMS IN THE CHICAGO REGION

Matthew Casali and Robert T. Fahey[1]

Oaks are a keystone species in northeastern Illinois, driving much of the biodiversity in the region. Oak ecosystems are in decline because of landscape-level changes such as alteration of disturbance regimes, habitat fragmentation, and urban development, as well as stand-level changes such as competition from shade-tolerant species, encroachment of invasive plant species, and lack of management or disturbance-related canopy openings—all of which have lead to widespread reproductive failures. The goal of this project was to identify existing oak dominated communities throughout the seven northeastern Illinois counties that make up the Chicago metropolitan region: Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will Counties. The current distribution of oak dominated ecosystems was compared spatially and temporally with records from multiple time periods dating back to the 1800s. The project provides spatially explicit information regarding the quantity and parcel size of remaining oak ecosystems, their ownership and conservation status, and relationship to drivers of change from original distribution.

Using ArcGIS software (Esri, Redlands, CA), oak dominated ecosystems were identified from a combination of presettlement vegetation information from 1800s public land survey notes, 1939 aerial photography, modern soils data, and orthoimagery from 2010. Using the 1939 aerial imagery, oak dominated parcels were located and digitized. Probable oak dominance for each parcel was evaluated based on species data from public land survey notes, landscape position, soil data, and user interpretation of the imagery based on tone, shape, size, texture, and association. These parcels were then compared to the 2010 orthoimagery and were reshaped or removed to include only the previously existing oak communities.

Our findings indicated a significant decline in the extent of oak ecosystems from presettlement baselines across the region, but also high spatial variability in this landscape transition and its drivers. Across the seven-county region, the estimated area of oak dominated ecosystems declined from 782,709 acres in the 1830s to 209,951 acres in 1939 (27 percent remaining), and 111,518 in 2010 (14 percent). The two highest levels of remnant oak ecosystems in 2010 were found in exurban Kendall County (27 percent) and highly urbanized Cook County (19 percent). The lowest levels were found in exurban McHenry County (10 percent) where oak ecosystems were especially dominant in the presettlement landscape. Conservation status also differed greatly across the region; the highest percentage of protected ecosystems was found in Cook County (82 percent) and the lowest in Kendall County (14 percent). Overall, there have been large declines in the number of remaining large oak parcels. In 1939, there were 11 parcels 500 acres or greater, 83 parcels 200 acres or greater, and 271 parcels 100 acres or greater. In 2010, there were 3 parcels 500 acres or greater (27 percent), 37 parcels 200 acres or greater (45 percent), and 119 parcels 100 acres or greater (44 percent).

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These findings indicate patterns of declined in the oak ecosystems of the Chicago metropolitan region. Further data analysis from this project will illustrate the effects of different urbanization patterns on landscape composition and will be essential in regional oak conservation efforts, including illustrating the importance of private lands and connections between existing large parcels.

INTERACTIONS AMONG INSECT DEFOLIATION, INSECTICIDE TREATMENTS, AND GROWTH RATE IN AMERICAN AND BACKCROSS GENERATION BC_3F_3 CHESTNUTS

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The American chestnut, *Castanea dentata* (Marsh.) Borkh, was once one of the most useful and abundant canopy trees in eastern North American forests. During the last 200 years, the species has been decimated by two exotic pathogens. *Phytophthora cinnamomi* (Rands) (Oomycetes: Pythiaceae) causes ink disease on wet or poorly drained sites, and *Cryphonectria parasitica* (Murrill) Barr (Diaporthales: Cryphonectriaceae) causes chestnut blight throughout the species' former range. Chestnut blight has been responsible for reducing millions of trees to short-lived understory sprouts. Breeding programs have aimed to transfer blight resistance from Asian chestnut species to American chestnut via a backcross breeding approach.

Seedlings from the third intercross of a third backcross generation (BC_3F_3) were planted in a series of field tests in southern Appalachian national forests. In these tests, the Asiatic oak weevil, *Cyrtepistomus castaneus* (Roelofs) (Coleoptera: Curculionidae), was identified as a primary late-season defoliator of chestnut seedlings. To better understand the impact Asiatic oak weevil has on seedling growth, we initiated a study using 1-0 bareroot American and BC_3F_3 chestnut seedlings. The seedlings were planted around the perimeter of a 40-year-old northern red oak, *Quercus rubra* L., seed orchard in eastern Tennessee where previous insect surveys detected an abundance of Asiatic oak weevils. In addition to quantifying the impact of *C. castaneus* defoliation on seedling growth, the study evaluated the efficacy of various insecticide treatments (imidacloprid, acephate, dinotefuran[2], and a water control) on phytophagous insects.

Ten seedlings of American and BC_3F_3 chestnuts, respectively, were randomly chosen from a pool of the healthiest individuals for each of four treatments in the study. Visual-categorical method and a digital-numerical method were compared in assessments of defoliation once a month from August through October. Height and root-collar diameter were also measured throughout the growing season to assess the impact of defoliation on seedling growth. Temporal and spatial fluctuations in weevil emergence was observed using 31 conical wire mesh insect traps placed on top of existing leaf deposits about 40 meters apart on the inside of the perimeter of the study site and beneath the drip line of the orchard's oaks.

Preliminary results showed a trend of greater defoliation on American chestnut than on BC_3F_3 chestnut seedlings. It is important to note the defoliation patterns observed cannot be solely attributed to *C. castaneus.* Future research will enclose *C. castaneus* on chestnut seedlings to further

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[2] Imidacloprid (BayerCrop Science, Monheim, Germany); acephate (Sigma-Aldrich, St. Louis, MO); dinotefuran (Mitsui Chemicals America, Rye Brook, NY).

understand the impact the weevil may have on seedling growth. In general, higher defoliation ratings were produced using the digital-numerical assessment method than with the visual-categorical method. Both methods suggested that imidacloprid and dinotefuran were effective in protecting American chestnut from defoliation. Defoliation ratings were less conclusive on BC_3F_3 seedlings, although seedlings that received imidaclprid treatments had the highest defoliation rates for both digital and visual ratings by October. *Cyrtepistomus castaneus* emergence peaked in late July and varied spatially within the study area, suggesting possible insect microsite preferences. Results from this research will aid in understanding the relationship that defoliation has on growth with American and BC_3F_3 chestnut seedlings and may ultimately contribute to the successful restoration of blight resistant American chestnut to eastern forests.

ASSESSMENT OF THE COMPOSITION AND STRUCTURE OF A SUSPECTED OLD-GROWTH, MESIC HARDWOOD FOREST IN THE SOUTHERN OZARKS

James Crawshaw[1]

This study assesses the quality of a small tract of mature forest in the Boston Mountains of the Southern Ozarks that exhibits characteristics of virgin, old-growth forest, and species typical of mixed mesophytic forests. The study site is about 200 m by 40 m and follows a northeast facing slope in the southernmost branch of Boen Gulf, a hollow in the headwaters of the Buffalo River. We hope to determine if this stand of mesic forest is remnant old-growth forest by assessing the age structure, species composition, density, frequency, and basal area of trees within the approximately 0.8 ha study site. All stems greater than 10 cm d.b.h. were inventoried. Twenty-one tree species were identified in the site with no clear dominant species based on frequency and basal area. Cucumbertree (*Magnolia acuminata*) represented 19.6 percent of the basal area present, more than any other species, followed in order by American basswood (*Tilia americana;* 15.1 percent), blackgum (*Nyssa sylvatica;* 12.5 percent), sugar maple (*Acer saccharum;* 11.1 percent), American beech (*Fagus grandifolia;* 7.8 percent), and umbrella magnolia (*Magnolia tripetala;* 5.6 percent). The diameter distribution for all species followed a reverse-J pattern with only a few individuals greater than 70 cm diameter. More data are being collected on the age structure of the stand by taking core samples from all the inventoried trees greater than 10 cm d.b.h. This study will serve as a baseline for future research in forest ecology and succession in Boen Gulf.

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SURVEY OF NORTHERN AND CENTRAL WISCONSIN FORESTERS REGARDING OAK SILVICULTURE

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Difficulties in regenerating oak (*Quercus* spp.) have been encountered over much of the eastern United States. These difficulties have been partially explained by a number of factors that include small or limited advanced regeneration, deer browsing, altered disturbance regimes, and competing vegetation. We surveyed foresters working in Wisconsin to determine the successes and barriers that they have experienced with regenerating oak.

Forty-three foresters working in 49 counties of northern and central Wisconsin were the subjects of this survey. Our goal was to survey at least one forester that worked in each northern and central Wisconsin county (noting that some foresters work regularly across more than one county). Nonrespondent bias was relatively low. One person stated that he had no time, several forwarded us to someone else in their office, three had retired, and we were unable to reach six for various reasons. Overall, we heard from foresters working in all but three counties in the northern two-thirds of Wisconsin. The survey was completed between September 2011 and May 2012.

Lower quality oak (scrub oak) sites presented a smaller regeneration barrier. For foresters that managed scrub oak (21 of the foresters included this as part of the areas they managed), 52 percent said that overstory removal was adequate for regeneration while 19 percent had encountered some issues. Other techniques that were tried with success on low quality sites included shelterwood, patch clear cut, group selection, and scarification. In Wisconsin, coppice is a generally accepted practice on scrub oak sites. These sites are usually cut while young (45-70 years) as a pulp and low grade log harvest. Nineteen percent of the foresters surveyed still encountered issues with regeneration on scrub oak sites; these issues included poor acorn crop, hazelnut competition, history of site degradation, or too small size (area) of cuts that encouraged deer browsing.

Higher quality sites presented more of a barrier. Only seven foresters found high quality sites easy to regenerate. The primary methods used, according to their responses, were shelterwood with site preparation (burning, chemical, chaining, or the combination of chemical and chaining; 71 percent), overstory removal over existing regeneration (29 percent). Group selection also was mentioned. Three of these foresters mentioned that oak regeneration was easier now that the deer population was lower in their area. For the 24 foresters that experienced problems with the success of oak regeneration on high quality sites, 63 percent had tried some form of shelterwood, with 21 percent also scarifying or chemically releasing, and 13 percent mentioned having done supplemental planting in the shelterwoods. One forester had given up hope that oak can be successfully regenerated under current conditions. A few other techniques were mentioned: releasing oak poles, single tree selection, and group selection. Two of the barriers that were mentioned were deer browsing and competing vegetation. While questions relating to deer were not asked in the survey, almost half of those

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surveyed still mentioned deer problems. Competing vegetation was also mentioned as a possible barrier. The combination of these two factors (existing competing vegetation and selective deer browsing) can present a rather significant barrier for oak regeneration. From these results, it appears that in some counties, shelterwood with site preparation may be adequate. In other counties, there may either be a more complex combination of barriers to successful regeneration or the local foresters have not devised a successful combination of treatments yet.

Overall, on sites where oak has a strong competitive advantage (dry, nutrient-poor sites), oak regeneration is easier to achieve. On high quality sites, foresters encounter more problems. The likelihood of success appears to improve either by using existing advanced regeneration or using a shelterwood with some site preparation.

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LEAF STRUCTURE AND PHYSIOLOGICAL ATTRIBUTES OF *AILANTHUS ALTISSIMA* IN COOL AND WARM TEMPERATE REGIONS

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To understand key attributes associated with the successful establishment and invasion of *Ailanthus altissima* (hereafter referred to as Ailanthus), we examined its leaf structure and ecophysiological characteristics from trees grown on sites in two different climatic regions: cool (Glenville, WV, USA) and warm (Fukuoka, Japan) temperate regions. Ailanthus was introduced in both countries from China and is considered an invasive species that threatens natural forests. Although leaf size was the same in both sites, specific leaf area, an indicator of photosynthetic capacity, was found to be larger in trees located in Glenville (297.2±23.7 cm^2/g) compared to those in Fukuoka (237.0±33.5 cm^2/g). Relative water content (RWC) was lower in Glenville (63.6 ±2.6 percent) than in Fukuoka (79.9±2.0 percent). Low RWC may indicate the ability of the plants to sustain excessive water loss without desiccation (RWC < 40 percent). There were also leaf structural differences between the two sites; those from Glenville exhibited light-adapted leaf characteristics with shorter stomatal length (22.03±0.46 mm) and higher stomatal density (232 ±8 per mm^2) than in Fukuoka (28.6±0.87 mm; 196±12 per mm^2, respectively). Trees from Fukuoka sustained higher stomatal conductance (205.0±14.7 mmol per m^2 per s) throughout the day compared to those trees in Glenville (135.6±14.5 mmol per m^2 per s). Result of chlorophyll fluorescence analysis showed that Ailanthus trees in Glenville had a higher mean Fv/Fm of 0.80 than in Fukuoka (0.78). A lower value of Fv/Fm (<0.80) may indicate photoinhibition, which can result in a decline in photosynthetic capacity due to high light intensity. The leaf structure and ecophysiological parameters measured in this study revealed the key attributes of Ailanthus that are associated with its invasiveness. Although Ailanthus in Fukuoka may still be in its early stage of invasion, its successful establishment where it was originally planted and aggressive physiological characteristics showed its potential to continuously invade natural forest ecosystems of Japan.

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IMPORTANCE OF OAK FOREST ECOSYSTEMS TO WOOD WARBLERS IN THE WESTERN HEMISPHERE

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Oak forest regeneration and management are important economic and ecological concerns in the Central Hardwood region and elsewhere. Similar concern exists in the nearctic-neotropical migratory avifauna. Wood warblers (Parulidae) are prominent among this avifauna. Extensive harvest of North American oak forests in the late 19th and early 20th centuries imposed great changes in occurrence, distribution, and age structure of oak forests. Oak species diversity is a point of pride for Mexico and its persistence is a point of concern. Current use of oak forest habitats by warblers and other avian species reflects a response to past wholesale changes in these forests and may guide future restoration and management activities. Our curiosity about the apparent co-occurrence of oaks and warblers led us to review the natural history of these birds and of oak forests in order to develop a base of information to suggest hypotheses and support the needs of managers and conservationists alike. This report indicates progress to date on this project. The avian family Parulidae comprises approximately 115 neotropical and north temperate species. We investigated the extent of their documented use of oak forest ecosystems and the overlap of their geographic range with that of oak forests at different stages of the life cycle. First, we searched existing literature for references to use of oak trees, oak forests, or ecosystems including oak. Second, we compiled electronic maps of distribution of oak species into a composite western hemisphere oak forest distribution map and compared that map with publicly available electronic maps of distribution of wood warbler species. Third, we compared the observed map overlaps between distribution of oaks and individual warbler species to the literature record of use of oaks by that species. We identified 446 papers during our initial literature review, of which 404 included a total of 2,542 references to use of oak forests by one or more warbler species. Of this large number of references, typically more than 90 percent refer to general use of forest types; only a small proportion specifically places warblers in oak trees. All 51 migratory warbler species use oak forest for some portion of the life cycle: 49 during the breeding season, 47 during the nonbreeding season, and 42 during migration. References to use of oak forest during the breeding season include all of the migratory species except Connecticut warbler, *Oporornis agilis*, and Cape May warbler, *Setophaga tigrina*. By contrast, the record of oak use by nonmigratory species is poorly documented, including 61 references to use of oak by 10 species. The mapped ranges of 38 of 60 nonmigratory species were found not to overlap oak forests in this review. However, three of these nonmigratory species, flame-throated warbler, *Oreothlypis gutturalis*; golden-browed warbler, *Basileuterus belli*; and collared redstart, *Myioborus torquatus,* show no range overlap but are listed in references as using oak forests. Furthermore, these migratory birds were shown to use, or are believed to use oak forest for a portion of the life cycle: 51 species during the breeding season, 46 during the nonbreeding season, and 45 during the migratory period. Forty-one migratory and 22

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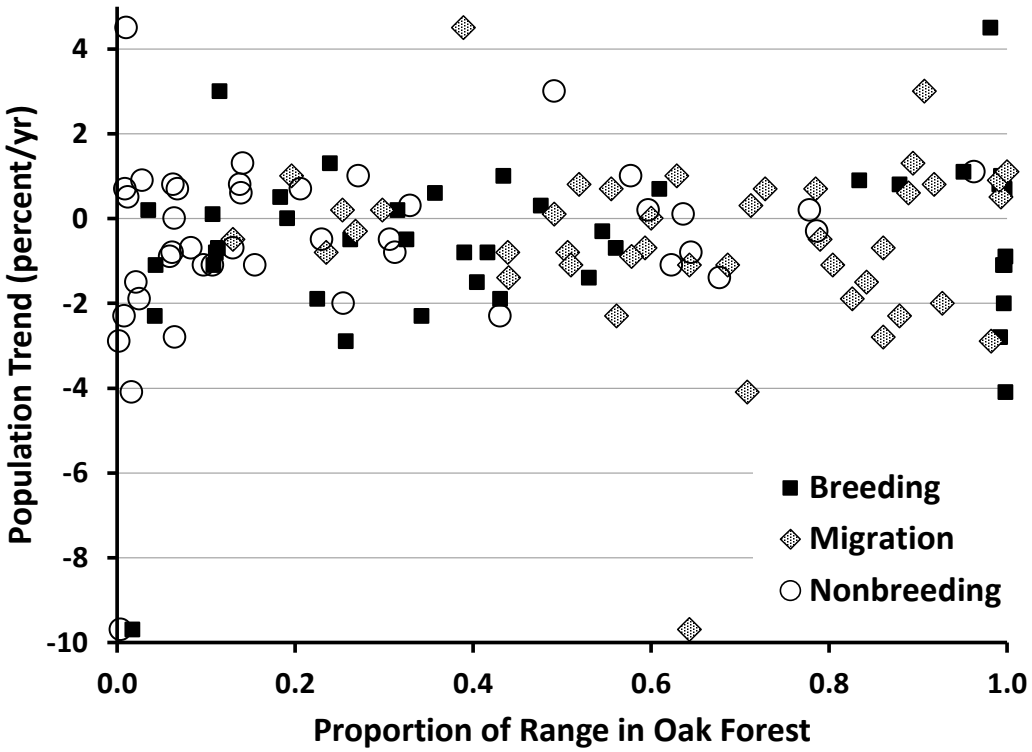

Figure1.—Relationship between population trends of warblers and proportion of range in oak forests during breeding, migration, and nonbreeding periods.

nonmigratory species use oak forest ecosystems throughout the year, of which 15 migratory and 10 nonmigratory species include more than 20 percent range overlap with oak forests. Additional species may do so, but insufficient data exist in our review to confirm this. Population trends of warblers are uncorrelated with proportion of range in oak forest, for any of the 43 species for which sufficient data exist to plot the relationship (Fig. 1). Among three warblers listed as endangered by the U.S. Fish and Wildlife Service, golden-cheeked warbler (*Setophaga chrysoparia*) depends upon oak forest ecosystems for nonbreeding habitat and Bachman's warbler (*Vermivora bachmanii*) is associated with cane (*Arundinaria gigantea)* stands in mixed oak bottomland forests. Two of 18 additional species also listed by International Union for Conservation of Nature (IUCN) in some category of vulnerability are long distance migrants, golden-winged warbler (*Vermivora chrysoptera,* IUCN Near Threatened) and cerulean warbler (*Setophaga cerulea,* IUCN Vulnerable). Central American resident pink-headed warbler (*Cardellina versicolor,* IUCN Vulnerable) and several migratory warbler species depend heavily upon oak forests and associated ecosystems. Resident warblers of the northern Andes Mountains also use oak forests. These birds, and other wildlife species, have a substantial stake in the successful restoration, sustainable management, and dependable regeneration of oak forests. (Citations available on request to phamel@fs.fed.us.)

AUTUMN BAT ACTIVITY IN SELECTION HARVESTS AND INTACT FOREST STANDS LOCATED NEAR HIBERNACULA

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Indiana's Harrison-Crawford State Forest (HCSF) is home to several major bat hibernacula, including the well-known Wyandotte Cave complex. HCSF is also a 24,000 acre actively managed forest which provides roosting and foraging habitat for bats of many species during the nonhibernation seasons. The autumn prehibernation period is particularly important at HCSF since high concentrations of bats use the caves and surrounding forest to prepare for hibernation or as a temporary stopover during migration. To determine if habitat use near hibernacula was affected by timber harvesting, bat activity in forest stands that had recently received selection harvests was compared with activity levels observed in "intact" mature forest stands (i.e., >15 years since single-tree selection harvest). Anabat SD2 acoustic detectors (Titley Scientific, Columbia, MO) were used to monitor bat activity at randomly located sites within 22 paired harvested and intact stands on HCSF during September-November 2012. All sampling sites were within 2 miles of a cave entrance serving a known bat hibernaculum. Mean distances were similar between harvested (0.9 miles) and intact (0.92 miles) sampling sites and the entrance of the closest known hibernaculum. Bat calls were identified to species group based on call characteristics using three automated software packages, EchoClass (U.S. Army Engineer Research and Development Center, Vicksburg, MS), Kaleidoscope (Wildlife Acoustics, Inc., Concord, MA), and BCID (Bat Call Identification, Inc., Kansas City, MO). For all species groups, activity levels were greater ($P < 0.05$) in recently harvested stands. Results indicate that recent selection harvests may be an important resource to foraging bats during migration and the prehibernation period.

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STATEWIDE PRESCRIBED FIRE NEEDS ASSESSMENT FOR ILLINOIS

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Extensive efforts are underway to increase the use of prescribed fire across many areas of Illinois. Prescribed fire use has certainly increased over the last decade but no entity has tried to assess these efforts using any standardized criteria nor have they made an attempt to disseminate the results to constituency groups. Many entities using prescribed fire to manage natural areas generally wish to increase their effectiveness and scope across the landscape. However, to do so would mean overcoming several obstacles to expansion and development of all fire programs including funding requests and training activities for a largely volunteer force of burn crew members. Before any coordinated expansion in the prescribed fire community occurs, it would aid planning efforts if the fire community were to conduct a frank and timely assessment of our capacity to plan, conduct, and monitor prescribed burns on lands within our state. A survey document has been developed and disseminated to all prescribed fire practitioners statewide to collect specific information about prescribed fire use. The data gathered though this survey along with the use of LANDFIRE spatial data layers will help quantify the amount and types of lands currently under prescribed fire management as well as qualify the current fire return intervals and FRCC (fire regime condition class) that the lands are in. This information will allow researchers to determine if prescribed fire managers in Illinois are meeting their burn objectives and specify the particular needs and limitations of practitioner burn programs.

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GAP AND UNDERSTORY LIGHT REGIMES ALTER STAND SIZE INEQUALITIES IN GARLIC MUSTARD

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ABSTRACT

Garlic mustard (*Alliaria petiolata*) is a biennial herb native to Europe that has become invasive to North American forests. Monospecific populations of first and second year garlic mustard plants were collected from both understory and gap locations in a temperate forest in central Illinois to determine how light regime influenced the formation of population size inequalities over the course of a full growing season. Aboveground biomass was measured for individuals within populations consisting of first or second year plants, and size inequalities were calculated using Gini coefficients. Greater size inequalities occurred in understory locations for first year populations at the end of the growing season, whereas second year populations exhibited larger size inequalities in gaps throughout the growing season. Results indicate that age classes of garlic mustard respond differently to varying light regimes, which could have meaningful implications on the genetic makeup of subsequent generations and future management strategies.

Introduction

Garlic mustard *(Alliaria petiolata)*, a biennial herb introduced to North America in the late 1800s, has become invasive throughout temperate forests in North America (Clapham et al. 1952, Nuzzo 1991). Garlic mustard's competitive advantage may be related to its ability to successfully grow and reproduce under light conditions ranging from undisturbed canopy to areas of moderate disturbance (Myers and Anderson 2003). Garlic mustard grows in dense monospecific clusters, which can exhibit strong intraspecfic competition resulting in alternating-aged cohorts within populations (Bauer et al. 2010). We predict that more pronounced size inequalities will develop within garlic mustard populations growing in forest canopy gaps and less developed size inequalities will be found in populations growing in intact understory (Weiner 1985). Our objective was to survey first and second year garlic mustard plants within gap and closed understory populations to evaluate if size inequalities exist in these populations and to consider the consequences of garlic mustard population size structure for forest management.

Methods

Gap and understory locations were determined based on visual inspection and confirmed by quantum flux measurements in a temperate, mixed hardwood forest in Peoria, IL. Sample populations of first and second year garlic mustard were harvested every 2 to 3 weeks from April through July 1999. Individual (aboveground) plants were dried, biomass was determined, and population size inequalities were calculated using Gini coefficients (Weiner 1986). Data were analyzed using a three-way ANOVA with harvest date, stand age, and light regime as fixed main effects.

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Results

- Understory light levels declined rapidly early in the season and remained low throughout the growing season while light levels in gaps were higher and more variable. Gaps had more overhead light and understories had more side light.
- Mean plant size within garlic mustard populations increased throughout the growing season for both first and second year plants, but did not differ by gap vs. understory location within either age group.
- Size inequalities in first year populations were not well-developed early in the growing season, but became more pronounced as the season progressed. Conversely, size inequalities for second year populations were initially high, and declined through the season.
- Size inequalities for second year populations were more pronounced in gap than in understory environments, particularly early in the growing season.

Discussion

Lack of appreciable size inequalities in first year populations early in the season is not unexpected, as the initially very small plants would not likely compete with each other for light; size inequalities typically develop over time as individuals grow larger and neighboring plants' canopies come in proximity to each other such that intraspecific competition for light becomes more pronounced (Weiner 1986). Size inequalities in first year populations increased as expected throughout the growing season.

Less expected were the large size inequalities in second year populations at the start of the growing season. If these populations exhibited similar population size structure to the first year populations in the current study, it appears that size inequalities became more pronounced during the overwintering months. This would occur if the smaller individuals within the population at the end of the first growing season were at a competitive disadvantage as growth recommenced in early spring. The reduction in size inequalities in second year stands is consistent with trends in size structure in populations undergoing size-specific mortality such that the smallest individuals are being "thinned" out of the population (Weiner and Thomas 1986).

The greater size inequalities of second year populations in gaps relative to those in the understory that are apparent early in the growing season may indicate that overwintering mortality was more pronounced in gaps. This is perhaps not surprising, as gaps are found to exhibit more extreme temperatures, humidities, and wind levels, and are thus likely to present a more hostile overwintering environment to these biennial herbs.

Although gap and understory environments differed in light conditions (e.g., directionality) and thus the potential for asymmetric competition, size inequalities were not appreciably different in these environments for first year populations throughout the growing season. The apparently greater overwinter thinning experienced in gap populations was more likely due to factors other than light availability, as it is assumed that these plants are largely photosynthetically inactive, and indeed are under leaf and snow pack during the winter months. Nonetheless, gap environments did result in greater size inequalities, and thus possibly greater genetic bottlenecks, for these garlic mustard populations. Since vegetative biomass predicts reproductive potential, greater vegetative biomass size inequalities in a population predict greater inequalities in reproductive fitness.

A better understanding of the controls on population size inequality in garlic mustard populations may help in the management of this invasive weed. Our data suggest that selective logging or stand thinning in forests could increase overwintering mortality and decrease genetic diversity in garlic mustard populations.

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FACTORS LIMITING OAK REGENERATION IN SOUTH CENTRAL PENNSYLVANIA

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Oak (*Quercus* spp.) regeneration on the 94,000+ acre Tuscarora State Forest has been problematic for decades. Early work in the 1970s implicated acorn insects, rodents, and deer as the major factors limiting oak regeneration. Foresters have used deer exclosure fencing, scarification, shelterwood harvest followed by prescribed burning, herbicides, and other methods, but with only limited success. The forest lies within the Ridge and Valley physiographic province, and soils derived from bedrock in the Tuscarora formation (Tf) can readily regenerate oaks. However, oak regeneration is problematic on the older Juniata formation (Jf) and on the younger lower Clinton formation. In 2013, three plots, each with 230 northern red oak (*Q. rubra* L.) (NRO) acorns, were planted on eight sites, four sites on soils that developed on the Tf and four sites on soils developed on the Jf. Preliminary results indicate heavy losses due to both deer browsing and small mammal clipping of emerging seedlings. In early July, 32 percent of NRO seedlings had germinated and survived on the Tf and 34 percent on the Jf. By August, only 25 percent of NRO seedlings survived on the Tf and 29 percent on the Jf. Duff samples from all 24 planted plots indicate duff thickness and mass are significantly ($P \leq 0.05$) greater for planted sites on the Tf compared with the Jf. Duff mass averaged 92 Mg/ha for stands on the Tf while it was only 61 Mg/ ha on the Jf. Duff thickness appears highly variable and a possible impediment to acorn germination and establishment.

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CHARACTERIZATION OF MATERNITY ROOSTS OF INDIANA BAT IN SOUTHERN ILLINOIS

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Indiana bat (*Myotis sodalis*), a federally endangered species, uses bottomland forests for both summer foraging and roosting habitat. A limiting factor for this species is the availability of roost trees, which provide day resting and maternity habitat. Most female Indiana bats form summer roosting colonies of 25 to 100 individuals. An individual Indiana bat maternity colony may use several different roosts to provide a range of environmental conditions needed for raising young. Colonies generally use both primary and secondary roost trees. Primary trees are typically larger snags with solar exposure that provide proper roosting conditions (cover and correct temperature) most of the time (Carter and Feldhamer 2005). Secondary roosts are generally used by fewer bats. Live trees that have exfoliating bark, such as shagbark hickory (*Carya ovata*), are known to have a relatively high value as roosts but are generally used as secondary roosts because bark structure limits the number of individuals that are able to roost together under the bark in one area of the tree. To manage for the Indiana bat, a sustained supply of suitable roost trees is critical. Our objectives were to characterize maternity roosts of Indiana bats and determine the optimal density of suitable roost trees necessary to support a healthy maternity colony.

Within Cypress Creek National Wildlife Refuge, seven 100-acre bottomland hardwood stands were surveyed using a point transect method. This habitat inventory covered bottomland hardwood forest with known Indiana bat maternity colonies. Within each stand, four transects consisting of five plots each were surveyed. Within the 0.2-acre sample plots, all snags and hickories greater than 5 inches in diameter were measured for height, diameter at breast height (d.b.h.), tree condition, decay class, and percentage bark remaining. Percentage canopy cover was also measured in the four cardinal directions at each tree. Known roosts (bats present), random snags (no bats confirmed), and hickories (both known roosts and random) were compared. Known roosts were located by tracking female Indiana bats using radio telemetry. SAS statistical software (SAS Institute Inc., Cary, NC) was used to generate parameter estimates for each tree and stand as well as combined stands where individual maternity colonies were located. A general linear model analysis ($\alpha = 0.05$) was used to compare diameter and height of known Indiana bat roosts to random snags and hickories. A chi-squared statistical analysis was used to compare tree condition, decay class, percentage bark remaining, and percentage canopy cover of known roosts to random snags and hickories.

Thirty-seven different known roosts of 11 different tree species were located. Average snag density per stand ranged from 3.3 snags/acre to 10.5 snags/acre with an average of 4.4 snags/acre across all stands. Hickory density ranged from 0.5 hickories/acre to 5.0 hickories/acre with an average of 1.75/acre across all stands. Initial results indicate known Indiana bat roost trees tend to have larger diameters and heights than random snags and hickories. Compared to known roosts, random snags were typically in a more degraded condition. Most were degraded to the point that only the bole was

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remaining whereas snags used as roost trees retained many twigs, or at least the large limbs. For the stage of decay, random snags covered several stages of decay whereas roost trees tended to be weakly decayed, with the wood still fairly hard and with loose bark. Trees used by roosting bats (snags and hickories) tended to have greater than 50 percent of the bark remaining. Unlike hickories, most snags (both known roosts and random snags) in the study had less than 50 percent canopy cover.

While the general roosting ecology of Indiana bats has been described, few studies have looked at actual roost availability and made recommendations on snag densities to assist land managers in managing for this species. Existing recommendations suggest optimal conditions for Indiana bat roosting occurs at a density of 16 to 17 trees/acre with a tree d.b.h. greater than 9 inches and retaining more than than 25 percent of the bark (Garner and Gardner 1992). While we found general roost characteristics similar to those in other studies, the densities of potential roosts on Cypress Creek National Wildlife Refuge were lower than existing recommendations. We recommend further research into the snag densities necessary to sustain healthy maternity colonies.

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DISPERSAL AND SEED VECTOR TRANSPORT OF JAPANESE CHAFF FLOWER

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Nonnative invasives are species that are introduced to a new environment and they frequently cause ecological problems within otherwise functional ecosystems. Invasive species have been noted to cause local extirpations and change community structure and function. An experiment was conducted to assess dispersal of a relatively recent invasive species in order to gain insight on the transport of its seeds. Unintentional dispersal of seeds attached to the clothes and shoes of humans has been recognized, but only recently have efforts been made to quantify the species dispersed. The nonnative invasive plant Japanese chaff flower (*Achyranthes japonica*), has morphological adaptations that appear to aid in seed dispersal that may allow it to spread over large distances. A previous study has noted mortality of young birds when ensnared by the fruiting stalks of Japanese chaff flower. When seeds are mature and ready to disperse, it is likely that they can become attached to the fur and feathers of game, such as white-tailed deer (*Odocoileus virginianus*) and turkey (*Meleagris gallopavo*), or the clothing of people, thus actively dispersing the seed. Few empirical investigations have occurred to monitor the dispersal by human aided vectors. Seeds are commonly observed on the surface clothing of people but there is currently limited empirical data on clothing as a seed vector. Most importantly, this experiment was conducted to gain an understanding of the movement and dispersal of seeds to plan control practices to reduce the spread of particular invasive species.

A 2-year experiment was conducted to assess dispersal of Japanese chaff flower, to gain insight on the transport of its seeds, and to investigate the efficacy of potential seed dispersal vectors at Chestnut Hills Nature Preserve, in southern Illinois. Japanese chaff flower dispersal data were recorded from 50 randomly located 1-m^2 plots from 2012-13. We also collected data on plant height and cover, seed rain, seed production, slope, canopy cover, and species richness within each plot. Soil samples were collected from the plots in autumn 2012 and analyzed for pH, conductivity, total nitrogen, and total carbon.

Deer fur, turkey feathers, and cotton fabric were systematically moved across the plants in each plot to "collect" seed. The materials were combed to remove and count the seeds that had become attached. Seed rain estimates were determined from counts in seed traps constructed from pie pans coated with Tanglefoot® (ConTech Enterprises, Victoria, BC, Canada) and placed on the ground to collect seeds that fell from mature adult plants. The field experiment showed that seeds are readily dispersed by deer, birds, and humans. The fewest number of seeds were collected by turkey feathers (28.88 ± 2.52 seeds/m^2), while twice as many seeds were collected on deer fur and cotton fabric (60.44 ± 8.21 and 56.61 ± 6.53 seeds/m^2, respectively). Deer and turkey are common in the forests that Japanese chaff flower is invading, as are humans (principally wild game hunters). These vectors collect large numbers of seed through brushing against the Japanese chaff flower. This 'hitch-hiking' mode of secondary dispersal is enabling Japanese chaff flower to readily invade plant communities of southern Illinois as well as the surrounding Ohio and Mississippi River Valleys.

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EVALUATING THE SUCCESS OF OAK AFFORESTATION ON FORMER AGRICULTURAL LANDS IN SOUTHERN ILLINOIS

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The establishment of oak (*Quercus* spp.) plantations has greatly increased in practice to reduce fragmentation and to promote wildlife habitat and valuable timber production across the midwestern United States. However, influences such as competing vegetation, previous land cover, plantation size, and site preparation techniques may result in varying outcomes on restorative successes. We established 237 plots (0.05 ac) in 32 oak plantations located within Crab Orchard National Wildlife Refuge (Williamson County, Illinois) 15-18 years after mechanical planting. Sampling data for all trees included species, diameter, and lianas existence on the main bole of the tree. Additionally, an evaluation of free-to-grow status was documented for all oaks present, and an estimation of cover of autumn olive (*Elaeagnus umbellata*) and Japanese honeysuckle (*Lonicera japonica*) was completed within the plots. In general, sites with the previous crops of soybeans and clover tended to have greater oak survival, more trees per acre, larger oak diameters, more free-to-grow oaks, and fewer lianas than sites that had been fallow at least 2 years prior to planting. These results will be used to develop management recommendations in similar afforestation efforts throughout the Midwest.

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POTENTIAL GAINS FROM BREEDING AND SELECTION OF EASTERN COTTONWOOD AND HYBRID POPLARS ON LOWER MISSISSIPPI ALLUVIAL FLOODPLAIN AND UPLAND SITES

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Abstract.—*Populus* is a genus of exceedingly fast-growing trees, with tremendous potential for sawtimber, pulpwood, and as a source for renewable biomass energy. The aim of this study was to determine growth rates, adaptability to different environments, and disease resistance of selected eastern cottonwood and hybrid poplar clones on alluvial (i.e., Lower Mississippi Alluvial Valley) and uplands sites. This study was established over a 4-year period (2010 and 2013), using plant materials from four different sources and taxa. Results from the 2010 and 2011 upland test sites showed that nine hybrid poplar clones exhibited growth rates great enough to place them in the top 15 percent of their respective test population. Fourteen eastern cottonwood (*Populus deltoides*) clones were also among the top 15 percent of the test population. On the alluvial test site, eastern cottonwood clones performed better than hybrid poplars in term of growth and disease resistance. The top performing clone at age 3 years of the 2010 trial was 8019 (0.56 ft^3), and age 3 for the 2011 trial was 26-2 (0.44 ft^3). *Septoria* canker was generally higher in hybrid poplars on the alluvial sites compared with the upland sites.

INTRODUCTION

Eastern cottonwood (*Populus deltoides* Bartr.) is the fastest growing hardwood species in the southern United States (Garnett et al. 2008, Kelliher and Tauer 1980) and attains its best growth on newly developed alluvial soils that are high in natural fertility and moisture availability (Garnett et al. 2008, Keith and Coleman 2010). When planted on less fertile upland soils, eastern cottonwood has not demonstrated rapid growth (Kline and Coleman 2010).

Hybrid poplars are known to exhibit hybrid vigor, thus making them superior to native *Populus* species and commercially significant for a number of geographic areas of the United States (Stettler et al. 1996). However, hybrid poplars have not demonstrated that same ability in the lower Mississippi Alluvial Valley (LMAV) of the southern United States due to their susceptibility to *Septoria musiva,* a common leaf spot disease that can manifest into stem cankers and result in mortality. Eastern cottonwood is susceptible to *Septoria* leaf spot, but is resistant to this disease occurring as a canker.

Hybrid poplar testing in the LMAV has been limited and had disappointing results. However, new selections of hybrid poplars may prove worthwhile even in the LMAV if they show resistance to *Septoria* and superior growth to the best cottonwood clones. This study is focused on these new selections of both eastern cottonwood as well as different hybrid poplar taxa to determine adaptability, growth, and disease resistance on sites in and outside of the LMAV.

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Objectives

The objectives of these studies were to determine performance ability of hybrid poplars on LMAV sites in the presence of diseases, to determine if cottonwood clones will demonstrate rapid growth on upland sites, and to estimate the type and intensity of diseases that may inhibit the performance of hybrid poplars on sites in Mississippi.

METHODS

In 2010, a clone test identified as the 2010 Populus Consolidated Trial was established on two test sites: an alluvial site near New Madrid, MO, and an upland site near Pontotoc, MS. Clones used in this test originated from four cooperators and were selected for their performance in the geographical region of the cooperators. The four cooperators were ArborGen, GreenWood Resources, Mississippi State University, and University of Minnesota. Each group donated 20 clones; GreenWood Resources and the University of Minnesota provided all hybrid taxa, while ArborGen and Mississippi State University provided primarily eastern cottonwood clones. The 80 clones included in the test consisted of a combination of taxa, which included a pure eastern cottonwood and five hybrid poplar taxa. Taxa identification is as follows: eastern cottonwood—*P. deltoides* (DD); *P. deltoides* x *P. nigra* (DN); *P. deltoides* x *P. maximowiczii* (DM); *P. deltoides* x *P. trichocarpa* (DT); and *P. nigra* x *P. maximowiczii* (NM).

In 2011, a second round of testing was established with the 2011 Populus Consolidated Trial, consisting of 60 unique clones (i.e., 15 from each cooperator) and 20 common clones (i.e., 5 clones from each cooperator) that were planted in the 2010 trial. Under this strategy, the 2010 and 2011 trials are connected by 20 common clones. Due to flooding, no alluvial field site was planted in 2011.

The planting stock was canker free, dormant, unrooted cuttings, with all hybrid poplars being 9 inches long, while the eastern cottonwood was 18 inches long, with all cuttings having a top stem diameter not greater than 0.5 inches, and a bottom diameter of less than 1 inch. After the cutting of the plant materials into specified sizes, they were hydrated for 24 hours in water that contained the labeled rate for Admire® Pro (Bayer CropScience, Research Triangle Park, NC).

Following the hydration treatment, the cuttings were placed in 4 mil plastic bags and placed in a cooler at 35 °F until planting. Prior to planting, the site was disked, then subsoiled at 9 foot spacing and a depth of 14 inches. Both the 2010 and 2011 tests employed a nested design consisting of three blocks, four sources, and 20 clones/source. Each clone was arranged in two-tree row plots at a spacing of 6 feet by 9 feet. Goal 2XL® selective herbicide was applied at 64 oz per acre immediately after planting. Competing vegetation (weed and vines) control was done mechanically and by hand-pulling throughout the study period.

Annual measurements taken for all tests included total height at age 1 year, diameter at breast height (d.b.h), and total height at ages 2, 3, and 4 years. In addition to growth measurements, all of the tests were graded for overall crown leaf health and retention (CLHR) and the presence of stem cankers. All measurements taken involved height in feet to the nearest tenth of a foot, and d.b.h in inches to the nearest tenth of an inch for all tests.

Table 1.—Top performing clones, age 3 years, 2010 Consolidated Trial at Pontotoc, MS, (upland)

	Clones	Taxa	Origin	Survival (%)	DBH (in)	Height (ft)	Volume[1] (ft^3)
1	8019	DM	GreenWood Resources	100	2.7	28.1	0.6360
2	AG443	DD	ArborGen	83	2.7	22.5	0.4998
3	147-1	DD	Mississippi State Univ.	100	2.6	23.0	0.4864
4	80-5	DD	Mississippi State Univ.	67	2.3	19.8	0.4842
5	7388	DM	GreenWood Resources	83	2.4	22.3	0.4429
6	24-128	TD	ArborGen	100	2.4	22.0	0.4340
7	110412	DD	Mississippi State Univ.	100	2.5	22.7	0.4267
8	105-1	DD	Mississippi State Univ.	100	2.3	19.3	0.4161
9	6323	DM	GreenWood Resources	100	2.4	22.4	0.4144
10	3-1	DD	Mississippi State Univ.	83	2.2	22 .4	0.4104
11	AG412	DD	ArborGen	83	2.4	20.9	0.3804
12	7416	DM	GreenWood Resources	67	2.2	22.7	0.3715

[1] Using Krinards equation=0.09+.002216(D^2H) (Krinard 2008).

We used SAS statistical software (SAS Institute Inc., Cary, NC) to compare sources and clones within sources for each site as well as among sites.

RESULTS

Results from the 2010 and 2011 upland test sites showed that nine hybrid poplar clones exhibited growth rates great enough to place them in the top 15 percent of their respective test population. Whereas, 14 eastern cottonwood clones were also among the top 15 percent of the test population (Tables 1 and 3).

On the alluvial test site, eastern cottonwood clones performed better than hybrid poplars in term of growth and disease resistance (Table 2).

Of the clones tested in the 2010 and 2011 Populus Consolidated Trials on the upland site, 12 clones exhibited mean height growth greater than 18 feet (at 3 years). Among these clones were 15 eastern cottonwood clones and nine hybrid poplar clones representing two taxa (i.e., DM and TD), as shown in Table 1 and 3.

The top performing clone at age 3 years of the 2010 trial was 8019 (0.56 ft^3); and the top performing clone at age 3 years for the 2011 trial was 26-2 (0.44 ft^3) (Tables 1 and 3).

Septoria canker rates were generally higher in hybrid poplars on the alluvial sites compared with the upland sites (Fig. 1).

Table 2.—Top performing clones, age 3 years, 2010 Consolidated Trial at New Madrid, MO (alluvial)

	Clones	Taxa	Origin	Survival (%)	DBH (in)	Height (ft)	Volume[1] (ft^3)
1	13788	DN	GreenWood Resources	16	5.6	27.8	2.0219
2	AG414	DD	ArborGen	50	4.3	29.3	1.3888
3	27-5	DD	Mississippi State Univ.	33	4.4	29.9	1.3759
4	011-32S	DD	ArborGen	67	4.4	29.3	1.3357
5	NM6	NM	Univ. of Minnesota	67	3.9	27.0	1.1253
6	4491	DT	GreenWood Resources	67	3.9	27.8	1.1034
7	9732-24	DN	Univ. of Minnesota	83	3.8	28.7	1.0606
8	3-1	DD	Mississisppi State Univ.	100	3.8	26.3	1.0577
9	30-4	DD	Mississisppi State Univ.	83	3.9	27.3	1.0418
10	9732-31	DN	Univ. of Minnesota	50	3.9	27.1	1.0220
11	S7C1	DD	Mississisppi State Univ.	100	3.9	25.5	1.0218
12	AG413	DD	ArborGen	16	3.7	29.7	0.9910

[1] Using Krinards equation=0.09+.002216(D^2H) (Krinard 2008).

Table 3.—Top performing clones at age 3 years of the 2011 Consolidated Trial at Pontotoc, MS, (upland)

	Clones	Taxa	Origin	Survival (%)	DBH (in)	Height (ft)	Volume[1] (ft^3)
1	26-2	DD	Mississippi State Univ.	83	2.8	20.0	0.4375
2	110412	DD	Mississippi State Univ.	50	2.3	18.5	0.3069
3	S7C8	DD	Mississippi State Univ.	83	2.4	18.9	0.3312
4	AG185	DD	ArborGen	100	2.6	20.2	0.3926
5	AG229	TD	ArborGen	100	1.9	18.1	0.2348
6	AG414	DD	ArborGen	100	2.2	19.5	0.2991
7	AG434	DD	ArborGen	83	2.3	21.0	0.3362
8	AG435	DD	ArborGen	67	2.0	18.2	0.2513
9	AG439	DD	ArborGen	83	2.3	19.8	0.3221
10	6329	DM	GreenWood Resources	100	2.2	18.3	0.2863
11	6612	TD	GreenWood Resources	100	2.4	18.2	0.3223
12	7300	TD		100	2.4	18.2	0.3223

[1] Using Krinards equation= 0.09+.002216(D^2H) (Krinard 2008).

CONCLUSION

Hybrid poplars continue to show problems from the susceptibility of *Septoria*, even at early ages of 1 to 3 years. We will follow those hybrid poplar clones that possess *Septoria* resistance in the LMAV and upland sites to determine long-term resistance.

Eastern cottonwood growth on the uplands is as expected dramatically reduced when compared to alluvial sites.

Adaptability of selected eastern cottonwood clones to upland sites may allow new clonal mating to define a group of clones that will exhibit better performance on upland sites.

Hybrid poplars also seem to be less adapted to annual flooding when established on alluvial sites, thus resulting in additional mortality.

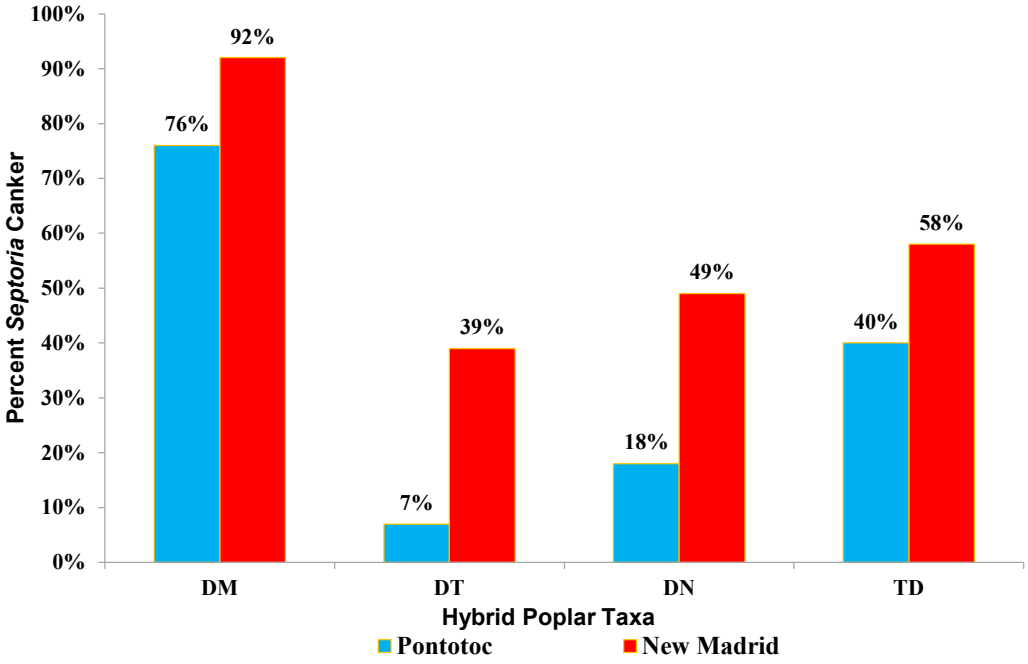

Figure 1.—Percentage of hybrid poplars with *Septoria* canker presence in 2010 Consolidated Trials by taxa for upland (Pontotoc) and alluvial (New Madrid) sites at age 4 years.

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THE APPLICABILITY OF TILMAN'S RESOURCE-RATIO HYPOTHESIS TO FOUR AMARANTHACEAE SPECIES

Lauren M. Schwartz, David J. Gibson, and Bryan G. Young

The resource-ratio hypothesis of succession states that plant species are specialized on different proportions of limiting resources (Tilman 1982). Thus, if resource levels are sufficient, the plant will have positive growth, and will draw down resource levels leading to a reduction in population growth rate for intra- and inter-species competition. Since different plant species use the same major resources, then the resource-ratio hypothesis predicts that the species that can maintain a positive growth rate at the lowest resource level will be the best competitor for that resource. Early seedling growth of four herbaceous species in the Amaranthaceae family were studied to test the applicability of the resource-ratio hypothesis for predicting competitiveness among southern Illinois forest herbaceous plants and field crop weeds. *Achyranthes japonica* and *Iresine rhizomatosa* are two perennial species that occur in similar habitats but differ in invasiveness. *Achryanthes japonica* is a nonnative invasive species that is threatening natural forested areas and also has been observed on the margins of agricultural fields. *Iresine rhizomatosa* also occurs in forest habitats but is an endangered species in Illinois. *Amaranthus palmeri* and *A. tuberculatus* are summer annuals typically found as undesireable agricultural weeds. The objective of this study was to determine the relative competitiveness of the closely related species in comparison to soybean (*Glycine max*). A greenhouse study was conducted in which each species was transplanted at the seedling stage, so that all species were similar in growth stage, in a closed system to assess resource use of an aboveground (light) and belowground (nitrogen) resource. Resource manipulation treatments were implemented by adding nitrogen as ammonium nitrate and by shading using a 60 percent shade cloth. Total nitrogen drawdown was significantly higher in the shaded treatments when ammonium nitrate was added ($P=0.0003$), but there was no species interaction ($P>0.05$). There was, however, a significant three-way interaction between species, shading treatment, and day ($P=0.0002$). In comparison to controls, the four species each used light, but not nitrogen, when treatments were compared. These results allowed a relative R* ranking (Miller et al. 2005) to be proposed based upon light use: *A. palmeri* > *A. tuberculatus* > *A. japonica* > *I. rhizomatosa*. Final biomass was reduced when plants were shaded ($P=0.006$) and there was a trend toward an increase in biomass with additional soil nitrogen ($P=0.08$). *Achyranthes japonica* produced the most belowground biomass of the four Amaranthaceae species in all treatment groups. *Amaranthus palmeri* and *A. japonica* had an increased amount of aboveground biomass when nitrogen was added. In the shading treatment, however, all species had a decreased amount of aboveground biomass in comparison to the controls. These results suggest that *A. japonica* could be a similar competitor with *G. max* to the *Amaranthus* species based on biomass, nitrogen use, and shade tolerance, with the assumption that all species would begin at the same seedling stage simultaneously. Applicability of the resource-ratio theory could lead to more effective management tactics by allowing prediction of susceptible areas of infestation or competitive outcomes based on resource levels.

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SALVAGING ASH FROM URBAN WOODLANDS IN SOUTHERN ONTARIO

Peter A. Williams[1]

Ash species (*Fraxinus* spp.) are important upland and frequently dominant lowland trees in southern Ontario that are being affected by emerald ash borer (EAB; *Agrilus planipennis*). Ash can dominate in urban forests because of their agricultural history and site characteristics. Since it is cost-prohibitive to chemically protect woodland ash from EAB, most will be killed and might become hazards.

A harvest-salvage strategy can remove ash from urban woodlands, reducing potentially hazardous situations and debris and at the same time, recover some removal costs. Oakville and Toronto have successfully implemented harvest strategies to remove dead and dying ash from parklands. This includes developing forest management plans and regeneration prescriptions approved by a registered professional forester, designating trees for removal, and planning the work using an integrated logging/arboricultural approach where conventional and small-scale harvesting methods are used. Arboricultural methods are important to help remove trees that may damage property, workers, or other trees. Cable skidders, tracked mini-skidders, and tractor skidders and forwarders have been used. The equipment used depends on site and weather conditions, equipment availability, access, and tree/forest conditions. A communication strategy aimed at the public is critical and should include public meetings, advertising, and direct contact with adjoining landowners and the neighborhood. Contractor diligence, landing management, and prompt trucking with appropriate use of the arboricultural methods and equipment are important in minimizing site and stand disturbance. Seventy-thousand board feet of logs and 150 full cords of fuelwood were salvaged and marketed from seven Oakville parks in 2013, recovering about 15 percent of the planning and removal costs.

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EFFECTS OF EVEN- AND UNEVEN-AGE FOREST MANAGEMENT ON SOFT MAST AVAILABILITY AND CORRESPONDING CHANGES TO SMALL MAMMAL POPULATIONS IN THE MISSOURI OZARKS

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The food and shelter resources that small mammals rely upon can be drastically changed after timber harvest. Significant increases in soft mast production are common after timber harvest, and berries make up a substantial proportion of small mammal diet in summer months. Increases in small mammal population densities may mirror increases of soft mast production due to enhanced survival and increased reproduction. Additionally, changes in vegetative cover, stand basal area, and canopy cover can affect small mammal habitat choices. We investigated small mammal responses to forest management practices in the Missouri Ozark Forest Ecosystem Project (MOFEP). MOFEP is a long-term, landscape scale study designed to assess the impacts of no harvest, uneven-age, and even-age forest management on wildlife and other ecosystem components in upland oak-hickory forests. Using data collected prior to and after a timber harvest in 1996, we examined *Peromyscus* mouse abundance in nine forested sites (average 400 ha, range 312-514 ha) in southeast Missouri. We constructed regression models to address the question: how is mouse abundance affected by soft mast abundance (i.e., berry counts), soft mast vegetative coverage, basal area, and canopy cover? Based on a multiple-regression model with mouse abundance, berry counts, soft mast vegetative coverage, and harvest type, preliminary results suggest that berry counts in the previous year and the number of mice in the previous year positively affect mouse abundance (overall regression model: $df = 44$, $F = 7.01$, $P < 0.0001$, $R^2 = 0.47$). Although there were not enough data to include basal area and canopy cover in the multiple regression model, single regression models of each variable showed some evidence of a negative effect on mouse abundance (basal area: $df = 53$, $F = 6.60$, $P = 0.0132$, $R^2 = 0.1125$; canopy cover: $df = 44$, $F = 15.08$, $P = 0.0003$, $R^2 = 0.26$). This is perhaps due to reduced production of soft mast brought about by shading soft mast species in the understory. These results show support for the hypothesis that timber harvests can increase mouse abundance by providing more soft mast berries. Future research directions include additions to the regression model of acorn production and climate data (precipitation and temperature) as environmental filters on *Peromyscus* abundance. As forest land managers widen their focus to encompass landscape scale and ecosystem wide impacts, results from the MOFEP experiment will provide important information about long- and short-term small mammal population dynamics in response to different forest management practices.

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