FIRE-ADAPTED NATURAL COMMUNITIES OF THE OZARK HIGHLANDS AT THE TIME OF EUROPEAN SETTLEMENT AND NOW

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Abstract.—The Ozark Highlands Plateau of southern Missouri and northern Arkansas is home to more than 2,000 vascular plant species and at least 15,000 species of various animals of which over 150 are endemic. The Nation's most significant karst region occurs here, boasting the most springs of any state and more than 6,000 caves. Missouri's Ozark biota is sorted into 65 distinctive mappable natural communities. Misconstrued as "oak-hickory forest", analysis of Missouri's historic vegetation, fire history studies, plant adaptations, and responses to fire management reveal that the Ozark's was a landscape dominated by a complex mosaic of fire and topography-mediated grass and forb-rich savannas, woodlands, glades, forests, and fens. Much of today's native Ozark vegetation is deceptively out of character for its structure, composition, species richness and former landscape patterns due to having suffered the consequences of destructive post-European settlement overgrazing, poor farming, fire cessation, and soil loss. Fallacies abound that "resilient" Ozark ecosystems will recover, succeed, and migrate in the face of climate change and homogenizing vegetation transformation. Monitoring of remnant high quality natural communities reveals their susceptibility to irreversible conservative species loss and simplification. Managers must understand and distinguish between the achievement of true ecological restoration outcomes of high quality habitats over personal/professional biases including grazing woodlands, timber production, and singular species emphasis.

BACKGROUND

This paper primarily employs the ecological classification and ecosystem restoration approaches used by the Missouri Natural Areas Committee. The committee is made up of six state and federal agencies that have cosigned a Memorandum of Understanding to administer a system of natural areas. Natural areas by definition are areas of the landscape that protect high quality aquatic and terrestrial assemblages of plants and animals as they may have existed prior to European settlement (Nelson 2010). It is this time period that sets the stage for defining and describing natural communities and the sequence of European settlement factors that have altered and damaged Missouri's historical fire-adapted natural communities.

The objectives of this paper are:

1. To describe the primary fire-adapted natural communities that occurred prior to European settlement
2. To list the modern day disturbances that have altered their historic patterns
3. To introduce some misconceptions about ecosystem restoration

Nelson (2010) describes natural communities as distinct assemblages of native plants, animals, and microorganisms that occur in repeatable (mappable) patterns across the landscape and through time. These assemblages of biota occupy definable physical environments, which in turn influence the structure and

composition of natural communities. In Missouri, 85 natural communities are described with approximately 65 occurring in the Ozarks. These natural communities fall into broad types including forest, woodland, savanna, glade, prairie, wetland, stream bank, cliff, and cave. High quality natural communities are generally rich in native plant and animal species including a host of "conservative species" that are sensitive to modern disturbances. Conservative species decrease or disappear in ecosystems degraded by clearing, plowing, overgrazing, over browsing, and fire cessation resulting in a loss of biodiversity. As many as 300 to 400 vascular plant species may occur in one natural community type. A second attribute of high quality natural communities is the abundance of flowers, seeds, and biomass cover produced by the rich groundcover plant species. In turn, a great variety of host specific and other invertebrates inhabit this ground layer, interacting as plant pollinators and providing food for predators higher in the food chain.

High integrity natural communities are characterized by woody vegetation of variable ages and patterns as determined and shaped by the presumed historical disturbance regime and climate. This includes differences in gap size, blow down, old growth character, spacing between trees, and the presence or absence of large dead or decaying wood. Ozark natural communities were further characterized by variable but connected landscape patterns differentiated by the distinctive features of a given ecological subsection. Those features included topographic expressions, bedrock type, drainage patterns, and disturbance processes.

Each natural community type is classified according to dominant or characteristic vegetation types, canopy height and openness, vegetation layers, rock type, age class variation, and disturbance processes. The author (and the Missouri Natural Areas Committee) recognizes the temporal nature of natural communities and the changes brought about by variations in climate and other disturbance processes. For the purposes of this paper, the Missouri Natural Areas Committee uses the pre-European time period as a reference point to differentiate the contemporary altered landscape from high quality ecosystems prior to their severe, modern day disruption (Nelson 2010).

THE OZARK LANDSCAPE SETTING

The Ozarks ecoregion encompasses nearly 34 million acres across the southern one half of Missouri, northern Arkansas, and small portions of Oklahoma and Illinois. This distinctive biogeographic region of southern Missouri and much of northern Arkansas is a low structural dome of variably aged rock strata with the dome center consisting of the oldest (1.5 billion years) igneous rock in the St. Francois Mountains (Nigh and Schroeder 2002). This elevated region of the central United States along with the Ouachita Mountains to the south is the highest elevated region of mid-continental North America. A quarter billion years of exceptional geologic erosion, wind transport, and subterranean karst dissolution has created a diversity of landforms that vary in degree of relief, dissection, and geologic parent materials. Ozark biota are characterized by an unusually high level of species disjuncts and endemism with more than 160 species endemic to the area. Among the diversity of plants and animals, 159 species are endemic, 77 are modal (meaning their primary population density exists there), 81 are globally rare, and 58 are disjunct. Of this number, 32 species are in decline with perhaps a dozen extirpated (Ozarks Ecoregional Assessment Team 2003).

Differences in landform, soils, and vegetation produce 16 ecological subsections in the Ozark Highlands of Missouri (Nigh and Schroeder 2002). These ecological subsections and their geologic, biologic, topographic, and historical Native American interactions prior to European settlement created mosaics of diverse fire-mediated prairies, savannas, woodlands, glades, fens, and forests.

OZARK VEGETATION SHAPED BY HISTORIC FIRE

Native Americans played a role in shaping changes across the Ozarks for as long as 12,500 years (Ray and others1998). When Europeans first arrived in Missouri, high integrity ecosystems had evolved with adaptations to disturbance processes. Nelson (2010) provides an in-depth accounting of the effects of Native American habitation ranging from the landscape application of fire to agriculture and settlement. The environment was radically different during the period between 8,500 and 4,500 years before present (YBP) when drought-adapted species expanded their range, and grasslands (among woodlands) dominated. Following 4,500 YBP, essentially modern vegetation and faunal patterns appeared. Extensive evidence of past fires started by Native Americans abound. Guyette and Dey (2000) and Guyette and others (2006) provide accurate records in the modeling of historic fires across North America and the relationship between historic human habitation, topographic relief, and climate. Abrams and Nowacki (2008) concluded that Missouri's subhumid Midwestern climate would not support prairie, savanna, and open woodland without the influence of Native Americans broadcasting fire over North America the past 5,000 years. Thus, the 65 distinct natural communities of the Missouri Ozarks were shaped by centuries of variable fire regimes.

THE OZARKS VEGETATION-DIVERSE ASSEMBLAGES OF FIRE-ADAPTED NATURAL COMMUNITIES, NOT OAK-HICKORY FORESTS

The mindset of early natural resource management by state and federal agencies was shaped throughout the early 1900s by the notion that fire was detrimental for plants and wildlife. Dr. Julian Steyermark who wrote "Flora of Missouri" (1963) and "Vegetational History of the Ozark Forest" (1959) falsely shaped this mindset by furthering the theory that the Ozarks was primarily a forested landscape succeeding from an earlier open savanna-woodland vegetation type. He attributed the "unnatural succession" of former open grass-dominated Ozark woodlands and savannas to the eventual mesification effects of a warmer-wetter climate following the xerothermic period (a postglacial interval of a warmer, drier climate that occurred 4,000-5,000 years ago). Dr. Steyermark never made the connection between the role of Native Americans in their broadcasting fire across all of North America and its profound effects in shaping fire-adapted natural communities. His reports to the Mark Twain National Forest and state foresters in the mid 1950s furthered the notion that post-European annual burning of the Ozarks was destructive to native flora. Later, natural features inventories conducted by the Missouri Natural Areas Committee (listed in Nelson 2010) would demonstrate that it was the combination of open-range overgrazing coupled with annual burning of the now logged over Ozarks that led to the widespread loss of the once rich grass-forb groundcover associated with ancient open woodlands, savannas, and glades.

Many early explorers in Missouri chronicled numerous accounts of periodic fires and their influence in shaping the open, park-like character of the Ozarks. Schoolcraft (1819) observed, "The Ozarks…covered with a very uniform growth of black oaks and post oaks, in the summer season by a vigorous growth of wild grasses, flowers and vines." Louis Houck (1908) states, "Open woods and a growth of wild prairie grasses and flowers filling the broad spaces between the trees. All the forests were free from undergrowth, and open and park like in appearance." George Swallow (1859) writes, "This growth is not due to the poverty of the soil but to the fires which have annually overrun this country since the earliest dates of the Indian traditions…" Table 1 shows the transitional continuum and breaking points between the primary fire-adapted natural communities in the Ozark Highlands.

Prairie

While over 13 million acres of prairie occurred across Missouri, its presence in the Ozarks is restricted primarily to the Central Plateau Subsection. Prairies were essentially treeless, primarily dominated by a

Table 1.—The Prairie, Savanna, Woodland to Forest Continuum for the Ozark Highlands

Attributes	Mesic Forest	Dry-mesic Forest	Dry-mesic Woodland	Dry (open) Woodland and Flatwood	Savanna	Prairie and Glade
Vegetation Layers	Multiple >4	Multiple >3	2 to 3	2 to 3	2	1
Age Classes	Variable - uneven age	Variable - uneven and even	Uneven/even	Multiple even age	Multiple even age	Not applicable
Tree Form/ Height	Narrow crowns, clean trunks 90+	Narrow crowns, clean trunks 70-90	Somewhat spreading crowns, clean trunks 60- 90	Spreading crowns and lower branches 20-60	Wide-spreading crowns, 20-60	Not applicable
Canopy Closure	90-100	90-100	80+	30-80	10-30	0-10
% Understory Cover	50-100 dense	50-100 dense	30-50 patchy	10-30 scattered	5-10 sparse	0-10
Ground Layer Cover	Dense in spring, patchy to sparse by mid-summer	Dense to patchy in spring, patchy to sparse by mid-summer	Dense to patchy in spring, patchy to dense by mid-summer	Patchy to dense all season	Dense all season	Dense all season
Ground Layer Plants	Rich diversity of spring ephemerals, and ferns; few summer/fall forbs	Moderate to low diversity of spring ephemerals, and ferns, few summer/fall forbs	Moderate to low diversity of spring ephemerals, and ferns; abundant C3 grasses, sedges, and summer/fall forbs	C3 and C4 grasses, sedges, diversity of forbs all season	C4 grasses, sedges, diversity of forbs all season	C4 grasses, sedges, diversity of forbs all season
Topography and Landform	Protected valleys, ravines, bluff bases, lower slopes of northerly aspects, fire shadow areas	Mid and upper slopes of northerly aspects, ravines, fire shadow areas	Mid and upper slopes of southerly aspects, fire prone landscapes	Steep upper slopes of southerly aspects, narrow ridges, broad ridges, fire prone landscapes	Level to gently rolling topography, steep loess hills, broad ridges	Level to gently rolling plains, steep loess hills, broad ridges; steep sw slopes-glades
Soils	Deep (>3') loams, nutrient rich, high organic matter	Moderate depth (24-36") silt loams, moderate organic matter	Moderate depth (20-36") silt loams, moderate organic matter	Shallow depth (<20"), droughty, often rocky and or nutrient poor	Wide range of soil types from shallow to deep, variably rocky	Wide range of soil types from shallow to deep, variably rocky
Fire Regime	Very infrequent (30+ years), and/or low intensity fires	Infrequent (20+ years), and/or low intensity fires	Low to moderate intensity fires every 3 to 15 years	Low to moderate intensity fires every 3 to 5 years	Moderate intensity fires every 1 to 3 years	Moderate to high intensity fires every 1 to 3 years
Dominant Trees	Red oak, sugar maple, ash, basswood, walnut	White, red, and black oaks, hickories	White, black, scarlet, chinkapin oaks, hickories, shortleaf pine	Post, blackjack, chinkapin, bur, white oak, pine	Bur, chinquapin, swamp oak, white oak	Shrubs
Basal Area # mature trees/ acre	70-80 >30	70-80 30	60-80 20-30	30-60 <10	<30 <5	<10 <2

mix of grasses, forbs, and low shrubs. The often level to gently undulating plateau was conducive to rapidly spreading, intense fires occurring as often as every 2-3 years, thus limiting tree growth. Only one occurrence of a remnant Ozark prairie exists today.

Savanna

Some 6.5 million acres of savanna occurred across the Ozarks, primarily on the Springfield Plateau and Central Plateau Subsections. Savannas were Serengeti-like landscapes of widely spaced, orchard-like trees of variable age classes ranging from old growth trees to islands and scatterings of oak regeneration. Tall grass species and forbs dominated the groundcover. Principle tree species included post oak, white oak and bur oak (scientific names listed in Appendix). The greater undulation and fragmentation of plateaus and plains by streams and rivers decreased the effects of rapidly spreading fires, thus leading to the increase in tree species, particularly post and white oak. Unfortunately, very little savanna remains in the Ozarks, having succumbed to exotic cool season grasslands used for pasture.

Woodland

By far the most diverse, 13 woodland types occur across the Ozark Highlands. This was the predominant natural community type with at least 11 million acres occurring. Fortunately, this is also the most recoverable, restorable natural community in the Ozarks with the potential of restoring 6 million acres (Spencer and others 1992). Woodland types often have a variable canopy openness ranging from 30 to 90 percent canopy cover depending on restoration objectives and fire effects. Important woodland types include post oak-black oak woodlands, mixed oak woodlands, shortleaf pine-bluestem woodlands, chinquapin oak woodlands, and bottomland woodlands. Many examples of woodland restoration abound across the Ozark Highlands as agencies and conservation groups continue actively restoring landscapes. The Central Hardwoods Joint Venture considers woodlands, particularly their early seral, grass-dominated patterns, vital toward the recovery of early seral bird species including blue-gray gnatcatcher, indigo bunting, prairie warbler, chipping sparrow, field sparrow, and bobwhite quail. Vaughn (personal communication) demonstrated the importance of the attainment of quality restored woodland vegetation structure and the recovery of diverse bird communities.

Forests

In the general absence of fire, trees formed a closed canopy interspersed with multi-layered shade-tolerant subcanopy trees, shrubs, vines, and scattered herbs. Trees attained their greatest height, forced to grow high, often competing for light in forest gaps. Ground flora often consisted of a rich assemblage of fire-intolerant spring ephemeral forbs, shade-tolerant sedges, grasses, and ferns. Much of Missouri's woodland landscape was regarded as "forest" (Braun 1950, Steyermark 1959) when in fact the present-day closed, dense canopy is an artifact of domestic livestock overgrazing and fire suppression (Pyne 1982). In the Ozarks, forest is confined to the most rugged, deeply dissected hills and breaks of the Current River and Eleven Point River watersheds with lesser amounts in protected valley coves, large river floodplains, and the base of bluffs elsewhere (Nigh 2002).

Glades

Five glade natural communities occur in the Ozark Highlands. Glades are essentially treeless shallow bedrock openings in woodlands ranging in size from one-half acre to 1,500 acres. Despite shallow bedrock, as many as 400 vascular plant species inhabit glades, including several endemic and restricted species. The extremely dry, desert-like condition of glades attract animal species with a primary distribution in the more arid southwestern United States including the eastern collared lizard, flat-headed snake, southern coal skink, tarantula, and greater roadrunner. The Ozark Highlands contain the highest number and acreage of glades in Eastern North America (Nelson and Ladd 1983). Approximate glade acreages and types, according to Nelson and Ladd, include: 200 acres of

chert glades (Springfield Plateau only); 5,000 acres of limestone glades (Springfield Plateau); 12,000 acres igneous glades (St. Francois Mountains); and 200,000 acres dolomite glades (located throughout the Ozark Highlands but greatest abundance in White River Hills, Osage River Hills, and Inner Ozark Border). Guyette (1982) estimated historical fire to occur every 3-4 years on glades in southwest Missouri.

NATURAL COMMUNITY PATTERNS ACROSS THE OZARK HIGHLANDS

Early interpretations of the falsely applied concept of "Oak Hickory Forest" portrayed the Ozarks as covered primarily in forest and dominated by mixtures of oak and hickory. Modern interpretations now cite several valuable sources. The Missouri Historic Vegetation Survey, Geographic Resources Center, University of Missouri, Columbia has attributed the characteristics of over 400,000 individual trees recorded by Government Land Office early land surveyors during the early to mid 1800s. The Geographic Resources Center has queried these data across a variety of stratified applications, including relative importance values for all tree species by ecological subsection, the relative openness of the tree canopy, and tree associations. Results reveal that the Ozark Highlands contained over 25 different tree associations, many of them attributed to the influences of fire, topography, and geology (Batek and others 1999). Oaks were important but so was shortleaf pine. Hickory was not an important (dominant) tree species. When modeling witness tree structure and openness (a measure of distance and diameter from section corners and section lines), much of the Ozarks was open in character, thus confirming the historical presence of savanna and open woodlands. Again, forest was confined to dissected river breaks. Table 2 shows the most important oak-dominated natural communities, landforms, and estimated fire interval. Table 3 lists the oak species known to occur in the Ozark Highlands and their optimal natural community (Nelson 2010).

THE PRESENT-DAY OZARK HIGHLANDS: OUT-OF-CHARACTER AND DEGRADED

Biotic homogenization (McKinney and Lockwood 1999) happens when native localized ecosystems are assimilated by widespread exotic or weedy native species, thereby increasing their compositional similarity. Biotic distinctiveness gradually dissolves. An example might be the replacement of 300 native plant species associated with a high quality, pre-European glade by 40 native species and dozens of exotics within the same landscape area. Present day homogenization processes include:

- Importation of exotic plants for agriculture, wildlife plantings, and landscaping/gardening
- Globalized transport of exotic pets (legal and illegal) along with accidental insect/diseases

Table 2.—Important oak-dominated natural communities of the Ozarks, their landform and presumed fire interval

Communities	Landform	Fire Interval
Post oak bluestem flatwoods	Gentle fragipan plains and ridges	Fire 3-5 years
Post oak and bur oak savanna	Gentle plains	Fire 2-4 years
Chinquapin oak bluestem woodland	Dolomite slopes and hills	Fire 3-10 years
White, black, and blackjack oak woodlands	Chert plains	Fire 3-5 years
Blackjack oak xeric woodland	Igneous rock outcrops	Fire 5-15 years
Post and chinquapin oak-smoketree glades	Dolomite bedrock of dissected hills	Fire 3-4 years
White oak-pine woodlands	Dissected hills and breaks	Fire 10-50 years
Mixed bottomland oak forests	Larger river floodplains	Fire 25-50 years
White, northern red oak/sugar maple forest	Deep coves and valleys	Fire 15-30 years

Table 3.—List of Missouri oak species and their optimal natural community type (Nelson 2010)

Oak species	Savanna	Open Woodland	Closed Woodland	Flatwoods	Upland Forest	Bottomland Forest	Glade
Blackjack oak		x					
Black oak		x	x				
Bur oak	x					x	
Cherrybark oak			x		x		
Dwarf chestnut oak	x						
Chinquapin oak		x					x
Nuttall's oak						x	
Overcup oak						x	
Pin oak						x	
Post oak	x	x		x			x
Red, northern oak			x		x		
Red, southern oak	x	x					
Scarlet oak		x	X		X		
Schneck's oak							x
Shingle oak						x	
Shumard oak						x	
Swamp white oak						x	

- Land fragmentation and parcelization
- Overhunting and wildlife persecution
- Agriculture
- Fire suppression
- Overgrazing (past and present)
- Modern developments; housing, reservoirs, roads, industry
- Variations in management philosophies

The consequences of these processes have impacted the Ozark Highlands in the following primary ways:

1. Overgrazing has decimated the once lush mantle of rich grass/forb groundcover and resulted in soil loss-erosion of gravel into Ozark streams (Smith 2003).
2. Soil erosion has exasperated watershed hydrology degradation with runoff increasing (even in dense, overstocked canopies) and subsequent landscape dehydration.
3. Loss of groundcover species has dramatically reduced or eliminated flower and seed production, thereby decreasing the abundance of insect populations important for foraging by birds and bats (Beilmann and Brenner 1951).
4. Fire suppression coupled with grazing and logging has led to dense overstocking of increasingly undesirable tree species (Ladd 1991, McCarty 1998, Nigh 1992).
5. Loss of topsoil has changed soil chemistry and dehydrated the landscape causing increased runoff and decreased spring flows.
6. Black and scarlet oak (preferred species for timber markets) have increased, but so have oak decline, oak wilt, and oak borer diseases (Law and others 2002, USDA 2005).
7. Exotic species are on the increase in especially vulnerable damaged woodlands. Of Missouri's 800 introduced nonnative plant species, 32 are recognized as invasive on the Mark Twain National Forest (USDA 2012). Feral hogs are increasing across the Ozarks.
8. Certain native species populations are out of balance including invasive red cedar on glades and isolated occurrences of heavy white-tailed deer overbrowsing. Rooney (2004) attributed biotic simplification of 62 forests in Wisconsin to the keystone effects of too many deer.

9. There is an increase in the listing of species of conservation concern, particularly those once associated with fire-adapted natural communities.

Over 75 percent of Missouri's 44 million acres of historic vegetation is completely transformed; most destroyed. The remaining 25 percent is fragmented, out-of-character, damaged, fire-suppressed, and subject to exotic species invasion. Of this percentage, the following acreages of various oak-dominated natural communities are estimated to be restorable to high quality natural community standards on the Mark Twain National Forest: 4,000 acres of post oak bluestem savanna; 15,000 acres post oak-chinquapin oak dolomite glade and woodland; 2,000 acres post oak igneous glade; and 150,000 acres of various oak and pine woodland types. The most threatened oak systems across the Ozark Highlands include mixed oak bottomland forests with few high quality examples occurring anywhere.

MISCONCEPTIONS OF ECOSYSTEM SUCCESSION AND MIGRATION

The old botanical theories of plant succession, species migrations, and reaccrual of species-rich ecosystems on the move in the face of climate change are not going to operate effectively, at least in the Midwest. Rooney (2004) and others observed that in the face of changing vegetation structure and patterns, species richness declines and there's no corresponding accrual of new species adapted to the different environment. We do not have any examples of an unmanaged savanna, woodland, or prairie that, when left to its own devices, has recovered or succeeded to an equally species rich ecosystem. Also a myth is the old concept that natural communities will migrate or succeed in response to shifts in climate (Steyermark 1959).

CONSERVATION STRATEGIES

The Nature Conservancy's Ozark Ecoregional Conservation Assessment (Ozarks Ecoregional Assessment Team 2003) has identified high priority portfolio areas within the Ozark Highlands to concentrate protection/management strategies. The Mark Twain National Forest used this assessment to design and delineate 19 management areas across distinctive ecological regions of the Mark Twain, emphasizing restoration of ecosystems. The 2005 Forest Management Plan for the Mark Twain identified objectives to restoration more than 150,000 acres to desired conditions for healthy natural communities. The Mark Twain has also increased prescribed burning to 40,000 acres annually. At the 2009 Missouri Natural Resources Conference, a multi-agency workgroup concluded that the best conservation strategy in response to climate change was to make ecosystems more resilient by restoring their historical condition and maintaining or emulating critical disturbance processes, especially fire.

CONCLUSIONS

In conclusion, much of the Ozark landscape was mantled in a park-like growth of mixed oak and pine interspersed with a nearly continuous ground cover of deep rooted perennial grasses and forbs. Most vegetation composition and structure directly reflected the effects of variable fire regimes, excepting the most deeply dissected river breaks. Open range overgrazing, soil erosion, poor farming, and fire suppression have obliterated the historic character of former fire-mediated woodlands, savannas, and glades resulting in population shifts for many plant and animal species. Hands-off management will result in declines in species richness for landscapes once dominated by fire-adapted ecosystems due to the homogenization process. Threats abound. To make matters worse, the preservation of biodiversity through ecosystem restoration is not a primary management goal of most land managing agencies. Managers differ in their land management aspirations, personal interests, philosophies, and management styles.

We have the resources: people, money, time. We have strategies: state park resource stewardship plans

and policies, Missouri Department of Conservation Comprehensive Wildlife Strategy, Mark Twain National Forest Plan ecosystem restoration objectives, and The Nature Conservancy's Ozark Ecoregional Conservation Assessment. But the statewide scorecard for ecosystem restoration work accomplished is far from achieving its objectives. Resistance prevails in many forms: budget cuts, layoffs, other priorities, manager philosophies, changing leadership, and government agency decentralization.

Perhaps toughest of all is our not accepting that sensitive plant and animal populations and quality ecosystems will in many places fall victim to the homogenization process. Protecting ecosystems is time consuming, expensive, and requires a constant dedicated commitment. This commitment requires that we institutionalize the idea of ecosystem restoration as a primary driver behind what land managing agencies and private nature organizations do. But changing politics, new leaders with their own aspirations, and the eventual "retirement" of those with passion and initiative to advocate make this extremely challenging.

LITERATURE CITED

Abrams, M.D.; Nowacki, G.J. 2008. **Native Americans as active and passive promoters of mast and fruit trees in eastern USA.** The Holocene. 18: 1123-1137.

Batek, M.J.; Rebertus, A.J.; Schroeder, W.A.; Haithcoat, T.L.; Compas, E.; Guyette, R.P. 1999. **Reconstruction of early nineteenth-century vegetation and fire regimes in the Missouri Ozarks.** Journal of Biogeography. 26: 397-412.

Beilmann, A.P.; Brenner, L.G. 1951. **The recent intrusion of forests in the Ozarks.** Annals of the Missouri Botanical Garden. 38: 261-282.

Braun, E.L. 1950. **Deciduous forests of eastern North America.** Philadelphia, PA: Blakiston Company. 596 p.

Guyette, R.P.; McGinnes, E.A., Jr. 1982. **Fire history of an Ozark glade in Missouri.** Transactions of the Missouri Academy of Science. 16: 85-93.

Guyette, R.P.; Dey, D.C. 2000. **Humans, topography, and wildland fire: the ingredients for long term patterns in ecosystems.** In: Yaussy, D.A., ed. Proceedings: workshop on fire, people, and the central hardwoods landscape. 12-14 March 2000, Richmond, KY. Gen. Tech. Rep. NE-274. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 28-35.

Guyette, R.P.; Stambaugh, M.C.; Muzika, R.M.; Dey, D.C. 2006. **Fire scars reveal variability and dynamics of eastern fire regimes.** In: Dickinson, M.B., ed. Fire in eastern oak forests: delivering science to land managers, proceedings of a conference; 15-17 November 2005; Columbus, OH. Gen. Tech. Rep. NRS-P-1. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 20-39.

Houck, L. 1908. **A history of Missouri: from the earliest explorations and settlements until the admission of the state into the union.** Chicago, IL: R.R. Donnelley and Sons Company. Vol. I.

Ladd, D. 1991. **Reexamination of the role of fire in Missouri oak woodlands.** In: Burger, G.V.; Ebinger, J.E.; Wilhelm, G.S., eds. Proceedings of the oak woods management workshop; 1988; Peoria, IL. Charleston, IL: Eastern Illinois University: 67-80.

Law, J.R.; Melick, R.; Studyvin, C.; Steinman, J.R. 2002. **Oak decline in Missouri: history revisited.** In: Spetich, M.A., ed. Upland oak ecology symposium; history, current conditions, and sustainability. 7-10 October 2002; Fayetteville, Arkansas. Gen. Tech. Rep. SRS-73. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 217-222.

McCarty, K. 1998. **Landscape-scale restoration in Missouri savannas and woodlands.** Restoration and Management Notes. 16: 22-32.

McKinney, M.L.; Lockwood, J.L. 1999. **Biotic homogenization: a few winners replacing many losers in the next mass extinction.** Trends in Ecology and Evolution. 14(11): 450-453.

Nelson, P.W. 2010. **The terrestrial natural communities of Missouri.** Jefferson City, MO: Missouri Natural Areas Committee. 550 p.

Nelson, P.W.; Ladd, D. 1983. **Preliminary report on the identification, distribution, and classification of Missouri glades.** In: Kucera, C.L., ed. Proceedings of the 7th North American prairie conference. Springfield, Missouri: Southwest Missouri State University: 59-76.

Nigh, T.A. 1992. **The forests prior to European settlement.** In: Journet, A.R.P.; Spratt, H.G., Jr., eds. Towards a vision for Missouri public forests. Cape Girardeau, MO: Southeast Missouri State University: 6-13.

Nigh, T.A.; Schroeder, W.A. 2002. **Atlas of Missouri ecoregions.** Jefferson City, MO: Missouri Department of Conservation.

Ozarks Ecoregional Assessment Team. 2003. **Ozarks ecoregional conservation assessment.** Minneapolis, MN: The Nature Conservancy, Midwestern Resource Office.

Pyne, S.J. 1982. **Fire in America: a cultural history of wildland and rural fire.** Princeton, NJ: Princeton University Press.

Ray, J.H.; Lopinot, N.H.; Hajick, E.R.; Mandel, R.D. 1998. **The Big Eddy site: a multicomponent paleoindian site on the Ozark Border, southwest Missouri.** Plains Anthropologist. 43(163): 73-81.

Rooney, T.P.; Wiegmann, S.M.; Rogers, D.A.; Waller, D.M. 2004. **Biotic impoverishment and homogenization in unfragmented forest understory communities.** Conservation Biology. 18: 787-798.

Schoolcraft, H.R. 1819. **A view of the lead mines of Missouri.** New York, NY: Charles Wiley and Company.

Smith, S.D. 2003. **Made in the timber: a settlement history of the Fort Leonard Wood region.** ERDC/CERL Special Report 03-5. [Publisher unknown]. 267 p.

Spencer, J.S., Jr.; Roussopoulos, S.M.; Massengale, R.A. 1992. **Missouri's forest resource, 1989: an analysis.** Resource Bulletin NC-139. St Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 84 p.

Steyermark, J.A. 1959. **Vegetational history of the Ozark forest.** Columbia, MO: University of Missouri Studies. Vol. 31.

Steyermark, J.A. 1963. **Flora of Missouri.** Ames. IA: Iowa State University Press. 1728 p.

Swallow, G.C. 1859. **Geological report of the country along the line of the south-western branch of the Pacific Railroad, State of Missouri.** St. Louis, MO: George Knapp & Co.

U.S. Department of Agriculture, Forest Service (USDA FS). 2005. **Land and resource management plan for the Mark Twain National Forest.** Rolla, MO: U.S. Department of Agriculture, Forest Service, Mark Twain National Forest.

U.S. Department of Agriculture, Forest Service (USDA FS). 2011. **Integrated non-native invasive plant control, Mark Twain National Forest.** Unpublished draft environmental impact statement. 209 p.

Yatskievych, G.; Turner, J. 1990. **Catalogue of the flora of Missouri.** Monographs in Systematic Botany. Vol. 37. St. Louis, MO: Missouri Botanical Garden Press. 345 p.

The content of this paper reflects the views of the author(s), who are responsible for the facts and accuracy of the information presented herein.

APPENDIX

List of scientific plant names (Yatskievych and Turner 1990) for cited common plant names.

Common name	Scientific name
Blackjack oak	*Quercus marilandica*
Black oak	*Quercus velutina*
Bluestem	*Andropogon* species
Bur oak	*Quercus macrocarpa*
Cherrybark oak	*Quercus pagoda*
Dwarf chestnut oak	*Quercus prinoides*
Chinquapin oak	*Quercus muehlenbergii*
Nuttal oak	*Quercus texana*
Overcup oak	*Quercus lyrata*
Pin oak	*Quercus palustris*
Post oak	*Quercus stellata*
Northern red oak	*Quercus rubra*
Scarlet oak	*Quercus coccinea*
Schneck's oak	*Quercus schumardii* var. *schneckii*
Schumard's oak	*Quercus schumardii*
Shingle oak	*Quercus imbricaria*
Shortleaf pine	*Pinus echinata*
Smoketree	*Cotinus obovatus*
Sugar maple	*Acer saccharum*
Swamp white oak	*Quercus bicolor*