# ANTHROPOLOGY OF FIRE IN THE OZARK HIGHLAND REGION

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**Abstract.**--Native Americans are often considered to have exploited available natural resources rather than modifying their environments to maximize yields. As simpler societies evolved into more complex ones, there is a consensus that intensification of habitat modifications also increased. However, landscape scale archeological inventories now show relatively intensive modifications of specific landscapes through most of human history, including so-called simpler societies. Records of these modifications are difficult to obtain. Archeological site distributions can be used to understand human settlement and selection of particular ecosystems. Another method uses tree-ring dating (dendrochronology) on fire-scarred trees that recorded fire frequencies and fire return intervals at points on the landscape that frequently burned due to natural and cultural processes. General Land Office records (1815-1840) provide firm evidence for culturally-induced changes in species distribution and historical landscape vegetation mosaics for the Ozark Highlands and Arkansas River valley.

## INTRODUCTION

The Ozark Highlands have for a long time been considered a "marginal" region marked by cultural conservatism and lack of developed prehistoric agricultural and urban settlement (Sabo 1986). This concept has also been applied to humans practicing a hunting and/or gathering subsistence strategy, and so-called "primitive" societies are considered to lack sophisticated environmental management skills. Through the study of human use of fire and inter-regional comparisons of patterns of cultural development, the "marginal-primitive" view of Ozark prehistory and history is now challenged. The theme of this paper is that fire use by native people at various stages of cultural complexity indicates landscape scale manipulation of natural resources, implying greater environmental sophistication of hunter-gatherers than previously supposed.

Throughout the history of anthropology, cultural anthropologists and archeologists were bounded by theoretical assumptions that reflected the accepted norms of European and Euro-American societies; primarily those of colonial powers. Julian Steward, for example, popularized the notion of "cultural ecology" but viewed Indians, particularly hunters and gatherers, as living fossils representing an earlier, more "primitive" stage of human evolution (Steward 1955). Cultural ecology became the dominant paradigm in North American prehistoric archaeology, where "all cultures are adaptations to their specific environments" (Cande 2008). A few voices in the wilderness, particularly Day (1953) and Stewart (1956, 2002), challenged both ecological and anthropological theorists with field data on Native American use of fire, cultural and subsistence practices, and the broader environmental consequences resulting from burning particular habitats at certain times of the year.

Miller (1972) employed the hypothesis that hunter-gatherers were totally dependent, and agriculturalists partially dependent, on the available natural vegetation and fauna. Citing Steward (1955), Miller posited that "fire was the prime tool available" to native North Americans, and his work using General Land Office (GLO) records and historical accounts of northwestern Arkansas and the Ozarks has become a seminal environmental reference for archeologists working in the region. Miller hypothesized that several plant communities (and associated fauna), especially prairies (upland and lowland), barrens (open areas with frequent fire regime), and open oak woodlands, were maintained for at least the last 1500 years by Native Americans (see Curtis 1959, Miller 1972, Sears 1925), and substantiated this inference with the prehistoric floral and faunal materials recovered from bluff shelters in the Ozarks (Cande 2008). Similar patterns of human use of fire are known from the Cumberland Plateau (Delcourt and others 1998). Ecological communities such as open oak woodlands, barrens, and prairies were maintained by Native American burning, and possibly natural fires, and were rapidly replaced by full forest vegetation (Kay 2003) after Euro-American settlement by the relative suppression of fire and landscape fragmentation. In another study, Jurney and Stahle (2004) found that some Ozark Highland prairies found in the GLO records are located on soils that formed under hardwood forest, suggesting that these prairies may have been culturally induced. During the 19th century, dendrochronological (tree-ring dating) data from fire-scarred trees indicate burning was conducted in some forested areas (e.g., Cross Timbers of western Ozarks) to improve range (Clark and others 2007, Griffin 2002), while other areas (e.g., central Ozarks) received less burning (Guyette and others 2002, Guyette and Spetich 2003). In the 20th century, fire was removed from many areas of the Ozark ecosystem, particularly where national forests were established and fire was considered counterproductive for timber management (Bass 1981).

The ecological role of fire and human influences over the structure and distribution of plants has and will continue to be controversial. Two extremes in this debate argue that: 1) fire is destructive and should not be (or never was) applied by humans to the landscape, and 2) fire is an essential management tool to restore forests and grasslands to more natural, ecologically healthy, or desired historical reference conditions. The use of long-term, longitudinal ecological studies has challenged the traditional "succession" paradigm of "let Mother Nature take her course", or "study only the wilderness", and the human role in vegetation changes through time is now a generally accepted fact (Anderson 2006, Denevan 1992, Mann 2005, Raup and Carlson 1941). The anthropological assumption that hunter-gatherers were "primitive," ecologically inept, and bound to the resources available to them (Anderson 2006) is central to the hypothesis that the origins of agriculture constituted a "revolutionary change" in how humans related to their particular environments. This theoretical bias persists today in archaeology and is challenged by the evidence presented in this paper.

## STUDY AREA

The study area falls primarily in the Ozark Plateau of north-central Arkansas, with outliers in the Mississippi Embayment and Gulf Coastal Plain, the Arkansas River Valley, and the northern uplift of the Ouachita Mountains (Magazine Mountain). The Arkansas Valley consists of Pennsylvanian-age clastic sediments arranged into broad synclines (troughs) with relatively narrow intervening anticlines (arches). The synclines are most conspicuous and are formed when the capping sandstones are breached, resulting in a more rapid erosion of underlying shale. The Ozark Plateau is made of generally level-bedded Paleozoic age strata divided into the Salem Plateau, the Springfield Plateau, and the Boston Mountains (USDA FS 2005). All these plateaus are deeply dissected by numerous streams. The St. Francis National Forest is located on Tertiary marginal marine and coastal plain continental deposits with a veneer of Quaternary terrace and alluvial deposits. Crowley's Ridge, formed by aeolian loess, runs through the center of this forest adjacent to the floodplains of the St. Francis River and the Mississippi River.

Land managers, archaeologists, and geoscientists need to develop sound baseline historical data on plant distributions and ecological processes over entire landscapes (Bragg 2002, 2004; Warren 1984; Warren and O'Brien 1984) as an aid to current forest, shrubland, and grassland ecosystem management and paleoenvironmental reconstruction. The National Hierarchical Framework of Ecological Units (NHFEU) is a standardized classification and mapping system for dividing the earth's biota into progressively smaller areas of increasingly similar ecology, providing baseline management information for each unit. It is derived from patterns of climate, soils, air quality, hydrology, geology, landforms and topography, potential natural plant communities, and natural disturbances. The Ozark-St. Francis National Forests in Arkansas (OSFNF) have completed (USDA FS 2005) an approximation of land type associations (LTAs) tiered to the NHFEU. This Forest has management units falling in the northern Ouachita Mountains (Magazine Mountain), the Ozark highlands and the Arkansas River valley rolling hills (Wedington Unit, Bayou, Buffalo, Pleasant Hill, Boston Mountain), and the Mississippi (St. Francis NF) alluvial valley (Fenneman 1938, Thornbury 1965). The LTAs generally trend east-to-west following the sloping trend of the underlying geology, with some orientation along streams that drain the interior Ozarks.

The maximum southern advance of glaciers (northern Missouri) occurred around 18,000 years before present (YBP, 1950 as datum). Pleistocene records from various paleoenvironmental contexts (pollen in adjacent areas, solution cavern speleothems, dendroclimatology) indicate the Ozark forests were composed of boreal species, predominantly spruce (*Picea* spp.). Summers were substantially cooler than present. Faunal species included the Columbia mammoth (*Mammuthus columbi*), American mastodon (*Mammut americanum*), ground sloth (*Megalonyx jeffersonii*), and horse (*Equus* spp.). Around 14,000 YBP, more mixed boreal forest developed with spruce and jack pine (*Pinus banksiana*), and the addition of oak (*Quercus* spp.), hickory (*Carya* spp.), ash (*Fraxinus* spp.), and maple (*Acer* spp.) as minor components. This mosaic of boreal and deciduous ecosystems has no modern analogue in present North America (Denniston and others 2000), and large scale herbivory may also have contributed to the vegetation mosaics of this period (Collins 1992, Nelson 2005). A brief cooling retrenchment occurred between 12,900 and 11,500 YBP, referred to as the Younger Dryas (Dansgaard and others 1989), which abruptly terminated with warming up to 7 °C (12.6 °F) in just a few years. Many large herbivores became extinct just prior to or following this event. Dry westerly winds increased, with eventual intrusion of prairie grasses into the Ozarks (Denniston and others 2000). Around 9,500 YBP oak savannah was well established across the Ozarks. A rapid decrease in speleothem values ca. 9,500 YBP indicates an increase in deciduous vegetation (Denniston and others 2000), followed by a prairie dominated environment about 7,500 YBP. Nelson (2005) attributes the spread of prairie ecosystems from the Great Plains to Ohio during this period to the combined effects of warming conditions, increased aridity, and Native American fire sets. This climatic episode was interrupted by increased deciduous forest ca. 4,500 and 3,000 YBP. Prairie returned between 3,000 and 1,500 YBP, with the establishment of current deciduous forest (Denniston and others 2000). The climate record shows that radical environmental and climatic shifts (Stahle and others 2000) have occurred in the Ozarks, with commensurate changes in fire ecology. Periods with expansion of grasslands were probably most pyrogenic, followed (in descending order of fire frequency) by pine forests, open oak woodlands, and closed deciduous forest. Humans were present throughout the last 18,000 years, with increased population spikes ca. 4,500 and 1,500 years ago (Sabo and Early 1990), domestication of wild plants and use of tropical cultigens ca. 4,200 YBP, and the introduction of maize agriculture ca. 750 YBP. These population spikes occurred during shifts from grassland to deciduous forest, and from forest to grasslands.

The modern climate is characterized as temperate, with west-to-east moving atmospheric circulation of air masses originating from the eastern Pacific, western United States, the Gulf of Mexico, and Canada. During winter, extreme north-to-south temperature variations occur. During summer, daily variations are less significant from north-to-south. Rainfall averages 114.3-139.7 cm (45-55 inches) per year, with March, May, and November the wettest and July, August, and January the driest (USDA FS 2005). Thunderstorms are greatest during the spring, summer, and fall, averaging 10-25 events during each season. Tropical cyclone and frontal passages are most severe in winter and spring. Tornados have been reported every month but are most frequent in April and May. Nine major droughts (reconstructed below average June-July rainfall) have occurred during the last 308 years (1703-1704, 1727-1741, 1780-1789, 1831-1840, 1855-1866, 1886-1887, 1923-1925, 1950-1957, and 1963-1965), generally lasting 2 to 3 years in duration (Blasing and others 1988).

Increased wildfires of human origin and lightning ignitions are noted for these periods, with some corresponding to drought episodes (Clark and others 2007, Jurney and others 2004). Florida and Texas experience more lightning strikes than any other areas of the United States (Orville 1992, Silver and Orville 1994), yet Florida's fire records indicate an average of 15 lightning-caused fires per million acres per year (437.56 lightning fires per year; 8.2 percent of total). Texas fire records indicate an average of one lightning fire per million acres per year (23.5 fires per year; 1 percent of total); and Florida has almost three times as much rainfall (Jurney and others 2004). Arkansas fire records indicate an average of 4.3 lightning fires per million acres per year (93.5 fires per year; 2.6 percent of total). Only during exceptional climatic episodes does lightning match the frequency of human-caused fires (Jurney and others 2004). In Arkansas from 1916-1990, the mean lightning-caused fire frequency was 2.78 lightning fires per year (range 0-25.7 percent). In this 75-year period of record, 26 years had greater than average numbers of lightning-caused fires, 15.4 percent of which were drought years (1956, 5.7 percent of total; 1954, 4 percent; 1964, 3 percent; 1923, 2.8 percent) with less than average tree-ring growth. In the 49 years of less than average numbers of lightning-caused fires, 8.2 percent were drought years (1924, 2.7 percent of total; 1925, 2.7 percent; 1965, 2.6 percent; 1957, 1.8 percent; 1952, 1.7 percent; 1953, 1.7 percent; 1963, 1.6 percent; and 1951, 1.1 percent). These data suggest that during drought years there is a greater chance for lightning-caused fires; however, during some drought years, human-caused fires also proportionately increased.

Another aspect of climatic cycles is the El Nino-Southern Oscillation (ENSO) which are short duration 3-7 year events which intensify both droughts and wet periods. ENSO events are known in the Pleistocene (radiometrically dated to at least 10,770 YBP), and it is possible that they can trigger broader patterns of climate change (Dunbar 2006, Guyette and others 2006). In the Ozarks, ENSO events are marked by the presence of 70 frost-damaged growth rings (spring wood) in oaks over the last 330 (AD 1650-1980) years that formed from false spring events (late spring severe frost damage captured in tree growth rings), correlating with the La Nina phase of ENSO (Stahle 1990). In 2007, such a false spring hit Arkansas during a La Nina year and produced extensive damage to both white oak (subgenera *Leucobalanus* with an annual nut mast) and red oak (subgenera *Erythrobalanus* with a 2-year nut mast) acorn yields, with lag effects lasting into the spring of 2008. Thus, periods of drought and false spring events that show the influence of ENSO have the potential to increase the effects of wildland fire ignitions (Clark and others 2007, Guyette and others 2006) and allow humans to further influence the spread of landscape scale fires. Also, climate changes and fluctuations influence the annual yields of nut mast and other natural resources, as well as predisposing the landscape to large scale fire ignition and fire spread.

## PREHISTORIC AGROFORESTRY

Native agroforestry practices are increasingly recognized through archaeological research, use of aerial and satellite imagery, and paleoenvironmental reconstruction around the planet. Many Native American elders report that plants benefit from human use, and many may actually depend on humans using them to fully function in the ecosystem (Anderson 2006). Denevan (1992) argues that the forest structure and landscapes of North and South America were greatly influenced by humans through the widespread use of fire to concentrate food resources. Forests of widely spaced trees with grass and herb understory were observed in New England, the Midwest, and southeastern North America upon European introduction but have vanished today (Black and others 2006, Denevan 1992). Data compiled from modern vegetation studies (Guldin and others 1999) compared to GLO spatial data (Foster and others 2004, Foti 2004) indicate that the Ozark Highlands forest of Arkansas is 2.3-2.8 times denser today than 180 years ago. Davies (1994) suggests that periodic low-intensity fires, particularly between November and April, increased vegetation yield from 20-100 percent and increased large birds and mammals by 100-400 percent. Humans used fire to concentrate foods on highly productive portions of the landscape (Williams 1993) and may have used similar strategies to achieve a "primary forest efficiency," a phrase coined by Caldwell (1958) and amplified in the works of Smith (1974, 1975, 1978) in the Mississippi Valley and in the Ozarks by Raab (1976) and Lockhart and others (1995). My discussion of Ozark Native American use of fire to modify their environment summarizes known information relating to archaeological finds of plants whose life histories suggest some form of human intervention in the ecosystem (Nowacki and Abrams 2008), dendrochronology, and proxy records of vegetated landscapes. Many species that are rare today appear to be artifacts of such fire regimes, including the federally endangered red-cockaded woodpecker (*Picoides borealis*) and Indiana bat (*Myotis sodalis*).

Beginning with the prehistoric archaeological record in the Arkansas Ozarks, dry rockshelter deposits preserve perishable material culture and food remains and provide empirical evidence for anthropogenic landscapes. Figure 1 shows giant cane (*Arundinaria* spp.) remains from the Penhook Rockshelter (3PP402) on the Middle Fork Illinois Bayou in the Lower Atoka Hills and Mountains LTA. This species is rare in the vicinity of this shelter today. Cane was a ubiquitous material found in dry shelter deposits that was used for food, basketry, tools, and other functions. It is dependent on fire to maintain habitat and stand viability. For the Late Prehistoric and Historic periods, the GLO surveys and some historical accounts provide data on landscape-scale vegetation patterns and disturbance regimes. General Land Office records indicate extensive stands of fire-dependent cane (*Arundinaria* spp.) were present in early 19th century Ozark valleys (Fig. 2) in the Lee Creek Rolling Hills, Lee Creek Atoka Hills, Atoka Mulberry Mountain Valleys, Arkansas Valley Hills, Lower Atoka Hills and Mountains, Bloyd Mountain Valleys, White River Rolling Hills, Wedington Boone Hills, and Mississippi Bottomlands LTAs. The floodplain landtypes within these LTAs require a 5-10 year fire return interval for health of cane stands (Brantley and Platt 2001, Frost and others 1986, Frost 1995, Gagnon 2006) and were probably influenced by, if not created by, late prehistoric burning practices.

Figure 1.—Giant cane (*Arundinaria* spp.) fragments from the Penhook Rockshelter (3PP402).

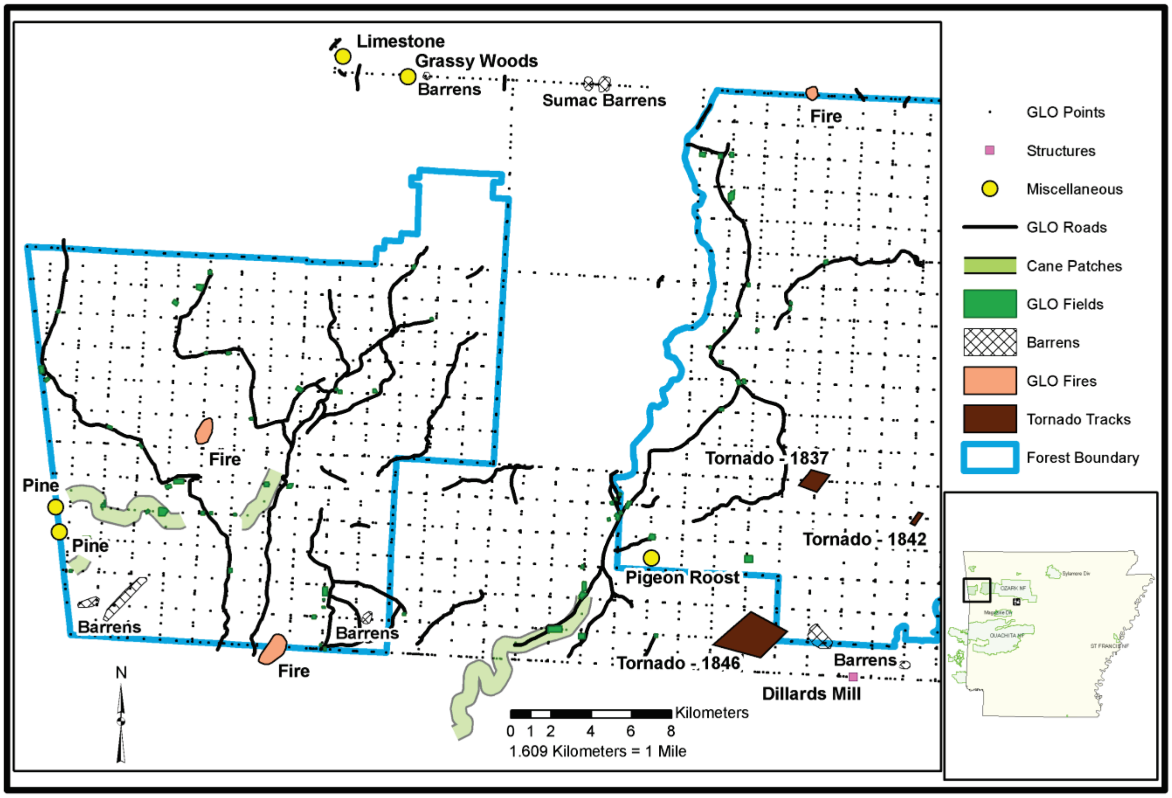


Figure 2.—General Land Office information related to vegetation and cultural and natural disturbances on the Lee Creek Unit of the Ozark-St. Francis National Forests.

Most evidence for prehistoric manipulation of their environments is derived from the excavation of perishable food and material culture remains from Ozark rockshelters, focused primarily in northwestern Arkansas. Most of the excavations were done in the 1930s and lack firm chronological and spatial controls. Since these sites have suffered over 100 years of looting, few remain that can be scientifically investigated today. Therefore, the studies of Gayle Fritz provide the best chronological control for Native American agroforestry, domestication of native wild plants, and adoption of tropical maize-bean-squash agriculture. Of particular note is the domestication of two native plants: *Iva annua* (sumpweeed) which favors floodplains, and *Phalaris caroliniana* (May grass or canary grass) which favors sandy soils and canopy disturbances from floodplains to uplands. Fritz (1986a, 1986b, 1990, 1994, 1997) argues they were domesticated because they have larger seeds than modern varieties and were recovered from archaeological contexts outside their modern ranges. Unfortunately, the paleobotanical literature lists species by presence/absence with little quantitative information on species abundance.

The life histories of other flora and fauna species strongly associated with fire-adapted ecosystems (e.g., shortleaf pine [*Pinus echinata*], various white and red oaks, bison [*Bison bison*], and elk [*Cervus elaphus*]) and their distributions confirm that native fire use played a role in ecosystem structure and function. Table 1 is a list of 64 plants found in Ozark rockshelters (Gilmore 1931) and provides a rough assessment of the ratio of fire-adapted to

**Table 1.—List of plant species recovered from Ozark rockshelters and identified by Gilmore in 1931. Theo Witsell (Arkansas Department of Natural Resources) provided updates to the scientific nomenclature. Fire code denotes species response to fire (1 = responds favorably; 0 = fire intolerant) as determined from the Fire Effects Information System database (USDA FS 2012). Note that many species respond favorably to environments cleared by fire. The last column lists any quantified information provided by Gilmore (1931).**

| Scientific Name | Common Name | Fire Code | Quantitation Information |
|---|---|---|---|
| *Pinus echinata* | shortleaf pine | 1 | one specimen |
| *Pinus taeda* | loblolly pine | 1 | one specimen twisted cord |
| *Juniperus virginiana* | red cedar | 0 | common in graves |
| *Typha latifolia* | cattail | 1 | abundant |
| *Tripsacum dactyloides* | gama grass | 1 | no data |
| *Zea mays* | Indian Corn | 1 | abundant all sites |
| *Andropogon furcatus* | big bluestem | 1 | many specimens (*Andropogon gerardii*) |
| *Andropogon scoparius* | little bluestem | 1 | no data (*Schizachyrium scoparium*) |
| *Sorghastrum avenaceum* | Indian grass | 1 | 1 specimen (*Sorghastrum nutans*) |
| *Phalaris caroliniana* | Carolina canary grass | 1 | many sheaves |
| *Elymus arkansanus* | slender wild rye | 1 | no data (*Elymus villosus*) |
| *Arundinaria macrosperma* | giant cane | 1 | no data (probably *Arundinaria gigantean*) |
| *Arundinaria tecta* | switch cane | 1 | no data |
| *Scirpus validus* | great bulrush | 1 | 1 specimen (*Schoenoplectus tabernaemontani*) |
| *Acornus calamus* | calamus sweet flag | 0 | abundant all sites |
| *Allium* sp. | wild onion | 1 | no data |
| *Yucca* sp. | Spanish bayonet | 1 | no data |
| *Populus deltoides* | cottonwood | 0 | many specimens |
| *Salix nigra* | black willow | 1 | 1 bundle |
| *Juglans nigra* | black walnut | 1 | no data |
| *Carya illinoiensis* | pecan | 0 | no data |
| *Carya cordiformis* | | | |
| *Carya laciniosa* | shagbark hickory | 0 | many specimens |
| *Carya alba* | mockernut hickory | 1 | no data |
| *Corylus americana* | hazelnut | 0 | many specimens |
| *Castanea pumila* | chinquapin | 1 | no data |
| *Quercus falcata/rubra* | red oak | 1 | no data |
| *Quercus alba* | white oak | 1 | no data |
| *Quercus marilandica* | blackjack oak | 1 | no data |
| *Quercus imbricaria* | shingle oak | 0 | no data |
| *Quercus macrocarpa* | bur oak | 1 | no data |
| *Ulmus fulva* | slippery elm | 0 | no data |
| *Morus rubra* | red mulberry | 0 | no data |
| *Maclura pomifera* | bois d'arc | 0 | 1 specimen bark cord |
| *Amaranthus* spp. | pigweed | 1 | many sheaves |
| *Chenopodium* sp. | lambsquarters, goosefoot | 1 | many sheaves |
| *Asimina triloba* | pawpaw | 0 | 1 seed |
| *Platanus occidentalis* | sycamore | 0 | 1 specimen |
| *Prunus chicasa* | chickasaw plum | 1 | 1 specimen (probably *P. angustifolia*) |
| *Gleditsia triacanthos* | honey locust | 0 | 1 specimen |
| *Lespedeza capitata* | rabbitfoot clover | 1 | no data |
| *Phaseolus vulgaris* | garden bean | 1 | varieties all sites |
| *Rhus glabra* | smooth sumac | 1 | many empty panicles |

(Table 1 continued on next page)

**Table 1 (continued).—List of plant species recovered from Ozark rockshelters and identified by Gilmore in 1931. Theo Witsell (Arkansas Department of Natural Resources) provided updates to the scientific nomenclature. Fire code denotes species response to fire (1 = responds favorably; 0 = fire intolerant) as determined from the Fire Effects Information System database (USDA FS 2012). Note that many species respond favorably to environments cleared by fire. The last column lists any quantified information provided by Gilmore (1931).**

| Scientific Name | Common Name | Fire Code | Quantitation Information |
|---|---|---|---|
| *Sapindus drummondii* | soapberry | 0 | 1 specimen |
| *Vitis* spp. | wild grape | 0 | abundant all sites |
| *Tilia americana* | basswood, linden | 0 | no data |
| *Dirca palustris* | leatherwood | 0 | no data |
| *Cornus florida* | dogwood | 1 | no data |
| *Diospyros virginiana* | persimmon | 1 | no data |
| *Fraxinus* spp. | ash | 0 | no data |
| *Apocynum cannabinum* | Indian hemp | 1 | many specimens |
| *Onosmodium subsetosum* | Ozark false gromwell | 1 | no data (*O. molle* var. *subsetosum*) |
| *Dasistoma* sp. | false foxglove | 1 | 1 specimen (may be *Aureolaria* sp.), some |
| *Dasistoma* spp. | (moved to *Aureolaria*) | | |
| *Catalpa speciosa* | catalpa | 0 | specimens |
| *Viburnum* sp. | viburnum | 1 | 1 seed |
| *Cucurbita maxima* | winter squash | 1 | 1 shell, 1 peduncle, several seeds |
| *Cucurbita ovifera* | egg gourd | 1 | 1 complete shell |
| *Cucurbita pepo* | pumpkin/summer squash | 1 | 1 complete shell |
| *Iva xanthifolia* | marsh elder | 1 | quantities |
| *Ambrosia trifida* | giant ragweed | 1 | considerable quantities, large seeds |
| *Liatris squarrosa* | blazing star | 1 | no data |
| *Liatris pycnostachya* | Kansas gayflower | 1 | no data |
| *Helianthus annuus* | sunflower (two cultivated varieties | 1 | quantities |
| *Cirsium altissium* | thistle | 1 | 1 leaf |
| *Rudbeckia* sp. | cone flower | 1 | 1 seed head disc |

non-fire-adapted plants exploited by Ozark Native Americans. Since full quantitative information was not available from the literature, each species was coded to indicate species with a favorable response to fire (coded as 1) and species that grow in non-pyrogenic ecosystems or that respond unfavorably to fire (coded as 0) based on the Fire Effects Information System (USDA FS 2012). Species that are favored by fire dominate (70 percent) over species that are from non-pyrogenic ecosystems or that do not respond favorably to fire (30 percent). Table 2 lists the plant remains found in the intestines of an elderly woman whose remains were exposed in the drip line of a rockshelter. All identified plant remains of this person's last meal were fire-adapted (100 percent) species. Ants, fruit beetles, and mites were found in the unidentified fruity substances. The ingestion of charcoal and sumac (*Rhus glabra*) suggests that the woman may have been ill, since sumac was used for food as well as medicine to stop vomiting (Hamel and Chiltosky 1975). Food residues from a ceramic vessel at the open air Copperhead Site (AD 819-1299), 3CW951 in the Atoka Hills and Valleys LTA (Cummings and Yost 2009), indicate cooking of squash/pumpkin (*Curcubita pepo*), sunflower (*Helianthus* spp.), oak acorns, beans (*Phaseolus* sp.), and sumac berries (*Rhus* spp.). All of these species (100 percent) were fire-adapted. Table 3 lists the plant remains from three rockshelters on Lee Creek in western Arkansas identified by Fritz (1986a).

**Table 2.—Listing of materials recovered from the feces of an elderly prehistoric woman indicating consumption of fruits with pests, oak acorns, and sumac (from Wakefield and Dellinger 1936). At least half of the remains provide evidence of fire use or fire-adapted habitats. Quantitative data were not provided. Species that respond favorably to fire are denoted by 1, and species that are fire intolerant are denoted by 0, however note that many species respond favorably to environments cleared by fire.**

| Scientific Name | Type of Material | Fire Code | Quantity |
|---|---|---|---|
| *Rhus glabra* | sumac | 1 | no data |
| *Quercus velutina* | black oak | 1 | no data |
| *Nitidulidae* | fruit beetles | | 2 specimens |
| *Tyroglyphidae* | mite in decaying matter | | a number |
| *Formicidae* | ant | | 1 specimen |
| - - - - - | fruit substance | | |
| - - - - - | charcoal | 1 | mixed throughout |
| | fungus | | growth on materials |

**Table 3.—Plant list from three rockshelters in Lee Creek (Fritz 1986b). Quantitative data were not provided, but are inferred by site catalog numbers provided in Fritz 1986a. Species that respond favorably to fire are denoted by 1, and species that are fire intolerant are denoted by 0; however, note that many species respond favorably to environments cleared by fire.**

| Scientific Name | Common Name | Fire Code | Quantitation Information |
|---|---|---|---|
| *Zea mays* | Indian corn | 1 | 37 specimens |
| *Cucurbita maxima* | winter squash | 1 | 38 specimens |
| *Cucurbita ovifera* | egg gourd | 1 | 12 specimens |
| *Cucurbita pepo* | pumpkin/summer squash | 1 | lumped with winter squash |
| *Laegenaria* | bottle gourd | 1 | 12 specimens |
| *Phaselous vulgaris* | garden bean | 1 | 11 specimens |
| *Phaselous polystachios* | wild bean | 1 | 1 specimen |
| *Strophostyles helvula* | wild bean | 1 | 1 specimen |
| *Helianthus* sp. | sunflower | 1 | 16 specimens |
| *Helianthus tuberosus* | "Jerusalem artichoke" | 1 | lumped with sunflower |
| *Iva annua* | sumpweed\polygonum | 1 | 4 achenes |
| *Phalaris caroliniana* | maygrass | 1 | 1 specimen |
| *Hordeum pusillum* | little barley | 1 | |
| *Amaranthus* sp. | amaranth | 1 | 1 specimen |
| *Ambrosia trifida* | ragweed | 1 | 1 specimen |
| *Nuphar luteum* | spatterdock/water lily | 0 | 1 specimen |
| *Optunia* sp. | cactus | 0 | 3 specimens |
| *Citrullus lanatus* | watermelon | 0 | 3 specimens |
| *Juglans nigra* | walnut | 0 | 11 specimens |
| *Carya* spp. | hickory | 1 | 8 specimens |
| *Quercus* spp. | oak | 1 | 19 specimens |
| *Fagus grandifolia* | beech | 0 | 1 specimen |
| *Prunus* spp. | plum | 1 | 10 specimens |
| *Prunus virginiana* | chokecherry | 1 | lumped with plum |
| *Diospyros virginiana* | persimmon | 1 | 4 specimens |
| *Platanus occidentalis* | sycamore | 0 | 2 specimens |
| *Ostrya virginiana* | ironwood (hophornbeam) | 0 | 3 specimens |
| *Acer* sp. | maple | 0 | 1 specimen |

(Table 3 continued on next page)

**Table 3 (continued).—Plant list from three rockshelters in Lee Creek (Fritz 1986b). Quantitative data were not provided, but are inferred by site catalog numbers provided in Fritz 1986a. Species that respond favorably to fire are denoted by 1, and species that are fire intolerant are denoted by 0; however, note that many species respond favorably to environments cleared by fire.**

| Scientific Name | Common Name | Fire Code | Quantitation Information |
|---|---|---|---|
| *Nyassa sylvatica* | sourgum | 0 | 2 specimens |
| *Compositae* spp. | (*Asteraceae* sp.) | 1 | 1 specimen |
| *Arundinaria* sp. | Cane | 1 | 15 specimens |
| *Juniperus* sp. | Juniper | 0 | 9 specimens |
| *Pinus* spp. | Pine | 1 | 5 specimens |
| *Vitis* spp. | Grape | 1 | 4 specimens |
| *Asimina triloba* | pawpaw | 0 | 1 specimen |
| *Vaccinium* spp. | Blueberry | 1 | 1 specimen |
| *Rubus* spp. | blackberry/bramble | 1 | 2 specimens |
| *Celtis occidentalis* | hackberry | 1 | 8 specimens |
| *Viburnum* sp. | Haw | 1 | 4 specimens |
| *Viburnum prunifolium* | black haw | 1 | lumped with viburnum |
| *Crataegus* spp. | Hawthorn | 1 | 1 specimen |
| *Rhus* spp. | Sumac | 1 | 1 specimen |

Here, species that are favored by fire comprise 76.2 percent of the plants recovered while fire sensitive plants comprise 23.8 percent of the assemblage. Primary occupations date to the Late Archaic-Woodland periods (3000-1000 YBP) for these species. Table 4 lists nine plants identified by Fritz (1997) that were recovered from a cache (radiocarbon dated 1301-898 BC, Fritz 1986b) in the Marble Falls Rockshelter on Mill Creek in north-central Arkansas. Fritz interprets that four species of wild plants (*Curcurbita pepo* spp. *ovifera*, *Chenopodium berlanderi* spp. *jonesianum*, *Iva annua* var. *macrocarpa*, and *Helianthus annus* var. *macrocarpus*) were domesticated and, along with *Ambrosia trifida*, were harvested from a garden and stored to be planted or eaten the following spring. All of these species (100 percent) are fire-adapted.

**Table 4.—Listing of domesticated wild plants from seed cache at Marble Bluff (Fritz 1997). Species that respond favorably to fire are denoted by 1, and species that are fire intolerant are denoted by 0; however, note that many species respond favorably to environments cleared by fire.**

| Scientific Name | Common Name | Fire Code | Quantity |
|---|---|---|---|
| *Chenopodium berlandieri* | Lambsquarters, goosefoot | 1 | |
| *Ambrosia trifida* | giant ragweed (stored in bags) | 1 | |
| *Lamiaceae* | mint | 1 | capsules |
| *Helianthus* | sunflower | 1 | 58 seeds |
| *Amaranthus* | amaranth | 1 | 18 achenes |
| *Polygonum* | knotweed | 1 | |
| *Curcubita pepo* | gourd/squash | 1 | 8 seeds |
| *Iva annua* | sumpweed | 1 | |
| *Phalaris caroliniana* | canary grass | 1 | least common |

Other indicators suggesting Native American ecosystem modifications include the presence of large herbivores such as bison and elk in Arkansas (Collins 1992, Nuttall 1821, Schroeder 1981). Bison and elk remains are known from rockshelter and open site deposits in the Ozark Highlands (Cleland 1965, Sabo and others 1990, Scott 1993, Trubowitz 1980). Six bison images painted by Native Americans are present in the dark zone of Gustafson Cave (3ST70) on a tributary of the White River on the eastern front of the Ozarks in the Sylamore Hills LTA. Three images have fletched arrows extending through the torso of the animal, matching ethnohistorical evidence (Swanton 1942) of the use of bois d'arc (*Maclura pomifera*) for bows by the Caddo Indians that shot arrows through the animal. Schambach (2000, 2001b) argues that the Spiroans of the Arkansas Valley near Fort Smith were key participants in interregional exchange during the last 1500 years. Bow wood from the bois d'arc collected in northern Texas (Jurney 1994) was exchanged for seed corn (stored in specialized ceramic vessels) and turquoise (Jurney and Young 1995) from the Pueblos of the Southwest and bison meat and hides from the Plains nomads (Schambach 2001b). These goods were then routed into the Mississippi Valley, and thence to the southeastern Gulf region. Bois d'arc has been found under Caddoan mounds in Louisiana, at the Lyons Bluff site in Mississippi, and at Fort Toulouse in Alabama (Jurney 1994), all areas where it was not a major constituent of the original plant landscape after the terminal Pleistocene. The Gustafson Cave rock art also is the first written record (ca. AD 200-900) of bison in Arkansas and suggests some form of human manipulation of this species. During the middle 1700s, Le Page Du Pratz (Du Pratz 1774) observed that the bottomland forest and canebrakes at the mouth of the St. Francis River (the St. Francis National Forest) were "always covered with herds of buffalo, notwithstanding they are hunted every winter in those parts" (see Key 2001). Among the Quapaw Indians and throughout Arkansas, these prairies were maintained by fire, "attracting grazers like bison" (Key 2001). In northwest Arkansas, historical accounts of bison in 1829 estimated one head for every 3 acre density, with the last bison observed in 1832 (Miller 1972). Patch burning of grasslands has shown that, given the choice, bison will only graze in burned areas with incipient revegetation (Kerby and others 2007), a behavioral response which was undoubtedly noted by Native Americans.

There was a heavy dependence on oak acorns found at all rockshelter sites (Harrington 1960) in the Ozarks and adjacent areas. The relative abundance of white oak and red oak (Jurney and Stahle 2004) mirrors that of the 1815-1840 reference conditions found in GLO surveys. Fritz (1986b) found that oak (*Quercus* spp.) acorns were the most abundant plant remains from the Lee Creek Valley, a tributary of the Arkansas River in the Lee Creek Atoka Hills LTA. These remains were apparently associated with Caddoan-affiliated farmer-hunters and their Fourche Maline (Woodland, 350 BC-AD 950) predecessors (Gilliland and others 2009; Schambach 2001a; Trubowitz 1980, 1983). In the Lee Creek area, Hilliard (1986) found dominance (67 percent) of red/black oak species (*Quercus shumardii*, *Q. veluntina*, and *Q.rubra*) in archeological sites, with high frequencies of white oak species (*Q. alba*, *Q. stellata*) growing in the same area. General Land Office records dating to the early 19th century indicate an opposite trend, with 62 percent white oak group species and 38 percent red/black oak species (Foti and others 2007). Hilliard hypothesized the dominance of red/black oak species was due to human selection. Since red/black oaks germinate in spring and white oaks in the fall, white oaks are preferred by wildlife competitors, and are more susceptible to insect infestation. All oak acorns found in archaeological storage contexts had been scorched or parched to prevent insect infestation and germinated before the acorns were consumed. This same phenomenon could occur if Native Americans burned the woods during the fall, halting insect entry and allowing humans to more easily find acorns in forest litter; thereby out-competing wildlife such as turkey, deer, blue jay, squirrel, and passenger pigeon (Ellsworth and McComb 2003, James and Neal 1986) that feed on acorns. If humans did not collect acorns soon after they fell, competing wildlife, insects, molds, and unfettered germination would greatly reduce the amounts available for human consumption. Such adaptive use of fire is known to be used by the Cherokee Indians who collected large quantities of chestnuts (*Castanea* spp.) in this manner (Fowler and Konopik 2007). Life history studies of oaks point to fire adaptations with oak stand development dependent on advanced regeneration coupled with sprout-generated cohorts (Guyette and Dey 2004, Guyette and others 2004). It is possible that Native American agroforestry practices were based on similar observations.

Sabo and others (2004) estimate that an average community of 20 during the Archaic (7550-600 BC) would require 5 acres of openings in forest canopy for camps per 4.7 square mile catchment across the Ozarks (see also Lockhart and others 1995). By using these data, approximately 7,960 people occupied over 2,000 acres of camps on the Ozark National Forest (1.2 million acres). By the Woodland transition (600 BC-AD 600), with the use of adopted horticulture of native plants, Sabo and others (2004) estimate that an average community of 250 would require 62.5 acres of garden space per 4.7 square mile catchment. Using these data, an Ozark NF-wide population of 99,734 people farmed over 25,000 acres of gardens. With the development of sedentary agriculture ca. AD 600-1500, Sabo and others (2004) estimate an average community of 400 would require 125 acres of garden space per 4.7 square mile catchment. Using these data, a population of 158,200 people farmed over 376,000 acres of gardens (Fritz 1994) on the Ozark National Forest. However, these estimates do not include nut, animal, and plant food collecting across the landscape that may have included the broadcast use of fire. An estimated population of 2.26 people/square mile was present on the Ozark National Forest during the late prehistoric/protohistoric periods ca. AD 1500-1700 (Sabo and others 2004). During the historic periods, land was purchased in up to 160 acre grants by 40 ac parcels at $1.25/acre (Rafferty 2001), and the nature of the rectangular land surveys (AD 1815-1840) greatly affected the size and shape of farmstead allotments. Rafferty (2001) presents population data that indicates by 1930, the interior highlands of the Ozark-St. Francis National Forests (OSNF) were settled by 6-8 people/square mile, the lower Atoka Hills and Arkansas Valley by 18-45 people/square mi, and the St. Francis/Mississippi valley by 45-90 people/square mi. Using these data, in the uplands of the OSNF approximately 15,000 people were present, the Atoka Hills and Arkansas Valley had approximately 84,375 people, and the smaller St. Francis National Forest had 2812 people. Thus, during the early 20th century, from 8-20 times more people were present on the Forests than during the late prehistoric/protohistoric periods at or near the time of European contact.

Human use of fire is now receiving attention through the reconstruction of fire regimes by using dendrochronology for the study of fire-scarred trees. Clark and others (2007) found that the mean fire return interval for all fires from AD 1772-2002 was 2.0 years and 7.0 for moderate-scale (more than 25 percent of sampled trees have that fire-scar year) fires in the Cross Timbers of Oklahoma. Low intensity fires probably were not recorded as fire scars on oak trees unless there was a pre-existing wound on the tree (Clark and others 2007). This fire return interval decreased following Euro-American settlement of the area, probably due to heavy grazing practices (Lane 1939). Oak recruitment was also found to increase with shorter fire return intervals (Clark and others 2007). In the lower Boston Mountains of the Ozarks, Guyette and Spetich (2003) found that between the years 1670-2000, the mean fire return interval ranged from 4.6 years (1680-1820), to 3.1 years (1821-1880), to over 80 years (1921-2000). This trend was opposite that of Clark and others (2007) until 1921 and may be due to sampling vagaries, such as temporal factors and number of long-lived trees, and landscape differences, such as topography, slope, aspect, and local climate variability. Fire scar records indicate that between 1748-1881 (excluding those low intensity fires that may not have left tree-ring evidence), an area about the size of the Ozarks burned every 20 years under moderate to severe drought conditions (Guyette and others 2006, Spetich and He 2008), producing a mosaic of burned and non-burned areas due to topographic roughness, fuels variability, and localized conditions (Collins 1992, Frost 1995, Frost and others 1986).

## PREHISTORIC SITE DISTRIBUTIONS

Table 5 lists the Landtype Associations (Fig. 3) on the Ozark-St. Francis National Forests with the number of prehistoric and historic components in each. Examination of the topographic distribution (Fig. 4) of historic and prehistoric sites across all Landtype Associations on the Ozark-St. Francis National Forests reveals that relatively more prehistoric sites are found in the Floodplain, South Aspect Lower Slope, and South Aspect Middle Slope landtypes than historic sites. The south aspect is the most pyrogenic landtype in the Ozark Highlands. Relative frequencies are nearly identical in the North Aspect Upper Slope and North Aspect Lower Slope landtypes. Historic sites exceed prehistoric sites in the Ridge and Flat Upper Slope landtypes.

In addition to the frequency distribution discussed above, a component density value is calculated for each by dividing the various acreages surveyed within each LTA by the number of sites discovered. Five LTAs have the densest number of both prehistoric and historic sites; Boone Mountain Valleys, Lee Creek Limestone Valleys, White River Rolling Hills, Lee Creek Atoka Hills, and Mesic Limestone Mountain Valleys.

**Table 5.—Landtype Associations (LTAs) and Prehistoric and Historic Archeological Site Component Density Values (CDV) on the Ozark-St. Francis National Forests, Arkansas.**

| LTA | LTA Name | Acreage | Pre CDV | Hist CDV |
|---|---|---|---|---|
| 0 | Private | 8695.57 | 414.1 | 44.4 |
| 1 | Boone Mtn. Valleys | 739.15 | 369.6 | 24.6 |
| 2 | Mesic Limest. Mtn. Valleys | 5934.4 | 197.8 | 131.9 |
| 3 | Mesic Morrow Mtn. Uplands | 50935.72 | 134.4 | 125.5 |
| 4 | Mesic Atoka Mtn. Uplands | 37909.24 | 972 | 170.8 |
| 5 | Hale Mtn. Valleys | 32208.34 | 1073.6 | 187.3 |
| 6 | Bloyd Mtn. Valleys | 84279.92 | 726.6 | 233.5 |
| 7 | Atoka Mulberry Mtn. Valleys | 55574.1 | 805.4 | 243.7 |
| 8 | Lower Atoka Hills & Mtns. | 85770 | 779.7 | 196.3 |
| 9 | Arkansas Valley Hills | 12628.76 | 451 | 157.9 |
| 10 | Lee Creek Rolling Hills | 4036.12 | 807.2 | 36.4 |
| 11 | Lee Creek Atoka Hills | 18555.78 | 343.6 | 51.1 |
| 12 | Lee Creek Limest. Valleys | 2641.99 | 188.7 | 41.9 |
| 13 | Wedington Calc. Uplands | 1590.72 | 113.6 | 56.8 |
| 14 | Wedington Boone Hills | 12663.6 | 107.3 | 58.9 |
| 15 | Sylamore Boone Hills | 21256.27 | 250.1 | 110.7 |
| 16 | Sylamore Hills | 10904.09 | 340.7 | 139.8 |
| 17 | White R. Rolling Hills | 19649.74 | 194.6 | 99.2 |
| 18 | Magazine Rolling Valley Hills | 42387.45 | 399.9 | 129.2 |
| 19 | Magazine Valley Ridge | 13612.08 | 1944.6 | 349 |
| 20 | Magazine Valley Hills | 41403.76 | 828.1 | 221.4 |
| 21 | Magazine Mtn. Uplands | 5969.06 | 663.2 | 170.5 |
| 22 | Mississippi Bottomlands | 10539.3 | 619.9 | 107.5 |
| 23 | Crowley’s Ridge | 10350.8 | 2587.7 | 145.8 |
| 24 | Bear/Storm Ck. Lakes | 761.69 | 0 | 152.3 |

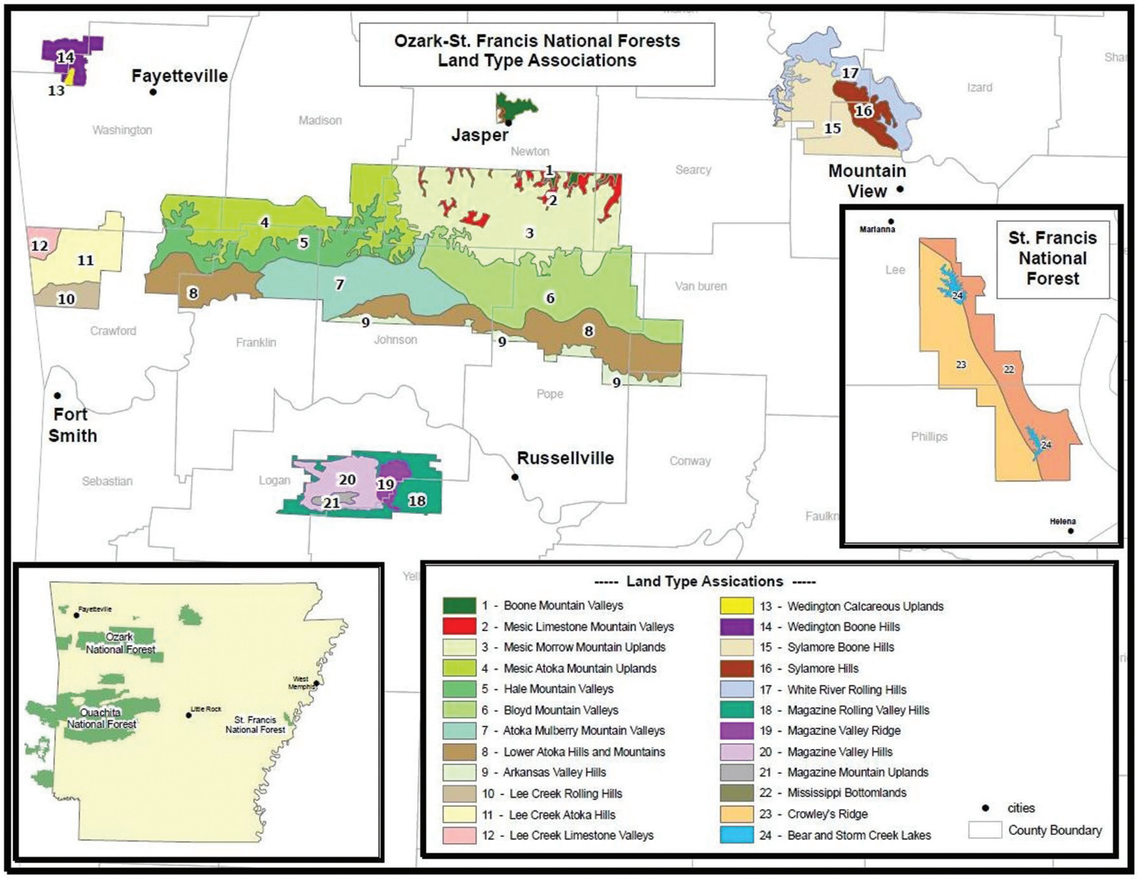


Figure 3.—Ozark-St. Francis National Forests Land Type Associations.

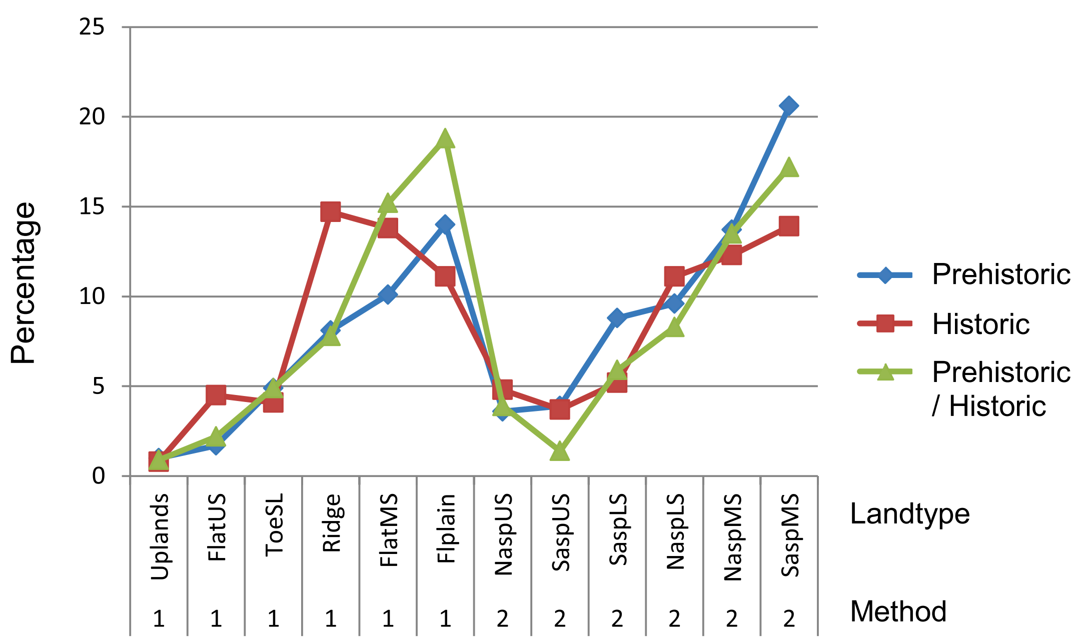


Figure 4.—Percentages of sites among landtypes on the Ozark-St. Francis National Forests. Landtype codes are: US = upper slope, ToeSL = toe slope, LS = lower slope, MS = mid slope, Flplain = Floodplain, Nasp = north aspect, Sasp = south aspect. Method: 1 = shovel probing, 2 = walkover survey.

The five LTAs with the densest prehistoric sites are Wedington Boone Hills, Wedington Calcareous Uplands, Mesic Morrow Mountain Uplands, Lee Creek Limestone Valleys, and White River Rolling Hills. This greater density correlates with the local prevalence of naturally occurring chert (Burlington/Keokuk/Cotter, Reeds Spring, and Pitkin) for manufacture of stone tools within or immediately adjacent to all of these LTAs. As noted earlier, the Wedington unit has extensive prairies dervied from the field notes and maps of the GLO surveys, with some prairies located on soils that developed under hardwood forest. Thus the LTAs with the highest density of sites are also the ones that have the most evidence of fire. The five least dense LTAs with prehistoric sites include Crowley's Ridge, Magazine Valley Ridge, Hale Mountain Valleys, Mesic Atoka Mountain Uplands, and Magazine Valley Hills. These areas lack local stone suitable for tool manufacture and lack readily available or permanent water sources. These areas also have the least evidence of fires, derived from the GLO field notes and maps.

The five LTAs with densest historic sites are Boone Mountain Valleys, Lee Creek Rolling Hills, Lee Creek Limestone Valleys, Lee Creek Atoka Hills, and Wedington Calcareous Uplands. The greater density correlates with more open woodlands and prairies, as well as dependable water flow in local streams and spring recharge rates. The five LTAs with the least dense historic sites include Magazine Valley Ridge, Atoka Mulberry Mountain Valleys, Boyd Mountain Valleys, Magazine Valley Hills, and Lower Atoka Hills and Mountains. These are the least arable LTAs with steep slopes, cobble-laden stream heads, and remoteness from established transportation routes.

## CONCLUSIONS

Fire is one of the oldest tools known to man and his relatives, dated in archeological contexts for *Homo erectus* to at least 780,000 years ago at Zhoukoudian Cave, ca. 48 km southwest of Beijing in China (Jia and Huang 1990). The contextual associations of man and fire at Zhoukoudian Cave are in dispute, with some insisting that lightning could have caused archaeological evidence for fire, therefore absolute proof of early man's deliberate manipulation of fire is still in question (James 1989).

The widespread use of nut (acorns, hickory, chinquapin/chestnut, walnut) resources in the eastern Woodlands in general, and the Ozark Highlands specifically, is evident in the archaeological records, written accounts, and land surveys. Mature oaks and hickories yield more mast than younger trees, and the seasonal use of fire to collect and preserve mast in quantities of chestnut suitable to feed large populations is known among the Cherokees of the southern Appalachians (Fowler and Konopik 2007). Based on the archeological evidence in rockshelters (Hilliard 1986), it is also highly likely seasonal fire was used by the Ozark Native Americans to collect and preserve oak as well. Fire was used to open grasslands and alter cover to increase nutrient cycling and also created the edge environment where prey could be concentrated. Canebrakes require periodic burning to maintain equilibrium and prevent floodplain canopy closure (Brantley and Platt 2001) and are an excellent example of high-yield, fire-adapted grasslands that are suitable for tools, fiber, food, and ceremonial use. Due to lack of fire in modern floodplain forests, cane is rapidly facing extirpation.

Although fire is a natural component of a disturbance regime in ecosystems of the Arkansas Ozarks, it appears that humans greatly extended the intensity and coverage of burns to collect and concentrate resources, beginning with hunter-gatherers and culminating with agriculturalists. This inference is based on the ethnohistorical evidence as well as direct archaeological evidence from dry rockshelter deposits, General Land Office field notes and maps, and dendrochronological evidence from fire-scarred trees for the Ozarks. It is now recognized that disequilibrium in ecological communities is more common than equilibrium (Pielou 1991). Healthy forests and ecosystems contain mosaics of stands at different ages and compositions, reflecting the vagaries of disturbances (Nelson 2005, Oliver and Larson 1996). Therefore, humans, and possibly ancestral humans, introduced disequilibrium into ecosystems with experiential knowledge designed to provide edge environments and maximize yields from hunting and gathering as well as incipient agroforestry.

The Native Americans of the Ozarks were historically seen as marginal participants in broader cultural developments. However, archaeological investigations have now covered a greater part of the region, and the marginality theme is now in question. During the earliest human occupations from ca. 18,000-6,000 YBP, population was low, but two important circumstances occurred that affected ecosystems: large herbivores became extinct, and prairies expanded from the Great Plains to the Ohio River. Several species of wild plants became domesticated ca. 4,200-3,000 YBP due to human manipulation, and intensive collection of other plants, including mast crops, indicate extensive agroforestry during this period.

The presence of Mesoamerican tropical plants such as maize (Sabo and Early 1990) and cotton (Horton 2008) in the Ozarks, and the distribution of large population centers indicate that ca. AD 1200-1500, an agricultural revolution did occur in the study area. The people of the Ozarks participated actively in regional exchanges and were not the conservative isolationists described in popular myth. Wild plant data (pollen, archaeological excavations, fire-scarred trees, and General Land Office records) from the Ozarks and Cumberland Plateau indicate genetic manipulation of a suite of species prior to the adoption of full-scale agriculture (Gremillion 1997). Native Americans in southeastern North America as early as 4000 BC had developed sophisticated knowledge of plants' life histories, and a form of agroforestry was developed to maximize the yield of oak (both regions) and chestnut (east of Mississippi River) for developing populations. In this paper, several types of proxy information are presented. However, three time capsules are noted where human consumption of fire-adapted species is clearly demonstrated. In one, the food items were taken from the intestines of a prehistoric woman. In another, food residues were identified from a single ceramic vessel. Finally, in the Marble Bluff seed cache, domesticated wild plants were clearly collected and stored for spring planting or consumption. In all three instances, all species are fire-adapted.

As a result of more intensive and extensive archaeological investigations, and the recordation of traditional Native American ecological knowledge, it is now recognized that most biotic communities are in a constant state of change due to natural and human-caused disturbances. In successional communities, it is necessary to manage the habitat to achieve stability or a desired stage of development (Anderson 2006). Fire use was the principal tool of Native Americans to achieve landscape scale modification of plant and animal communities.

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