Special Session Abstracts— Sustainability of Eastern Oak Forest Ecosystems

Non-game Wildlife and Oak Interactions

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Abstract: Although the structure of oak (*Quercus* spp.) forests can provide suitable cover for many species, it is through the production of seed that oaks have a unique role in eastern deciduous forests. Hard mast provides an overwintering food resource that is not matched by other tree species. This over-winter food resource is especially important to small mammals, which unlike large mammals and birds, cannot store sufficient energy as body fat to ensure overwinter survival. During the winter, small mammals rely on cached food stores or uncovering seeds buried in leaf litter. Hard mast crops can be stored and eaten months after production, unlike soft mast that decomposes quickly. Studies in the eastern United States have reported complex relationships between acorn production and species assemblages across trophic levels. For example, the prevalence of Lyme disease in humans is correlated with the abundance of the tick (*Ixodes scapularis*) vector whose earlier stages depend on deer mice *Peromyscus* population numbers and the movement of white-tailed deer (*Odocoileus virginianus*), both factors influenced by mast production. Other studies suggest an interaction between acorn production, deer mice population numbers, and gypsy caterpillar (*Lymantria dispar*) infestations, with higher mast production ultimately reducing gypsy moth infestations. I have been part of a long-term project that is monitoring mast production and its impact on small mammal and bird populations at mature oak forest sites in northern Virginia since 1988. Based on tracking mast production at 12 four-ha sites, oaks in eastern forests failed to produce significant mast crops one out of three years. The sporadic pattern of mast production by oaks resulted in changes in small mammal populations. Over a nine-year span, small mammal trapping revealed mast production to be significantly correlated with white-footed mouse (*Peromyscus leucopus*) and eastern chipmunk (*Tamias striatus*) survival rates. This relationship was most obvious when mast production was below 200 kg/ha and at sites where deer were not excluded, suggesting that mast may influence populations of these rodents, especially when acorn competitors are present. The relationship between mast and rodent populations has implications across trophic levels, as usually-granivorous rodents sometimes become generalists that consume other food items, including bird nestlings in the summer. Regional breeding bird surveys for four understory bird species (ovenbird, worm-eating warbler, hooded warbler and Kentucky warbler) were negatively correlated with mast production two years previously. Current forests are not necessarily representative of the forests that coevolved with many present-day vertebrate species. Both the loss of American chestnut (*Castanae dentata*) and reduction in forest age probably reduced seed production and consistency in these forests. Within the complex food webs that are evident in eastern deciduous forests, the role of acorns is critical and most likely cannot be replaced by other mast producing trees.

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Oaks, Acorns, and Game Management

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Abstract: Acorn crop production significantly influences reproduction, survival, harvest rates, movements, and body condition of many game species. Understanding acorn crop production, including amount and variability, has long been a focus of land managers and researchers because of its impact on populations and harvest levels. I focus on white-tailed deer (*Odocoileus virginianus virginianus*), black bear (*Ursus americanus*), wild turkey (*Meleagris gallopavo*), and ruffed grouse (*Bonasa unbellus*) to illustrate the impacts of mast production on harvest rates and key life history parameters such as survival, reproduction, and movements. I used regional and state datasets in the Southern Appalachians and relevant studies to examine long-term relationships (1983–2005). Acorn production often affects the four game species similarly. Mortality rates can increase during poor mast years, but these can be buffered by the presence and abundance of alternate food sources. All four species exhibit short-term adaptability and flexibility to changing food sources. The effects of mast on reproduction are more complex and seem dependent on more than one factor. Deer, bear, ruffed grouse, and turkey have four distinct reproductive strategies, and these interact in different ways with acorn abundance and variability. For example, in bears, ovulation rates and implantation rates seem unaffected by mast; however, reproductive failures are significantly more prevalent during poor mast years. The effects of poor mast years do seem to impact recruitment similarly among the four species. Poor mast years generally resulted in increased movements, increased energy consumption, and, in general, poorer animal condition. Harvest rates generally increase during poor mast years, but this is dependent on the method of hunting (i.e., still, dog, baiting). I introduce potential management schemes for mast-dependant systems based on our current understanding of the interaction between mast crop production and life history parameters, harvest rates and hunting methods.

Given the importance of mast to game species, what are the potential ramifications of the current decline of our oak forests? Clearly, factors such as fire exclusion, oak decline, gypsy moth, and increased lack of active forest management will act together to reduce the oak component in our forests over the next 50–100 years. Many of our oak forests are passing through peak mast production years and into senescence. The lack of disturbance regimes in our forests also impacts the abundance and availability of food sources other than acorns. Many game species have shown remarkable resilience to increasing human populations and to significant habitat alterations. Will game populations remain resilient in the face of reduced acorn production? Should we expect lower densities and reduced harvests over the next century? How will our hunters respond and what will be the impacts to license sales and funding? Clearly, these questions must be addressed by wildlife management agencies in order to plan current and future management programs. Further, and perhaps most important, biologists working with management agencies and research institutions must partner to promote the need for periodic disturbance to sustain oak ecosystems. We should begin by educating sportsmen and women in addition to the general public about the plight of our oak forests and why disturbance is so important for these forests. SEAFWA has issued policy and position statements on important forest management issues (e.g., Forest management guidelines for black bears in the southeast, Warburton et al. 2003) and it would be appropriate for SEAFWA to take a lead role in promoting the importance of oak forests also. Finally, we must continue to research ways to successfully establish oaks on various sites across the eastern United States.

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Distribution of Oaks in the Eastern United States: Troubling Changes in Abundance and Species Composition

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Abstract: Oaks (*Quercus* spp.) are one of the most widely distributed tree genera in North America and prevalent in most of the major forest type groups in the eastern United States. In spite of this prevalence, concern exists that oak forests are aging with an insufficient base of young stands to replace them. Using data from the USFS Forest Inventory and Analysis (FIA) program collected in 1989 and 2000, I estimated the current distribution and abundance of select oak forest types and oak species within the red and white oak subgenera in 29 eastern states. I also examined trends in the distribution and abundance of the species and oak forest types over the past decade. In 1989, oak stems represented 32% of the intermediate forest canopy and 52% of dominant and co-dominant classes. These numbers declined to 21% and 47%, respectively, by 2000. Also, the average density of maples (*Acer* spp.) in the forest understory increased three-fold within oak stands between 1989 and 2000 from 625 to 2144 stems/ha, and currently have a 35% greater stem density than that of oak species in the understory. These data expose two trends detrimental to the long-term conservation and persistence of oak forests in the eastern United States. First, oaks are declining in prevalence in stands where they tended to be the most dominant, and there appears to be a poor reserve of intermediate stems available to replace them. Second, the density of maple stems is increasing rapidly in oak stands, especially within the understory, and this may interfere with oak seedling recruitment. Maples and other species [e.g., beech (*Fagus grandifolia*) and poplar (*Liroden-droan tulipifera*)] are either more shade tolerant or grow faster than oaks and thus are capable of out-competing oaks following canopy disturbance, a situation which ultimately can result in a change in forest composition. These changes in forest composition are likely the result of a combination of factors including disruption of historic disturbance regimes (e.g., fire suppression), poor silvicultural practices (especially on private lands), impacts of white-tailed deer (*Odocoileus virginianus*) on forest regeneration, and introduced insects and pathogens that reduce oak stand health and recruitment. The continued loss of oaks from eastern forests will negatively impact numerous wildlife species that use acorns as a primary or secondary food source and have unknown effects on the overall forest ecosystem. Such a loss would be similar to that of the American chestnut (*Castanea dentata*), except that oaks served to fill their niche and mitigated the detrimental impacts of their loss. No comparable replacement species exists for oak trees.

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Potential Impacts of Non-indigenous Insects and Pathogens on Eastern Oak Forests

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Abstract: Oaks (*Quercus* spp.) in the United States are affected by more than 80 documented insects and diseases, with escalating international trade likely to introduce new pests. Impacts of these pests range from minor defoliation to rapid mortality. In some years, pests cause the loss of a major portion of the acorn crop, impeding oak regeneration. Typically, outbreaks are geographically or temporally limited, but a few pests have altered or may alter eastern United States oak forests on a broad scale, with negative consequences for associated wildlife species. Moreover, human activities significantly increase the long-term threats posed by these pests. For example, the regional impact of the introduced gypsy moth (*Lymantria dispar*) has been exacerbated by oak dominance in the eastern United States following the decline of American chestnut (*Castanea dentata*) due to chestnut blight (*Cryphonectria parasitica*). The spread of this defoliator has also been aided in the last few decades by the accidental transport of egg masses by humans. While "slow-the-spread" efforts have been successful, control of outbreaks appears linked to a healthy acorn supply to feed overwintering populations of mammalian predators. Oak wilt (caused by the fungus *Ceratocystis fagacearum*) has resulted in substantial mortality, particularly of red and live oaks, in 22 states. Notably, it appears most successful in anthropogenically-altered landscapes, in part because trees wounded by construction or similar activities are susceptible to infection via spore-carrying insects. It has reached epidemic levels in Texas and the Midwest, but the oaks of the eastern United States represent a highly-susceptible and widely-distributed host, especially given increased development in forested areas. Detected in California in 1994, the sudden oak death pathogen (*Phytophthora ramorum*) has infected live and red oaks in the state's coastal forests with mortality greater than 40%. More critically, it also infects dozens of shrub species (e.g., rhododendrons, azaleas), many of which are regularly sold as landscaping plants. In the last few years, wholesale nurseries on the West Coast have unknowingly shipped hundreds of infected plants to retail outlets in the eastern United States. While surveys have not detected the pathogen in eastern forests, red oak dominance, near-ubiquitous presence of suitable understory shrub hosts, and appropriate climatic conditions in the southern and central Appalachians translate to a high potential risk of infection. Successful minimization of the risks posed by these and other pests requires a multi-faceted approach. Stakeholder awareness is vital, as alterations in human activities at the wildland-urban interface may reduce the threat. Long-term pest monitoring may also be made more efficient by identifying and focusing on high-risk areas in these interface zones. Toward this end, data on potential transport vectors (e.g., understory vegetation, movement of at-risk materials) should be developed or enhanced. Ultimately, active management to promote overall oak forest health may be the most effective preventative measure.

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Silvicultural Methods and Successful Oak Regeneration

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Abstract: The oak forest type in the Central Hardwoods Region (CHR) is the largest forest type in the United States. Mature forests (>80 yr) in the CHR are dominated by oaks (*Quercus* spp.) regardless of site, aspect or slope. However, without proper management, oaks on intermediate and mesic sites will be replaced by more mesophytic species, such as maples (*Acer* spp.) and tuliptree (*Liriodendron tulipifera*). In general, oaks will dominate xeric sites such as ridgetops because of their resistance to drought. The key to managing a sustainable oak forest is obtaining ample advanced oak regeneration: stems greater than 1.2 m (4 feet) in height. This is accomplished by managing light intensity. Currently, forests in the HR are 1.5–2 times as dense as the forests at the time of European settlement. In the past, fire was the ecosystem process that maintained the open woodland settings which provided the proper light conditions for oak forest sustainability. Oak species evolved adaptations that allow them to withstand repeated fires, such as root development and basal sprouts. However, successful fire suppression programs in the United States have essentially removed fire from these ecosystems for the past 70 to 80 years, allowing the development of advanced reproduction of mesophytic species. Partial harvesting techniques (e.g., shelterwood, two-aged cuts) can provide the proper light for advanced oak regeneration; however, these methods also release the competing mesophytic species. Reintroduction of high-frequency, low-intensity, prescribed fires may not be successful in restoring the proper forest structure for successful oak reproduction in the short term. Fires must be intense enough to kill a few overstory trees and injuring the remainder; causing a great loss in timber value. However, the combination of partial harvests and repeated prescribed fire can create the desired forest structure for oak regeneration quickly, and may control the advanced mesophytic species. Seedlings and saplings are more susceptible to root death if prescribed fires are executed after bud break, when the starches have been transferred above-ground. Maples leaf-out before oaks, providing a window to enhance selective mortality. Prescribed fires should not be conducted for three-five years after a bumper acorn crop to give the oak seedlings time to establish adequate roots. The use of herbicide is a silvicultural tool to eliminate undesirable non-oak tree species prior to harvest and prescribed burning. It should be noted that these management techniques may be ineffective if white-tailed deer (*Odocoileus virginianus*) browsing is intense.

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Oak Forest Management Issues on Non-industrial Private Land

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Abstract: Declines in the abundance of oak (*Quercus* spp.) and the failure of oak to regenerate after harvest are widespread problems in eastern North America. Sustaining oak forests will require large-scale and long-term effort. Most of the oak forest resource is owned by individuals, collectively referred to as non-industrial private forest (NIPF) owners. Conservation on NIPF lands is inherently difficult because ownership objectives vary, land tenure is generally short, and land parcels are small. Few NIPF owners have technical training in forestry or wildlife management. Timber harvest is generally conducted without the help of natural resource professionals and silvicultural techniques that would maintain oak are rarely used. Technical advice and support is available for NIPF owners through both public agencies and private organizations. Public support is delivered through a network that involves the university extension service, the state forestry agency, and the U.S. Department of Agriculture (USDA). The USDA administers a variety of incentive programs that provide partial payment for conservation practices prescribed in forest stewardship or management plans. There are substantial reductions in property tax rates for land enrolled in stewardship programs. The majority of private forest landowners, however, do not participate in stewardship programs despite the diversity of services and economic incentives available to them. The complexity of the delivery system may be a significant factor in the lack of acceptance of stewardship programs. There is great potential to improve forest management on NIPF land by increasing owner participation in forest stewardship programs. Natural resources professionals need to become familiar with public and private services and incentives available to landowners, and advocate private land management whenever the opportunity arises. Wildlife biologists need to understand the Farm Bill and work with their counterparts in the USDA Farm Service Agency, USDA Natural Resources Conservation Service, and state forestry agency to implement wildlife habitat incentive programs. All of these agencies need to develop policies that promote interagency collaboration and cooperation. Participation in stewardship programs by forest owners will not guarantee the maintenance of oak forest ecosystems. Participants in stewardship programs, however, are more likely to implement silvicultural practices that benefit oaks than are owners with no contact with professional resource managers.

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Restoration and Enrichment of Hardwood Forests using High Quality Oak Seedlings from Local Seed Sources

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Abstract: Hardwood forests in eastern North America have been important to the nation's economy from wildlife, timber, and recreational perspectives. Since colonial times, the existence, structure, and function of these forests have been subjected to many challenges. In the westward expansion of this country, forested land was often converted to agriculture. More recently, marginal bottomland sites were drained or harvested to create new opportunities for row cropping. Exotic forest pests, such as chestnut blight (*Cryphonectria parasitica*) and gypsy moth (*Lymantria dispar*), have further impacted hardwood forests. Many hardwood forests contained significant populations of oak (*Quercus* spp.) species, which have diminished over time. Correspondingly, wildlife populations that depend on hard mast have been negatively impacted. Restoration of an oak component or enrichment of existing oak populations is a common goal for many wildlife organizations and agencies. In response to this need, the University of Tennessee's Tree Improvement Program (UT-TIP) has been working with various groups to promote the planting of high quality oak seedlings from local seed sources. Reversion of bottomland hardwood forests using artificial regeneration is becoming increasingly common due to decreased profitability of agricultural production and persistent flooding of marginal farmland. In west Tennessee, the Tennessee Wildlife Resources Agency has been acquiring former bottomland agricultural sites for conversion to wildlife habitat. Guided by the UT-TIP, a planting program using high quality oak seedlings from local seed sources was initiated in 2000 to eventually provide a source of hard mast. Acorns were collected from local sources of nine species and grown at the Georgia Forestry Commission's Flint River Nursery. Seedlings were planted on 23 sites, ranging from 1.22 ha to 320 ha in size for a total of 890 ha. Species were initially matched to site by visual inspection, which evolved into species/site matching by elevation. Survival and invasion of other woody species were evaluated through sample plots at each location. The logistics of establishing a project on this scale and post-planting management are discussed. Restoration and enrichment oak plantings have been established in different states through cooperation with the UT-TIP. Experimental plots have been nested within operational plantings and will elucidate relationships among site, seedling quality, genetics, and cultural treatments. On-going efforts, including an initiative by the National Wild Turkey Federation and the UT-TIP to establish hardwood seed orchards in the eastern United States, are being pursued to address the issue of hardwood restoration and sustainability.

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Arkansas Upland Oak Experience: The Effectiveness of Partnerships

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Abstract: Fossil pollen records depict the forests of the Ozark Highland as being dominated by oaks (*Quercus* spp.) for the last 4,000 years. Early explorers and naturalists from Desoto to Schoolcraft left written records of forest conditions and the impact of anthropogenic influences such as fire and the use of forest products on the upland landscapes. Fire scar studies from Missouri and Arkansas confirm these influences and report average historical fire intervals of <15 years from the mid 1600s through the early 1800s. The turn of the 20th century spawned drastic changes in disturbance regimes including fire suppression. Oak dominated forests in the Ozarks and Boston Mountains by the 1970s had become three times as dense as a century before. Then in 1997, with insect populations at record levels and the occurrence of a minor drought, an oak decline event had devastating effects on an estimated 261,000 ha of the Ozark National Forest. Up to 75% of the oaks in affected areas were dead or dying. This event, bringing national attention to the sustainability of oak forests, was a catalyst for the formation of an Arkansas Conservation Coalition, eventually named the Oak Ecosystem Restoration Team (OERT). This group, composed of state, federal, and private interests, developed a strategy that focused on increasing professional knowledge and public awareness along with ways of influencing policy decisions regarding the ecology and sustainability of the Interior Highlands oak ecosystem. The initial step was to hold a symposium of experts in oak ecology, management, and research and glean ideas and recommendations for how to proceed. The conference ended with the collection of recommendations from the more than 350 participating professionals. This allowed OERT to develop a plan that included landscape demonstrations of oak ecosystem restoration, monitoring and sharing information on progress, and development of policies and funding mechanisms to support education and restoration efforts. Still on target, OERT has accomplished many of the initial recommendations, including over 122,000 ha of sites; elevating public interest and awareness through articles, television and tours; and training and educating hundreds of professional managers in oak ecology. The next step is to enlarge the focus of oak management and restoration beyond state borders and to partner with similar efforts in Oklahoma and Missouri.

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Future Opportunity: Multi-agency Cooperative Programs to Address Wildlife Management in Changing Oak Forests

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Abstract: Multi-agency cooperative approaches have proven to be an effective, pragmatic, and often necessary means of achieving landscape-level wildlife conservation goals. The most compelling and historic examples involve bird conservation initiatives. Wildlife conservation agencies have collaborated in addressing broad scale population and habitat challenges. These collaborations began with the Migratory Bird Treaty Act and the advent of the Flyway management system. Efforts have increased with the North American Waterfowl Management Plan and the development of Joint Ventures and more recently with Partners in Flight and associated bird conservation initiatives. The challenges associated with sustaining eastern oak ecosystems are somewhat different than bird conservation issues because there is no focal species group, the problem is insidious, and existing management of private lands represent a major source of the problem. However, the establishment of a scientific basis for the decline in oak ecosystems and the implications for wildlife conservation can provide a foundation for comparable efforts. Potential approaches range from incorporating oak conservation within existing bird habitat joint ventures to development of a multi-agency/organization plan focused on oak conservation. Examples of regional, science-based, cooperative initiatives that have successfully focused funding from a variety of entities and programs towards specific conservation efforts will be used to illustrate how similar resources could be mustered to sustain oak ecosystems. The Atlantic Coast Joint Venture (ACJV) is a geographic-based effort that identifies and prioritizes migratory bird habitat protection. ACJV focuses funding from sources such as the North American Wetlands Conservation Act, the Neotropical Migratory Bird Conservation Act, the National Coastal Wetlands Conservation Grant Program, and others. The Northern Bobwhite Conservation Initiative (NBCI) is an example of a geographic-based habitat recovery effort focused on a single species. NBCI has developed a plan for quail population recovery that has population and habitat objectives. Funding and implementation is a partner-driven effort, utilizing existing mechanisms such as Partners in Flight, Farm Bill funding, and collaboration with private landowners. The Northeast Association of Fish and Wildlife Agencies has developed a multi-state effort to identify and prioritize regional conservation actions identified in State Wildlife Action Plans. This collaborative effort includes all states in the northeast as well as conservation partners. Funding from the Doris Duke Foundation, State Wildlife Grants, and other sources will be used to implement these priority projects.

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