THE FOREST AS A RESOURCE: FROM PREHISTORY TO HISTORY IN THE ARKANSAS OZARKS

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Abstract—Study of past human land use in the Lee Creek Unit of the Ozark National Forest challenges the existence of "pristine" forests predating the arrival of historic Americans. The distribution of early nineteenth century American settlements corresponds closely to the distribution of late prehistoric Native American archeological sites. One explanation for this finding is that pioneer American settlers occupied lands already altered by earlier Native Americans. To test this hypothesis, we used historical accounts and Geographic Information Systems approaches to develop a model of late prehistoric land use, emphasizing agricultural field clearing practices and wood consumption for building and fuel use. The extrapolated impacts of these Native American activities may well account for the forest environment encountered by historic American settlers. The major implication of this study is that long-term dynamics of forest ecosystems are best understood when human populations are included as components of those systems.

INTRODUCTION

Prehistoric Native Americans entered North America more than 12,000 years ago. Archeologists and paleoecologists have documented the important role Native Americans played in shaping forest ecosystems through use of fire, harvest of timber, tree stand management, plant domestication, and agricultural land clearing (Delcourt 1987, Denevan 1992, Hammett 1992). As a result, we now believe that European explorers entered environments already modified by native land use practices (Cronon 1983, Silver 1990).

Cooperative efforts by the Arkansas Archeological Survey and the Ozark-St. Francis National Forests begun in 1993 provide an opportunity to examine these issues in detail (Harmon and others 1997, Lockhart and others 1995). We discuss here research that addresses one issue in particular: How did prehistoric Native American land use practices impact Ozark forest ecosystems?

LEE CREEK STUDY AREA

Our study area in the Lee Creek Unit of the Ozark National Forest covers an area of approximately 404 square kilometers located in the Boston Mountains province of the Ozark Plateau (fig. 1). Narrow, V-shaped valleys bordered by steep slopes and vertical bluffs rise from clear, gravel-bedded streams. Flat ridge tops separate adjacent valleys. The vegetation today is upland hardwood dominated by oak and hickory with scattered pine and brushy undergrowth.

Lee Creek and its tributaries flow in a southwesterly direction from higher elevations in the northeastern corner of the study area. Valley bottoms are less than a kilometer wide. Sediments are thin and rocky, with narrow bands of moderately fertile soils extending along the streams. Bottomland floods create conditions suitable for limited agriculture.

ENVIRONMENTAL AND CULTURAL HISTORY

Three major climate events affected the region during the period of human occupation: (1) the Pleistocene/Holocene transition, which began about 12,000 years ago and brought an end to Ice Age conditions; (2) the mid-Holocene Climatic Optimum or Hypsithermal episode from 9,000 to about 5,000 years ago, during which warmer and drier conditions prevailed; and (3) the Late Holocene Neo-Boreal episode, which began about 500 years ago and brought cooler and less stable conditions. Tree rings studies indicate that our region experienced frequent and protracted drought conditions during the Neo-Boreal era (Cleveland and Stahle 1996).

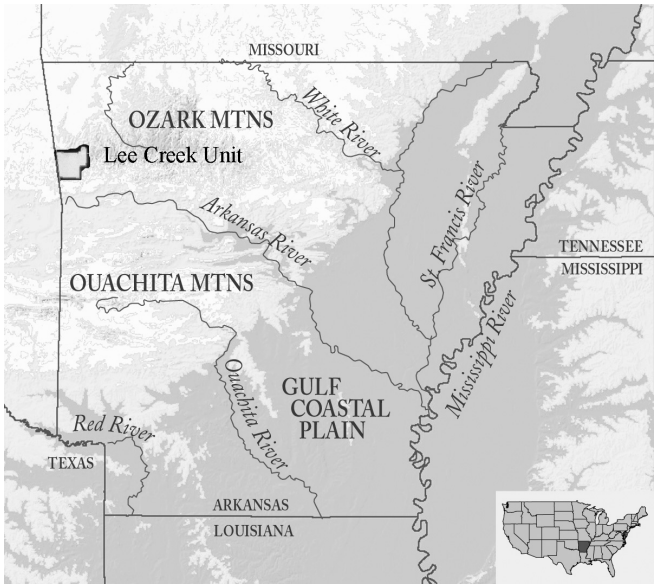

Figure 1—Location of the Lee Creek Unit.

Known archeological sites occur in our study area in sufficient number and distribution to permit study of prehistoric land use strategies, especially for the period covering the past 5,000 years (Harmon and others 1997, Lockhart and others 1995). Evidence from these sites and others located in the Pine Mountain area farther downstream (Raab 1976, Trubowitz 1980) makes it possible to identify general trends of prehistoric cultural development.

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The first human occupants of the Lee Creek valley arrived about 12,000 years ago, when a late Pleistocene spruce-jack pine boreal forest was giving way to an early Holocene oak-hickory forest (Delcourt and Delcourt 1981). The solitary archeological site dating to this era represents the presence of small groups of mobile hunters and gatherers who probably did not have much impact on local environments.

The region remained sparsely populated during the next few thousand years; only two sites have been discovered that date to the mid-Holocene era. The region had been encroached by open oak savannah when those sites were occupied (Delcourt and Delcourt 1981). Deer and other forest animals, fish and shellfish, birds, and wild plant foods including nuts, seeds, and fruits were the primary food resources supporting those groups. A slight increase in local environmental impacts probably resulted from the increased use of plant foods.

Native populations expanded after 5,000 years ago, as indicated by the presence of 48 sites in the study area that were occupied between 5,000 and 500 years ago. We recognize three types of sites: rock shelters (n=18) used for temporary camping, burial of the dead, and storage of perishable foodstuffs; small, special-purpose sites (n=15) located in a wide variety of settings; and residential sites (n=15) covering areas larger than 1,000 square meters that were occupied year-round by several extended families for long periods of time. The people who lived at these sites were engaged in the production of locally domesticated plants including lambs-quarters, little barley, knotweed, sumpweed, and several varieties of squashes. Corn, a tropical cultigen domesticated in Mexico, was also grown in small amounts. The advent of plant domestication, coupled with significant population growth, increased the level of human impact on the forest ecosystem.

Northwest Arkansas was part of the Osage Indian hunting territory during the late seventeenth and early eighteenth centuries. French hunters and traders entered the region toward the end of that period, and Euro-American settlement began after Fort Smith was built along the Arkansas River in 1817. A series of treaties signed during the following decade forced the removal of Native Americans from the region.

METHODS

Our investigation of the environmental impacts of past land use strategies in the Lee Creek valley involves three tasks: (1) creation of environmental models using Geographical Information System (GIS) techniques; (2) reconstruction of past land use strategies from archeological and historical evidence; and (3) analysis of the geospatial impacts of reconstructed land use practices on Ozark forest ecosystems.

Several environmental models were developed as GIS data layers for this project: elevation, slope, aspect, hydrography, soils, and line and witness tree locations recorded by nineteenth century General Land Office (GLO) surveyors. These initial models were used to create a series of derived products. Elevation and slope gradients and hydrography were used to create a terrain model based on a drainage class technique that specifies ten landforms. The addition of a fourth variable — aspect (defined in terms of four 90º quadrants plus a fifth category for flat surfaces) — yields an expanded model comprised of 50 landform classes. The accuracy of both models was confirmed through extensive testing in which the expected and actual distributions of several cultural and environmental features were compared (Lockhart and others 1995: 8-20). For the sake of simplicity, we use the ten-class model here (fig. 2).

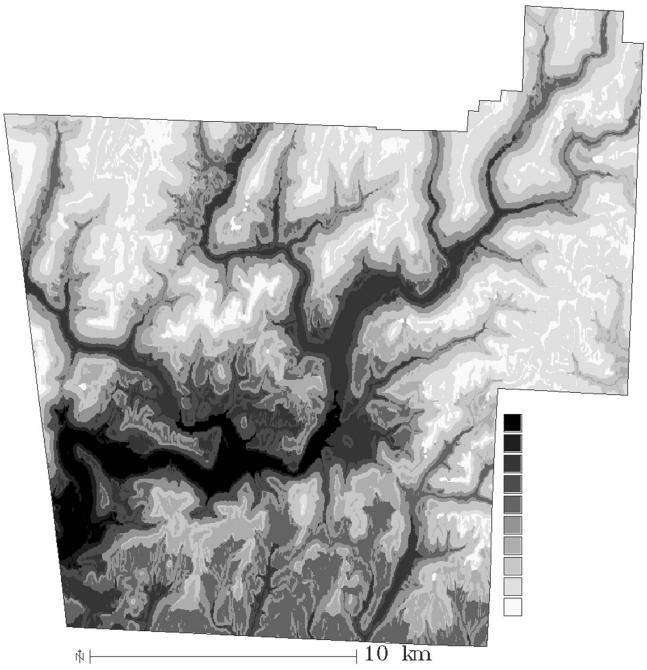

Figure 2—Terrain model for the Lee Creek Unit showing ten landform classes top to bottom: lower, middle, and upper stream floodplains; lower, middle, and upper stream slopes and bluffs; intermediate and high slopes and bluffs; intermediate and high flat uplands.

Analysis of archeological data within an “adaptation type” model provides a way to reconstruct ancient land use patterns with respect to past environmental features (Sabo and others 1989:1-2). These models define relationships that connect social, technological, and economic practices with the abundance, distribution, and predictability of environmental resources such as food and raw materials. Two prehistoric adaptation types are represented in the archeological data from the Lee Creek Unit: semisedentary hunting/gathering/gardening and semisedentary agriculture. In both of these models, local groups occupy year-round base camps, but part of the resident group spends part of each year engaged in seasonal subsistence pursuits elsewhere.

Geographical Information System applications are used to reconstruct the spatial impacts of past land use strategies on Ozark forest ecosystems. Here we illustrate the use of historical analogs and catchment analysis to estimate environmental impacts in the Lee Creek study area.

THE FOREST AS A RESOURCE

Let us turn now to an examination of three prehistoric land use practices to estimate their impact on Ozark forest environments.

The first practice is timber harvest for construction purposes. In excavated dwelling structures in northwest Arkansas, hardwoods such as red oak, white oak, and hickory were preferred for wall posts, which typically measured 10-30 cm in diameter. These structures average four to eight meters on a side and required about 50 stems for the walls, and half again as many stems for the roof timbers, interior roof supports, and interior bench supports.

Wood charcoal from archeological hearth features provides evidence of a second practice for firewood collecting. A breakdown by species of samples recovered from excavations at the Dirst site along the Buffalo National River reveals that oak species were by far the most preferred fuel woods, followed by sycamore, pine, hickory, and maple (Guendling and others 1992, Sabo and others 1990).

The advent of gardening and, later, more intensive field agriculture created a need for cleared areas, possibly in excess of land cleared through timber harvest and firewood collecting. We'll consider this hypothesis shortly.

How can we estimate the cumulative environmental impacts resulting from these three activities over several centuries of human occupation in the region? That is the question to which we turn next.

PREHISTORIC LAND USE IN GEOSPATIAL PERSPECTIVE

Since early historic Osage lifeways correspond to both of our target adaptation types, we can search historical records for useful analogs to the more ancient ecosystems.

Several visitors to Osage settlements during the early nineteenth century left observations indicating that wood, water, and fertile soils were important limiting factors in settlement location choices. For example, in 1819 Thomas Nuttall observed: "The river lands are no less extensive and luxuriant between the Verdigris and the Arkansa, and would apparently support a condensed settlement; but the prairies will only admit of settlements along their borders, in consequence of a scarcity of wood and water" (Nuttall 1999:211-12). Victor Tixier described an Osage village he visited in 1839: "Hunting lodges had been erected in a bend of the stream. Water and wood were near at hand" (McDermott 1940:159).

To quantify wood consumption and land clearing requirements, it is necessary to consider settlement population size. Here again, historical sources provide guidance. On December 30, 1819, Henry Rowe Schoolcraft happened upon three recently abandoned Osage hunting camps along Swan Creek in southwest Missouri, in an environmental setting similar to the Lee Creek Valley. Schoolcraft described these camps as "all very large, arranged with much order and neatness, capable of quartering probably 100 men each" (Rafferty 1996:78). Using a conservative 1:4 ratio of hunters to overall population, we estimate a group size of 400 individuals. A similar contingent of Little Osages encamped near Fort Osage along the Missouri River were living in 60 lodges "circular in form, not more than ten or fifteen feet in diameter" when they were visited in 1811 by Henry Marie Brackenridge (Brackenridge 1814:217). These numbers suggest that each family of 4-8 members occupied its own lodge. The total floor area of those lodges, estimated at 480 to 985 square meters, could be accommodated at our large open archeological sites in the Lee Creek study area.

Since Lee Creek is narrower than the Verdigris and Missouri Rivers along which Nuttall's and Brackenridge's observations were made, we need to evaluate the 400-person village size in relation to estimates of regional population densities. For the early historic era, these range from 0.05 and 0.64 persons per square kilometer (Guyette and others 2002). These densities translate to a range of 20 to 259 people for our study area. The late prehistoric population in the Lee Creek valley undoubtedly was distributed among several settlements, so the existence of 15 large, permanent settlements is consistent with the higher population density figure, considering the likelihood that only a few of those sites were occupied simultaneously. Furthermore, the Native American occupants of that area made seasonal visits to other areas, such as the prairie-plains region to the west, for economic activities that included hunting buffalo. These considerations suggest that our study area probably was "home" at any particular time to several extended families representing a total population of no more than 250 people. The use of conservative wood consumption and land clearance estimates is appropriate in view of seasonal fluctuations affecting the resident population size.

What was the annual timber consumption of this community? Unfortunately, our otherwise keen observers of nineteenth century Osage village life fail us on this question, necessitating an appeal to other sources of information. Robert Heizer's (1963) calculation of 83 pounds of wood per family per day for Native Americans living in northern California (where comparable annual temperature ranges prevail and where hardwoods were likewise the major fuel source) provides a yearly per capita figure of 2.3 tons that seems reasonable for our study area. From this, the annual firewood requirement for 250 people is calculated at 575 tons. Using U.S.D.A. figures of ten cords of mixed hardwood per acre and with each cord weighing about 1.5 tons (Graves 1919), our 575 tons represents the timber resources of roughly 38 acres.

How much wood was required for construction and for manufacture of other items? If each dwelling required about 75 stems (adding roof and bench supports to the 50 wall stems mentioned previously), then the 40 structures required to shelter 250 people would consume about 3,000 stems. Using modern figures from the Lake Winona Research Natural Area in Arkansas, timber of 10-30 cm diameter in this quantity would clear an additional 12 – 15 acres at 250 stems per acre, more or less (Fountain 1991). These structures, however, would not need to be replaced every year. French colonists at Arkansas Post complained in the early eighteenth century that wall posts set into the damp, frequently flooded sediments of eastern Arkansas had to be replaced every eight to ten years, so we can estimate that the wall posts of structures built along Lee Creek would last at least that long. Even with additional timber requirements for ancillary structures, dugouts, and

other items, the total quantity of timber required for construction and manufacturing represents but a small fraction of the annual firewood requirement. We therefore decided to use the 575-ton figure as a conservative estimate of total annual wood needs for all purposes.

The area of Ozark forests impacted by this magnitude of wood harvest can be calculated through site catchment analysis. That is, an occupied settlement has a surrounding "catchment area" from which residents harvest resources like firewood. The overall dimensions of site catchments are usually set in relation to the maximum distance people are willing to travel to acquire those resources. How far were Osages willing to walk to collect firewood? Again, our keen observers don't provide exact figures, but in 1819 Thomas Nuttall accompanied an Osage hunter "about 9 or 10 miles over the alluvial lands of the Grand river" (Nuttall 1999:211). They were not burdened by heavy loads of firewood, but it would be unwise to underestimate the capacity of Osage women who, according to Nuttall, were "accustomed to perpetual drudgery," and were "stouter and lower in stature than the men" (Nuttall 1999:216). Still, it seems unlikely that the range for firewood collecting would have extended beyond one-third of the range of fast moving hunters. A 5-kilometer catchment area surrounding each Lee Creek settlement seems reasonable in view of these considerations, and is consistent with worldwide ethnographic data on human foraging ranges.

A second issue concerns the overall shape of the catchment area. Most applications use a "concentric circle" approach, which assumes that a person can move with equal ease in every direction. That is not the case in the highly dissected Ozark terrain of the Lee Creek valley. Our solution involves defining catchments in relation to estimated travel costs, where costs accumulate in relation to incremental increases in the slope angle of the ground. Put simply, it is more difficult or "costly" to travel up (or down) a steep slope than it is to travel across flat land.

Catchment areas were calculated for three of the large, open sites in the Lee Creek Unit. All of the Late Holocene semisedentary sites (representing both hunting-gathering-gardening and agricultural adaptation types) occur on the lower and middle stream valley classes of our terrain model. Therefore, we selected one site from the lower stream valley class, a second site from the middle stream valley class, and a third site from the boundary where these two units join.

The areas encompassed within 1-, 3- and 5-kilometer catchments surrounding these sites are shown in figure 3 (see also table 1). These catchments yield fairly consistent estimates on the availability of local wood supplies: the 1-kilometer catchments contain less than four years' supply, the 3-kilometer catchments expand the supply to one or two decades, and the 5-kilometer catchments contain timber sufficient to meet demands for roughly four decades, or about two generations.

We are not suggesting, of course, that Native American groups in the Lee Creek valley were clear-cutting 38 acres of timberland per year. More likely, they were cutting some trees to acquire building timbers and wood for other manufacturing purposes (i.e., dugouts), collecting deadwood to use as fuel, and culling both young and old trees from nut tree groves to increase the room for crown breadth development of productive middle-aged trees – thereby producing additional firewood supplies. The immediate result of these activities was thinning of local tree stands, but over several years cleared areas were likely produced, especially in the bottomlands surrounding larger settlements. The number and distribution of large open sites in our study area therefore probably represents a series of generational relocations

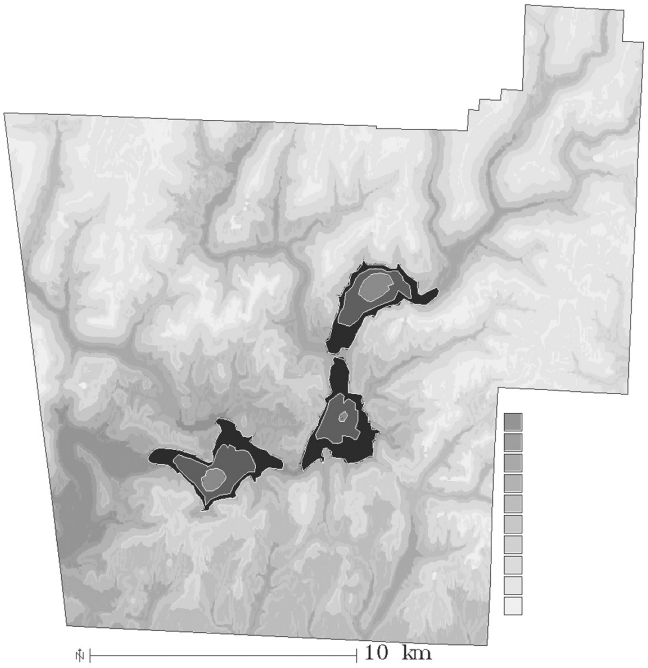

Figure 3—Catchment areas for three archeological sites in the Lee Creek Unit calculated in relation to travel cost surfaces. The light gray (smaller) areas represent 1-km catchments, the intermediate gray areas represent 3-km catchments, and the dark gray (larger) areas represent 5-km catchments.

Table 1—Catchments and estimated wood supplies for archeological sites in the Lee Creek Unit

Site	Catchment range	Area	Wood supply
	km	*acres*	*years*
3CW42	1	133.3	3.5
	3	832.2	21.7
	5	1,675.9	43.7
3CW119	1	15.8	< 1.0
	3	512.7	13.4
	5	1,521.3	39.7
3CW132	1	216.3	5.6
	3	785.9	20.5
	5	1,499.0	39.1

prompted by exhaustion of local wood supplies within adjacent catchment areas. The distribution of these sites in addition to the time span they represent (roughly 4,000 years) further suggests a cyclical pattern of movement in which abandoned sites were reoccupied following reestablishment of forest vegetation.

Under a hunting, gathering, and gardening economy, requirements for cleared land would be modest; a figure of 0.25 acres per person per year is a reasonable approximation. At this amount our 250-person community might require as much as 62.5 acres of garden space. With the emergence of more intensive field agriculture, cleared land requirements in the Lee Creek valley, as elsewhere in eastern North America, increased to something on the order of 0.5 acres per person per year. This produced an overall requirement for as much as 125 acres of croplands, coupled with an increased rate of soil exhaustion.

To determine annual requirements for cleared land, we also need to consider the effects of field rotation. We can never be certain about prehistoric rotation cycles; however, many Southeastern and Southern Plains groups shifted to new fields after old ones had been used for about five years (Moore 1987:143-44, Silver 1990:50-51). If one of every five fields were rotated in this manner in any given year, then old fields would have at least a 25-year recovery period – a time interval during which trees would grow to about the right size for use in dwelling construction but would not have grown so large that they would be difficult to remove (Silver 1990:50). At this rate, annual field expansion requirements would range from roughly 12.5 acres (gardening) to 25 acres (agriculture) per year. If these estimates correspond to prehistoric circumstances in the Lee Creek valley even approximately, then the annual requirement for newly cleared lands for either gardening or field agriculture would fall well within the annual amounts of land from which firewood was collected.

In sum, these estimations suggest that firewood collecting by the late prehistoric occupants of the Lee Creek valley produced the single most extensive impact on local forest resources. Garden and agricultural field production were probably embedded within the areas cleared as a result of timber harvest and firewood collecting. The calculated catchment areas suggest that wood supplies were obtained from the bottomlands, terraces, and adjacent hill slopes along Lee Creek. Over several generations, a community of 250 persons would have cleared extensive tracts of bottomlands in an area the size of the Lee Creek Unit, even with cyclical return to favored sites.

FROM PREHISTORY TO HISTORY

The extent of prehistoric land clearance reconstructed here suggests that Euro-American settlers entered Ozark forests that were already modified by previous groups of Native Americans, who had been living in the region for many thousands of years. Plotting the locations of the first white settlements on a map along with the late prehistoric sites provides additional support for this suggestion (fig. 4). The major implication of this study is that long-term dynamics of forest ecosystems are best understood when human populations are included as components of those systems.

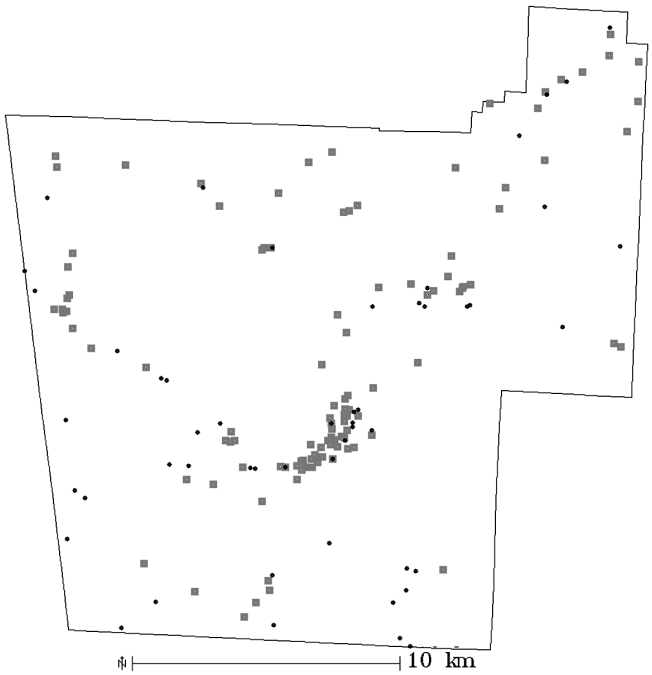

Figure 4—Late prehistoric Native American sites (gray squares) and early historic Euro-American sites (black circles) in the Lee Creek Unit.

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