

Archaeology, Paleoecosystems, and Ecological Restoration

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Archaeologists have long been interested in the role the physical environment played in structuring the activities of prehistoric human groups. More recently, research has begun to shift toward the role of humans as active participants in paleoecosystems. This move toward paleoecology has not signaled an abandonment of traditional research questions having to do with humans and their environment—why groups lived in certain locales and not others; why they selected certain foods over others; and why they chose particular raw materials for their clothing, tools, and weapons. It has, however, signaled an end to the centuries-old belief in environmental determinism.

Despite this trend, paleoecological research is still an undercurrent in terms of actual archaeological practice. Although modern archaeologists are more familiar with paleoecology than their predecessors were, today's "ecologically oriented" archaeological applications are often based on methods more than on anything else. With a few exceptions—for example, the earlier work of Kent Flannery (1968) on systems theory and, later, the work of human evolutionary ecologists (Bettinger 1991; Kelly 1995)—theoretical work on such topics as grain response (MacArthur and Pianka 1966; Pianka 1974), patchiness (Wiens 1976), and central-place foraging (Orians and Pearson 1979) have not had the kind of impact in archaeology that one might have hoped.

One reason archaeologists fail to connect their studies of paleoenvironments to paleoecology is because of the difficulty inherent in reconstructing historic settings. Archaeologists are aware that attempts to understand both the paleoenvironment of a specific locality or region and how that environment influenced the actions of organisms living in it are difficult endeavors because environments change, and the rate and

magnitude of change are never constant. They realize that, in the end, the best we can hope for are environmental snapshots taken at different times. If the data permit, we can stack those snapshots to create a moving picture, but we have to be honest about what it is that we have created—a jerky composite consisting of a set of still photographs taken at arbitrary points along a continuum. We might speak colloquially about having “reconstructed” paleoenvironments, but we need to keep in mind that we haven’t reconstructed anything. What we have done is to model paleoenvironments using available evidence, and, as we all know, models are merely educated guesses about how things might have been. On the positive side, the more lines of corroborating evidence there are, the more refined the model will be.

My goal in this chapter is threefold: (1) to present a brief overview of how archaeologists have adopted changing perspectives on human-environment interactions; (2) to discuss the sources of environmental information of which archaeologists routinely make use; and (3) to indicate some of the ways in which theoretical issues can be integrated into paleoecological research.

Human-Environment Interactions

Despite an early recognition of the importance of the environment and its effects on humans, archaeologists were for the most part slow to recognize the intricacies of human-environment interactions. Throughout the late nineteenth century and well into the twentieth century, most archaeologists were environmental determinists, viewing human actions simply as automatic responses to what the environment allowed (Wissler 1926). At an elementary level, the environment is deterministic—you can’t, after all, grow corn at the North Pole—but to suggest that a particular environment triggers automatic, predictable responses on the part of any animal, particularly humans, is short-sighted. All organisms modify their environments—some in more dramatic fashion than others—and most enjoy a kind of phenotypic plasticity that allows them to escape sudden and automatic extinction in the face of environmental change.

By the 1950s, a significant portion of the discipline of archaeology had pushed aside the doctrine of environmental determinism of earlier decades. Archaeologists began leaning heavily on one of two sets of ideas: (1) environmental “possibilism”—a kind of indeterministic process in which the physical environment was seen not so much as determining cultural outcomes but as setting limits on cultural development; or (2) the cultural ecology of anthropologist Julian Steward (1949, 1955), which held that certain relational links between technology and environment, regardless of geographic locale, created similar cultural outcomes.

Included in the list of topics addressed in archaeological reports of the 1950s were the physiographic and geological setting of the locale, hydrologic resources, vegetation, climate, soils, and often the fauna native to the locality under investigation. However, those reports failed to consider both the changes that had taken place in the physical environment and any concomitant changes in human populations due to those changes. Lack of attention to those changes meant that the environment was really being viewed as a static backdrop against which human interactions were carried out. The lack of integration between archaeology and paleoecology was one of archaeologist Walter Taylor's major complaints in his 1948 summary of the state of the discipline. His (1957) report to the National Research Council's Committee on Archaeological Identification called for closer coordination of work between archaeologists and paleoenvironmentalists. The 1960s witnessed phenomenal growth in large-scale archaeological survey-and-excavation projects in the Near East, a significant number of which were directed by Robert J. Braidwood, Robert McCormick Adams, and their students (Adams 1962, 1965; Braidwood 1958, 1960; Flannery 1965; Hole 1966; Hole, Flannery, and Neely 1969; Kraelin and Adams 1960). These interdisciplinary archaeological studies, which focused on the physical environment and its role in the development of settled life, agriculture, and eventually urban areas, led to a series of conceptual changes in how archaeologists approached the topic of human-environment interactions. They spawned a whole new generation of similar studies in semiarid regions of the New World, such as Highland Mexico (Byers 1967; Flannery 1966, 1968; MacNeish 1964; MacNeish, Nelken-Terner, and Johnson 1967; MacNeish, Peterson, and Flannery 1970; MacNeish, Peterson, and Neely 1975). These studies became models both for later archaeological projects carried out in the United States (O'Brien, Warren, and Lewarch 1982) and for the currently emerging discipline of historical ecology (Crumley 1994; Balée 1998).

Sources of Environmental Information

One of the obvious problems facing archaeologists interested in understanding how aspects of the physical environment have changed through time is locating the data necessary to pinpoint the changes. The basic mechanics of landscape evolution became well known by the middle of the nineteenth century, at which time it became evident that the North American continent had undergone successive climatic changes, including periodic "ice ages." One of the burning issues of nineteenth-century prehistory was whether Ice Age humans had been present to hunt the megafauna, especially mastodons and mammoths, that amateur prehistorians had recovered from mid-continental bogs (O'Brien 1996). By the

late nineteenth century the issue had been expanded as archaeologists attempted to determine whether there had been a North American Paleolithic period (Meltzer 1983, 1985) similar to that in Europe.

Answers to many of these questions came with the development of radiocarbon dating in the late 1940s (Marlowe 1999). We often think of radiocarbon dating as being solely the province of archaeologists, but its development was also a boon to paleoclimatologists, who could then date their pollen sequences and, like archaeologists, begin to focus on finer and finer units of time. It no longer was enough to place a terminal date on the last glacial episode and then to lump the last ten thousand or so years into a single unit. Through the use of radiocarbon dating, it became clear that the Holocene had witnessed considerable climatic variation and that if the proper data were available, the period could be subdivided into finer units of time.

Archaeologists quite naturally were interested in such research because the data would allow them to understand something of the past environments in which their subjects had lived. Some of the earliest work on paleoenvironments of the terminal Pleistocene and early Holocene (ca. 30,000–7,000 B.C.) was done in the western United States and the Mississippi River alluvial valley. Research done in various parts of the West, including the Rocky Mountains (Matthes 1951), the Great Basin (Antevs 1948; Heizer 1951), the Southwest (Bryan 1950; Sayles and Antevs 1941), and the Great Plains (Antevs 1950; Moss 1951; Schultz, Lueninghoener, and Frankforter 1951), incorporated a variety of data such as rates of varve buildup (Antevs 1950), cross-correlation of terrace sequences (Moss 1951), sediment analysis (Heizer 1951; Sayles and Antevs 1941; Schultz, Lueninghoener, and Frankforter 1951), the positioning of glacial moraines (Antevs 1950; Matthes 1951), and floral analysis (Schultz, Lueninghoener, and Frankforter 1951). Many of the paleoclimatic interpretations that grew out of this early research are now outdated, but what is important is that by 1950 archaeologists had begun to team up with geomorphologists and paleoclimatologists in an effort to document the myriad landscape and climatic changes that various localities had witnessed during the terminal Pleistocene and the Holocene.

Farther east, most of the work carried out in the Mississippi River alluvial valley—that portion of the valley from near Cairo, Illinois, to the Gulf of Mexico—was by Harold Fisk (1944) and those influenced by him (Saucier 1964, 1968). Fisk realized that the Mississippi Valley contained a chronicle of geomorphological responses to changing Tertiary and Quaternary climatic episodes that had affected the North American continent. His goal was to reconstruct the history of landscape development, especially during the terminal Pleistocene and Holocene epochs.

Archaeologists (Ford, Phillips, and Haag 1955; Phillips, Ford, and Griffin 1951) viewed Fisk's development of a relative chronology as a boon to their own work because it gave them another way to date their study sites. Although subsequent work, primarily by Roger Saucier (1974, 1968, 1981) and P. D. Royall and his colleagues, Paul and Hazel Delcourt (1991), has shown Fisk's chronology to be grossly inaccurate and flawed in terms of his postulations about the magnitude of certain processes, the importance of his work is unquestioned. He was the first researcher to tie the landscape evolution of the alluvial valley to climatic change and to the corresponding rates of water and sediment discharge in the upper reaches of the Mississippi system.

The region in which Fisk was working—an active floodplain setting in humid, mid-continental North America—was not comparable to western North America. In fact, many of the problems that Fisk encountered in his attempt to document the evolution of the Mississippi alluvial valley would have been foreign to researchers such as Ernst Antevs (1948, 1950), who was doing the same kind of work but in more stable environments. Thus it is quite understandable that the majority of paleoenvironmental research conducted in the 1940s and 1950s took place in the West (Bryan 1950; Heizer 1951; Matthes 1951; Moss 1951; Schultz, Lueninghoener, and Frankforter 1951).

Sustained interest in the Holocene climate and its relation to other aspects of the midwestern physical environment dates at least to the 1950s. Archaeologists viewed the upper Midwest, in particular, as an excellent laboratory for the study of environmental change because of its unique vegetational composition—a mixture of forest and prairie—with the specific makeup depending on location within the region. Stretching eastward from the Great Plains to central Indiana is a complex mosaic of tallgrass prairie and deciduous forest known as the Prairie Peninsula (Transeau 1935; Küchler 1964, 1972) (figure 1.1). The peninsula of interdigitating fingers of prairie upland and forested river valleys formed early in the Holocene and throughout its history has been vulnerable to climatic change. This vulnerability shows up in the pollen record and in such things as soil composition, valley-fill sequences, and archaeological site locations.

In 1955, W. H. Horr completed the first boreal pollen record in the mid-continent at Muscotah Marsh in northeastern Kansas (see also Wells [1970], who identified the pollen as being from spruce). The zone containing the boreal pollen was subsequently dated to $13,000 \pm 1500$ B.C. Here was evidence that during the close of the Pleistocene, spruce forests had grown where now there were tallgrass prairies. By the 1960s, pollen studies from other parts of the Midwest supported the long-held proposition that

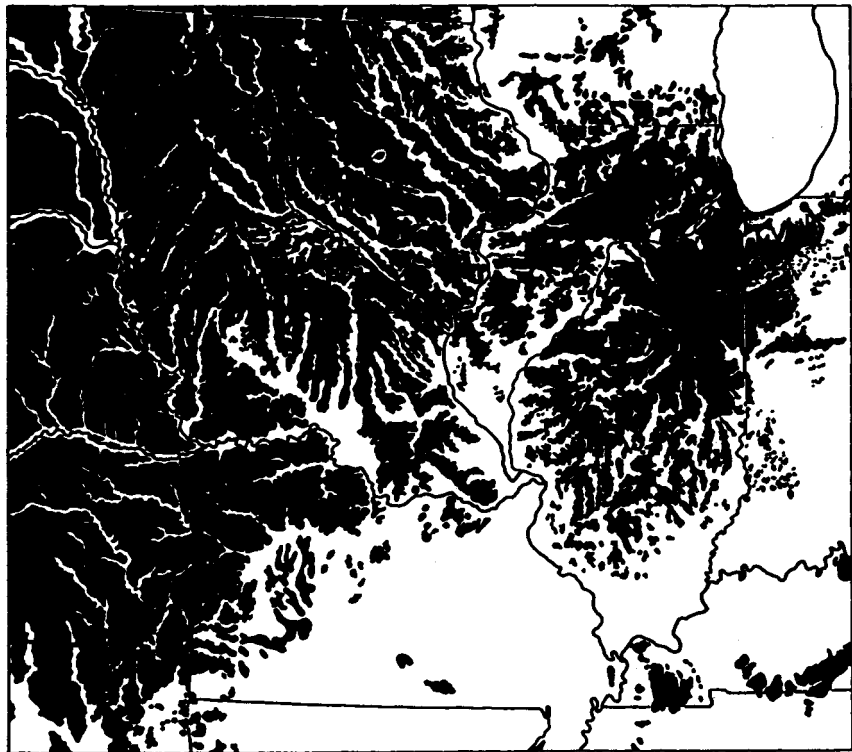


Figure 1.1. Map of the mid-continent Prairie Peninsula showing the interfingering of grasslands (black) and deciduous forests (white) (after Küchler 1964, 1972; Transeau 1935; from Warren 1982a).

boreal forests had been far south of their current latitudes during the terminal Pleistocene, and that, as these forests retreated northward with a rise in temperature, they were replaced in some areas by hardwood forests and in other areas by prairies. What happened next—that is, how climate changed throughout the Holocene—was open to question.

In 1960, James B. Griffin advanced the notion that climatic change contributed to the growth and decline of some northern prehistoric cultures through its effects on their crop cycles (Griffin 1960). The importance of that paper was not whether Griffin was correct (we now know that the situation was much more complex than he suspected) but that he tied the disappearance of a major Native American culture, termed Hopewellian by archaeologists and dating roughly A.D. 1–200, to climatic change.

This examination of the nature of the relation between climate change and human settlement and subsistence practices was the basis for a long-term study of late-ceramic-period cultures in the upper Midwest. It

was titled "Climate, Ecology, and the Oneota Culture" and was done under the direction of archaeologist David Baerreis of the University of Wisconsin–Madison. That National Science Foundation–supported program involved intensive study of archaeological materials from Oneota and Mill Creek culture sites in Iowa, Missouri, Minnesota, extreme southeastern Nebraska, and western Wisconsin. It also involved studies of paleoclimatic indicators such as plant and animal remains, snails, and pollen. Baerreis's collaboration with climatologist Reid Bryson of the University of Wisconsin–Madison produced a series of reports and monographs (Baerreis and Bryson 1965, 1967; Bryson 1966; Bryson, Baerreis, and Wendland 1970; Henning 1970) that modeled Holocene climate in the upper Midwest and examined the archaeological record, especially the late portion, in terms of the documented changes in climate (see also Bryson [1966] and Bryson and Wendland [1967]). The site-specific analyses built on work that was more regionally extensive (Borchert 1950; Deevey and Flint 1957; Wright 1968) and produced a concise set of data that would repeatedly be incorporated into later work in the Midwest (Baerreis, Bryson, and Kutzbach 1976; Webb and Bryson 1972; Wendland 1978; Wendland and Bryson 1974).

As a result of numerous palynological and sedimentological analyses, paleoclimatologists (Bryson, Baerreis, and Wendland 1970; Bryson and Wendland 1967; Wendland 1978, 1995; Wendland and Bryson 1974) isolated ten postglacial climatic episodes, each of which affected portions of the Midwest, though the effects often differed substantially from area to area. Four episodes are of concern here: the pre-Boreal, dating between about 8050 B.C. and 7550 B.C., the Boreal (7550–6550 B.C.), the Atlantic (6550–3050 B.C.), and the sub-Boreal (3050–850 B.C.). These are shown in figure 1.2 along with generalized climatic conditions, vegetational changes, and cultural periods. Some of the general climatic trends that characterized these episodes can be extrapolated to regions outside the Midwest, but the magnitude of the trends is uncertain.

The boundary between the pre-Boreal and the Boreal is difficult to pinpoint because of the numerous continuities that carried over from one period to the other. By 8050 B.C. much of the Midwest contained essentially modern assemblages of plants and animals, which continued to extend their ranges throughout the Boreal. The slightly cooler and moister climate during the Boreal, which was extremely localized, may have allowed for the return of some more northerly plants and animals into portions of the upper Midwest, but on a regional basis the climate was becoming slightly warmer and drier. In Missouri, for example, grasses predominated in northern and western parts of the state; oaks (*Quercus*) and hickories (*Carya*) in the Ozark Highlands; oaks, hickories, ash

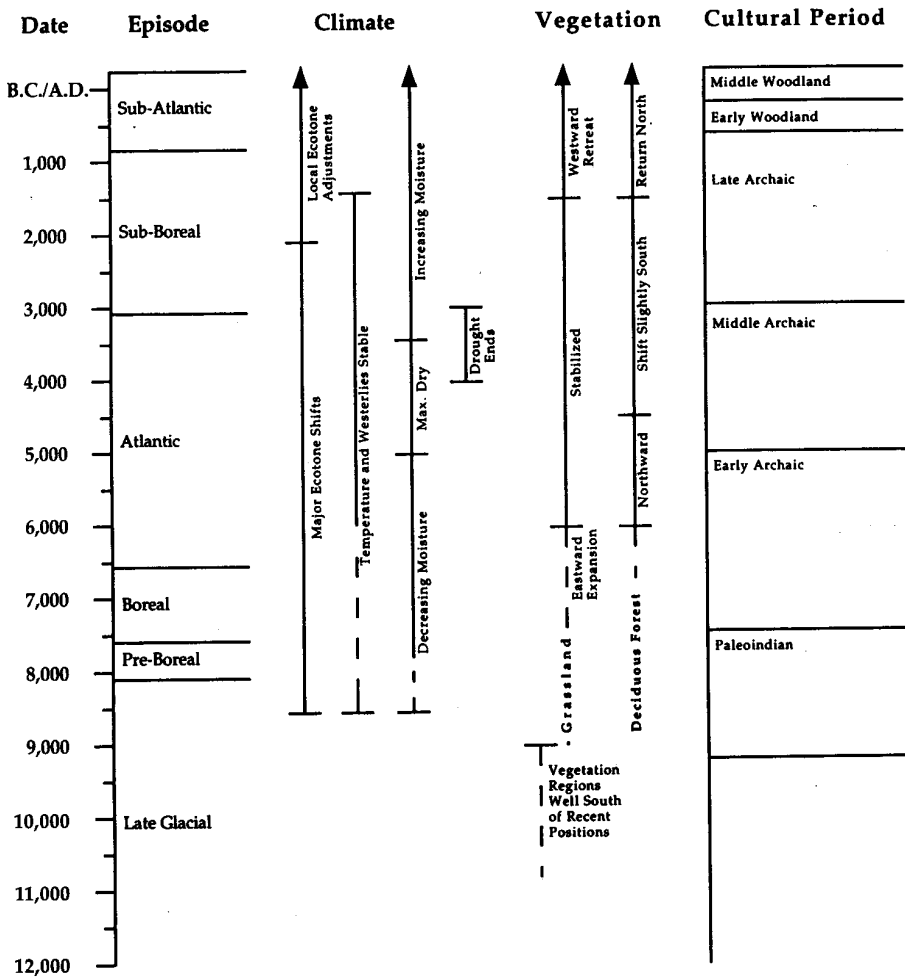


Figure 1.2. Chronological correlation between climatic episodes (left-hand column) and archaeological periods (right-hand column) between 12,000 B.C. and A.D. 250, along with generalized climatic conditions and vegetational changes (modified from Teter and Warren 1979).

(*Fraxinus*), elm (*Ulmus*), and maple (*Acer*) in the river valleys; and a host of water-tolerant species in the Mississippi alluvial valley.

An increased flow of dry, westerly winds in the Pacific air mass allowed prairie grasses to expand eastward from the Great Plains in a broad bisecting wedge that may have reached Missouri sometime around 7000–6550 B.C. Grasses took over the rapidly drying uplands, whereas forests retreated toward relatively moist positions along stream courses and sloping valley sides. This was the beginning of what has been referred to variously as the *Hypsithermal* (Deevey and Flint 1957), the *altithermal*

(Antevs 1948, 1950), and the *xerothermic* (Sears 1942)—a climatic event that began during the Boreal episode and reached its peak during the Atlantic episode.

Our earliest knowledge of the effects of this mid-Holocene warming and drying period came from pollen cores taken from upper-midwestern localities in South Dakota (Watts and Bright 1968) and Minnesota (McAndrews 1966; Winter 1962). These cores consistently demonstrated a decrease in tree pollen and an increase in herb pollen between about 6000 B.C. and 2000 B.C. Wright (1968) calculated that the prairie-forest ecotone in western Michigan might have moved northeastward by as much as seventy-five miles during that period. The height of the dry period in the upper Midwest appears to have occurred about 5000 B.C. (Webb and Bryson 1972; Wright 1971).

As James E. King and Walter Allen (1977) point out, there were as recently as two decades ago few pollen records for mid-Holocene vegetation and climatic change in areas south of the northern border of the Prairie Peninsula. Fortunately, spring bogs and swamps have begun to yield relatively long pollen sequences, and we now have a sample of data points from southeastern Missouri and northeastern Arkansas from which to examine the effects of the Hypsithermal on vegetation in the Mississippi alluvial valley. These include Powers Fort Swale (Royall, Delcourt, and Delcourt 1991) and Old Field (King and Allen 1977) in southeastern Missouri (see figure 1.3 for locations); and Big Lake (Guccione, Lafferty, and Cummings 1988) and Pemiscot Bayou (Scott and Aasen 1987) in northeastern Arkansas. They tell a tale of climatic variation similar to that of their northern counterparts. However, these cores do provide evidence that the xeric (dry) conditions evident over much of the Midwest during the Hypsithermal might not have been as drastic in the meander-belt portion of the Mississippi alluvial valley.

Another line of evidence for the effects of mid-Holocene climate on the Midwest is contained in sedimentological analyses. For example, it appears that there was a dramatic decrease in sediment size in Powers Fort Swale between 7550 B.C. and 2550 B.C., to the point where the percentage of clay fraction increased 31 percent from the early Holocene to the mid-Holocene. The changeover to clay particle dominance occurred at around 4650 B.C. (Royall, Delcourt, and Delcourt 1991), which is near the midpoint of the Atlantic episode. I interpret the decrease in grain size as reflecting the peak of the Hypsithermal, when little or no water was entering Powers Fort Swale and clay particles previously held in suspension began to be deposited as the water level in the swale fell. This phenomenon corresponds chronologically with the decrease in surface area of the Old Field swamp (King and Allen 1977) and was roughly contemporary with similar phenomena elsewhere in the Midwest. For example, a

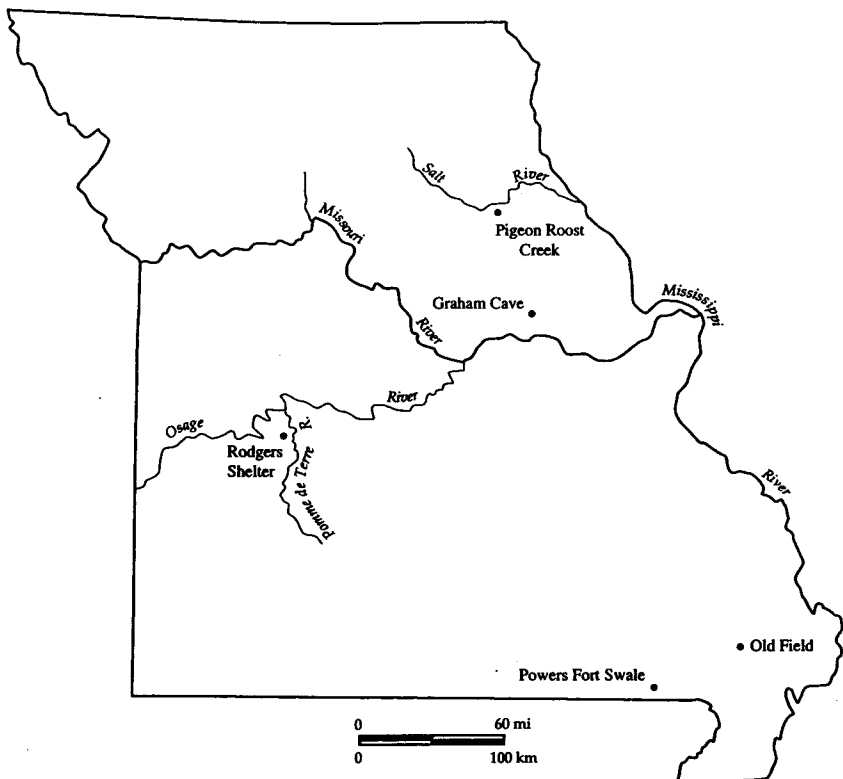


Figure 1.3. Map of Missouri showing locations of archaeological sites and pollen records.

decrease in stream discharge occurred in Illinois and Missouri (Hill 1975; Klippel, Celmer, and Purdue 1978), and a drop in lake levels occurred in Iowa and Minnesota (Brugman 1980; Van Zant 1979).

The death of mesic forests as a result of the onset of mid-Holocene drying could have led to increased wind erosion in certain areas. Stanley Ahler (1973, 1976) postulated that this occurred on the hillslopes around Rodgers Shelter, a stratified archaeological site in Benton County, Missouri (figure 1.3). Similarly, it is possible that some or all of the prairie mounds that dot the western lowlands along the Black and St. Francis Rivers (O'Brien, Lyman, and Holland 1989) were formed during the Hypsithermal as accumulations of windblown sediments derived from the Ozark Escarpment.

Some of the climatic trends mentioned above are mirrored in sources of data other than those from pollen and sediment profiles. For example, based on both the relative abundance of various grassland animal

remains—bison, pronghorn, prairie chicken, jackrabbit, spotted skunk, badger, and plains pocket mouse—in the mid-Holocene levels of Rodgers Shelter, Bruce McMillan (1976) proposed that prairies had pushed as far eastward as the Pomme de Terre River valley by about 5000 B.C. A related study by McMillan and Walter Klippel (1981), which incorporated data from an earlier study (Klippel 1970, 1971) of fauna from Graham Cave (figure 1.3), demonstrated higher relative frequencies of edge species, such as deer and cottontails, in the mid-Holocene levels, suggesting that the prairie-forest ecotone had once been well east of its current position. Likewise, James R. Purdue (1980, 1982) found that body sizes of cottontails (*Sylvilagus floridanus*) and gray squirrels (*Sciurus carolinensis*) from archaeological deposits at Rodgers Shelter decreased significantly during the mid-Holocene to sizes that were comparable with those of modern cottontails and squirrels found farther west. Klippel (1970, 1971) noted the same body-size decrease in gray squirrels from Graham Cave.

Thus, despite spotty information, several lines of evidence suggest that the climate of the mid-continent changed dramatically during the early and mid-Holocene. Nevertheless, there still is some debate over the intensity of disruption. Although much of the Midwest was affected by the Hypsithermal, it is fairly clear that not all areas were affected equally (Wright 1976). Comparisons of climates and their effects on vegetation are risky, but there might be a modern analog to the mid-Holocene dry period. Although the drought that occurred in the central plains during the 1930s was much shorter than that which occurred during the Hypsithermal, results of that drought give us the opportunity to see what the short-term effects of a prolonged hot, dry spell are on vegetation communities.

In a series of papers written near the end of the 1930s drought and shortly thereafter, John Weaver and Frederick Albertson (1936; Albertson and Weaver 1945; Weaver 1943) documented wholesale changes in floral communities that occurred over a short period of time. They noted that the effects of the drought built up over a period of years, finally reaching a critical point where trees and grasses began to die. After four or five drought years, water in the uplands was so depleted that nowhere was it nearer to the surface than four feet—well beyond the ability of grasses and most trees to reach it. As conditions worsened, lower-elevation localities such as slopes and ravines began to be affected. Big bluestem (*Andropogon gerardi*), the dominant grass in lower-slope and streamside positions, decreased in relative frequency from about 75 percent of the grass community to about 50 percent at the peak of the drought. Weaver (1943) reported that as a result of the drought, an area of prairie 100–150 miles wide running north through Kansas, Nebraska, and South Dakota was transformed from a grassland in which little

bluestem (*Schizachyrium scoparium*) was the dominant grass into a mixed-grass prairie of short grasses and western wheat grass (*Agropyron smithii*). Albertson and Weaver (1945) estimated 50–60 percent of the trees in the central plains died during or shortly after the drought. The losses were staggering: 28–70 percent loss (depending on area) of trees along bluffs and ravines; 59–75 percent loss along tributary streams; and 5–6 percent loss along the banks of continuously flowing streams.

These accounts lead one to suspect that during the Hypsithermal, the uplands would have been affected first and most severely. Tallgrass prairies would have been replaced by more drought-resistant grasses typical of the short-grass and mixed-grass prairies to the west. Upland forests would have been reduced in size as the drought persisted and the amount of available water declined. After a time, even the floodplains would have been affected by the prolonged effects of the Hypsithermal. Further reductions in composition, density, and extent of floodplain forests could be expected as drought conditions persisted.

Changes in vegetation would have caused simultaneous changes in the composition and distribution of fauna. Deer, squirrels, and other animals that feed on mast resources, such as acorns and hickory nuts, would have had to change their feeding behaviors in concordance with the shifting patterns of food distribution and abundance. Climatic change also would have affected the abundance and distribution of aquatic animals such as fish, reptiles, and mussels.

A Paleocological Case Study: The Cannon Reservoir Human Ecology Project

I have yet to address the question of how climatic change affected humans residing in the Midwest during the Holocene. For that purpose, I will discuss the Cannon Reservoir Human Ecology Project (Warren 1976, 1979, 1982b; Warren and O'Brien 1981), an archaeological program that investigated changing adaptations on the part of indigenous peoples residing in the central Salt River valley of northeastern Missouri (figure 1.3). In this interdisciplinary study, fieldwork and analysis were designed to test the implications of specific propositions about the way indigenous hunters and gatherers structured their responses to changing physical and cultural environments.

Analysis of the physical environment of the project area (Warren 1982a, 1984) suggested that variation was expressed along two major dimensions. The first was an upland-lowland gradient of slope position that both reflected downslope increases in moisture, forest cover, and biotic diversity and correlated directly with proximity to major perennial

streams. The second was an upstream (northwestward) gradient of decreasing relief, moisture, and density and width of forests. Despite the geographic independence of these two dimensions, common to both was variation in the abundance and diversity of forest and aquatic resources. Assuming that (1) subsistence economies of all indigenous groups in the region focused on forest and aquatic resources; (2) site locations were conditioned by access to important resources; and (3) environmental change during the Holocene was expressed along these same two geographic dimensions, sites were expected to be concentrated near waterways in the central and eastern parts of the project area, regardless of their ages.

Three hundred fifty-three sites—defined as any isolable aggregate of five or more surface artifacts—were discovered during the survey. Seventy-five of these sites were assigned to a temporal period by using temporally diagnostic projectile points. The locations of the Archaic components are shown in figure 1.4. With the exception of the Paleoindian–Early Archaic configuration (shown together), distinguished by three sites in level upland prairies that were at least three miles away from major perennial streams, all distributions appeared to fit expectations. Sites were more abundant along the Salt River and lower reaches of its major tributaries, and all sites more than a mile away from the major streams were located in the eastern half of the project area. Thus, sites tended to aggregate in those parts of the region where forest and aquatic resources were most abundant and diverse during the nineteenth and twentieth centuries. This association has an important implication: Differences in resource availability across the region were important enough to indigenous groups to influence relative values of different site locations, and upstream locations were generally less desirable than those downstream. Significantly, the causal direction of this relation was supported by the predominance, in excavated faunal and floral assemblages from the region, of the remains of forest and aquatic resources (Bozell and Warren 1982; King 1982).

A second perspective on site-context variation focused on characteristic positions of sites within regional environments, without regard to broad geographic distributions. Continuities and changes in physiographic contexts of dated sites were evaluated in light of hypothetical responses of regional floral communities to Holocene climatic change. Analysis of modern soils data and General Land Office records (see chapter 6) demonstrated that climatic change during the Neo-Boreal (Little Ice Age) climatic episode (ca. A.D. 1550–1850) caused extensive expansion of timber onto what previously were prairies. The magnitude of this episode and its effect on floral distributions were used as a baseline from

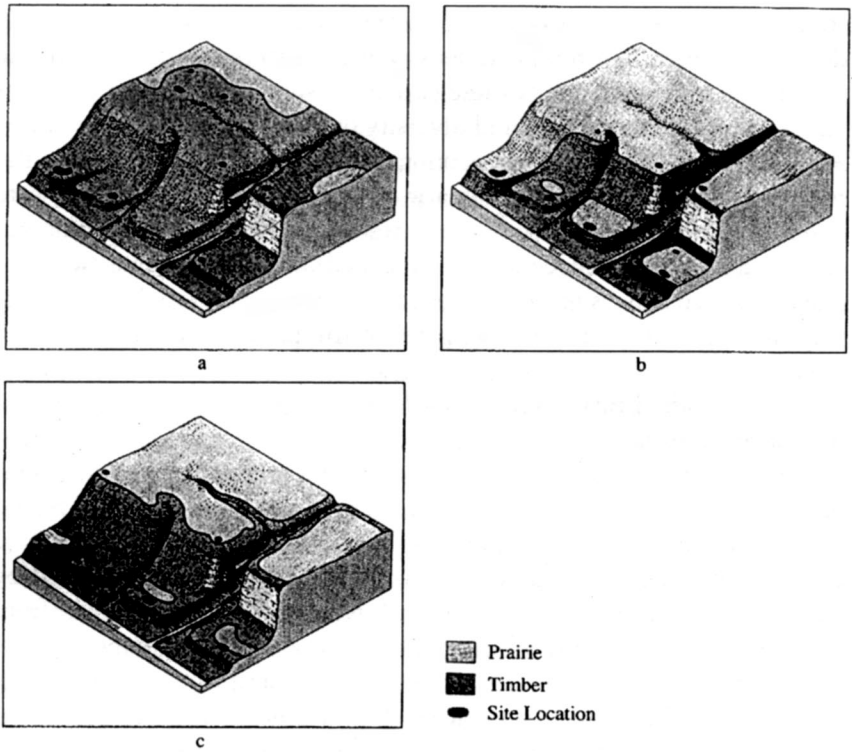


Figure 1.4. Models of site locations, showing hypothetical distributions of contemporary floral communities in the Cannon Reservoir sampling area, northeastern Missouri: (A) Paleoindian–Early Archaic period (eight out of eight sites plotted); (B) Middle Archaic period (9/18 plotted); (C) Late Archaic period (11/22 plotted) (from Warren 1982b).

which to predict the effects of other climatic episodes on the environment (Warren 1982b; Warren and O'Brien 1985). Assuming that the postulated magnitudes and directions of climatic trends during other periods were correct, Robert E. Warren (1982a) then projected hypothetical spatial configurations of floral communities for all major episodes of the Holocene.

To systematically evaluate site locations and to trace context changes through time, Warren (1982b) then compared the localities of all dated sites (including those postdating the Archaic period) in terms of their native physiographic, vegetational, and soil characteristics. A notably high incidence of sites—73 percent—were in bottomland contexts, whereas sites in upland contexts were relatively rare. This bias was significant in light of the fact that only 25 percent of the area surveyed was bottomland, but it was consistent with the proposition that access to

resources generally favored bottomland settlement in the region. Proportions of components, calculated by cultural period and by context, illustrated several noteworthy trends. First, the bottomland bias began only during the Middle Archaic period (5000–3000 B.C.); no Paleoindian (9250–7500 B.C.) sites and only three of eight Early Archaic (7500–5000 B.C.) sites were located in bottomland contexts. Second, all periods had unique arrays of context occurrences. Proportional patterns between the Middle Archaic and Late Archaic (3000–600 B.C.) sites were similar but not identical. Third, there was a steady rise in the number of contexts in which sites occurred, from two in the Paleoindian period to six in the Late Archaic period. Warren (1982b) evaluated this trend of increasing site-context richness vis-à-vis two assumptions of the model that structured work in the Salt River valley: (1) hunter-gatherer population density in an environmentally diverse region increases as land use intensifies; and (2) population density increases with the varieties of environmental contexts that must be exploited to house and sustain the population. He found that the data supported both the notion of population density increase and the hypothesized change in land-use intensity throughout the Archaic period.

Specific contexts in which sites of various periods were located are noteworthy. Paleoindian sites occurred in two contexts—near small streams in locales that historically were prairie and on gently sloping margins of level upland forest (figure 1.4). Importantly, all four Paleoindian sites also contained Early Archaic components, signifying that later peoples used the same localities as earlier people. Early Archaic groups also exploited forested high and moderately high bottomland terraces near perennial streams, although no sites were found in those contexts during the probabilistic survey. However, excavations at the deep, stratified Pigeon Roost Creek site, located on a bottomland terrace near the main stem of the Salt River (figure 1.3), produced ample evidence that Paleoindian groups used bottomland contexts.

Despite several important continuities, site contexts from the Middle Archaic period represented a settlement pattern radically different from that of the Early Archaic period (figure 1.4). There was a sharp reduction in the proportion of upland sites to about 17 percent. Conversely, there was a sizable increase in the proportion of sites on very high bottomland terraces, and bluff-base sites occurred for the first time. The proportion of sites on margins of lower terraces changed very little. The new focus on lowland contexts probably represented either a major shift in resource orientation or significant shifts in the distribution of resources.

Prairies undoubtedly expanded beyond their nineteenth-century limits and probably also invaded many areas currently underlain by forest

soils. Valley sides with relatively gentle slopes, which are common along the Salt River's major tributaries, may have been transformed into extensive hill prairies and open-canopy woodlands, or savannas. Many bottomland forests probably formed galleries along major streams and survived on steeper protected slopes. The resulting increase in resource accessibility could have obviated the value of many upland locations and could have encouraged recurrent occupation of stable bottomland contexts. Observed distributions were consistent, for the most part, with these propositions. Nevertheless, sites were common on upland rims, suggesting that the degree of settlement mobility was still quite high among Middle Archaic groups. Moreover, it also implies that the Middle Archaic settlement pattern may have been similar to the Early Archaic pattern. Although the distributions and physiographic contexts of sites changed a great deal, the biotic contexts and functions of sites may have remained the same.

Late Archaic period components in the central Salt River valley continued the trend of decreasing proportions of sites in upland contexts (roughly 9 percent). All but two components occurred in lowlands, and both exceptions were situated on the gently sloping edges of upland flats near major streams (figure 1.4). The proportion of bottomland sites was similar to that of the Middle Archaic period; most were located near major streams on the outer margins of high terraces. However, several other lowland contexts increased in relative frequency or were represented for the first time. Bluff-base sites in wide valley bottoms replaced upland rim components as the third most common context, and one site was located on the narrow terrace of a perennial tributary stream.

The increased proportion of lowland sites during the Late Archaic period represented a striking contrast to contemporary environmental changes. At the end of the Hypsithermal, effective moisture increased in the Prairie Peninsula, and timber reclaimed many contexts that previously had given way to prairie. Given these environmental changes, the relative decrease in numbers of upland sites during the Late Archaic period was anomalous from the perspective of changing resource distribution. If the Middle Archaic settlement-subsistence pattern had persisted, there should have been a proportional increase in upland sites, rather than a decline. Thus, observed trends indicated that there was a significant change after the Middle Archaic period, either in the kinds of resources exploited or in the settlement strategy used to house and sustain communities. Contrasts between site contexts of the Early Archaic and Late Archaic periods suggest that selection for patterns of settlement and subsistence after the Hypsithermal involved cultural factors rather than environmental ones. One important factor may have been population

growth, whether that growth was simply the natural product of more births than deaths among native residential groups or was attributable in part to migration into the region.

In summary, settlement data from the central Salt River valley showed both an increase in the number of sites through time and an increase in the number of contexts that were used. These data, however, make little sense except when viewed in the context of changing Holocene environments. Even though our knowledge of Holocene environments and environmental change is incomplete, what we do know allows us to begin to understand why, for example, archaeological materials from certain periods are located in one topographic setting as opposed to another. Our knowledge of paleoclimatic regimes, especially the timing of the appearance and disappearance of those regimes, allows us to model vegetative and animal response, the former of which leaves its imprint in the soils it helps build and the latter in faunal assemblages in archaeological sites. As important as this information is, in and of itself it tells us little about what indigenous groups were doing at those sites and why they might have selected certain localities over others. This kind of information is derived in large part through excavation.

Archaeology and Restoration

Archaeology has come a long way in the past half century in terms of how it views human-environment interactions, but it has not reached the point where paleoecology is a decided research focus. Nonetheless, archaeologists have used a variety of methods and techniques to study previous environments, and there are signs of a growing interest in ecological theory among archaeologists—an interest and expertise that can contribute in significant ways to ecological restoration projects. I am in complete agreement with one of the central tenets of this volume—that the success of restoration ecology rests in large part on its incorporation of the historical dimension.

In this chapter, I have discussed the effect of climate on vegetation and on human and animal populations. Climatic change may, in fact, be the ultimate cause of future changes in the environment, but restoration ecologists have to wrestle with myriad other aspects of the historical dimension. From my perspective, one of the more important ones is human agency. Humans, as I've noted, are not simply passive recipients of whatever nature happens to throw their way—that is, they are not environmentally determined. Rather, they can and do modify their environment, sometimes with devastating effects. We need not restrict our focus to the twentieth century or even to the last few hundred years to see how humans can radically alter an ecosystem. As Raymond Wood and I have

pointed out (O'Brien and Wood 1998), among the greatest such transformations are those that have come about by the human release of fire, which was an important environmental component long before humans tried to control it. Fire in most landscape settings is not only natural, it is historic, desirable, and inevitable (Pyne 1982; Wright and Bailey 1982).

In the popular mind, and until recently in much of the academic literature (Cronon 1983; Denevan 1992; McCann 1999), the pre-Columbian eastern United States is perceived as having been a vast and essentially uninterrupted tract of dense forest—a collection of pristine ecosystems that were massively disrupted by Euroamerican settlers. Today many restorationists and land managers are devoted to returning regional vegetation to a pre-Euroamerican standard—without realizing that what the first Europeans saw was a landscape that had been molded by fires and other management practices of Native Americans. For example, early historical narratives, whether by explorers, settlers, or scientists, “display a compelling uniformity in their depiction of Missouri woodlands as far more open than today” (Ladd 1991, 70–71). Henry Rowe Schoolcraft’s travels through the Ozarks in the early nineteenth century led him through the countryside near the Meramec River, where he noted that “a tall, thick, and rank growth of wild grass covers the whole country, in which the oaks are standing interspersed, like fruit trees in some well cultivated orchard” (Schoolcraft 1821, 54). Accounts of regions as far east as the forests of Virginia echo this language and reinforce the importance of fire in Native American land management practices (Hammett 1992). Similarly, as Kat Anderson points out in this volume (chapter 2), ethnologies and ethnobotanical studies of indigenous peoples throughout North America also demonstrate their use of various techniques, including fire, to acquire food, medicine, and materials for clothing, shelter, transportation, defense, and ritual.

In conclusion, those interested in restoration ecology cannot ignore the temporal dimension, nor can they ignore perhaps the most important players in the ecosystems that evolved along that dimension: humans. Ecologists can learn from archaeologists as they explore the ways in which human groups have helped shape past ecosystems, and I would maintain that archaeologists have a lot to learn from restoration ecologists, especially as members of their project teams.

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