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Sustainability: The Long View from Archaeology

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Abstract

Knowledge of prehistoric human ecology is useful for achieving a sustainable future. Outlined here are four ways archaeological data are valuable: 1) understanding environmental dynamics, including anthropogenic factors, 2) documenting ancient crops, 3) inventorying prehistoric agroecology, and 4) building a long-term ecological perspective.

Introduction

The past can serve the future. By definition, sustainability is long term, so it may be useful to consider this topic from an archaeological perspective. People have lived in the area now know as the southwestern United States and northwestern Mexico (henceforth called the SW/NW) for at least 10 millennia.

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The record of their adaptations, successes, and failures offers information useful for building a sustainable future.

The earliest known people of the SW/NW were small groups living during the end of the last glacial age in environments profoundly different from today (for summaries of SW/NW archaeology, see Cordell 1997; Plog 1998). As environments changed dramatically, these ancient hunting-gathering peoples responded by altering their lifestyles. Then beginning 4 to 5 millennia ago, the use of domesticated plants, particularly maize, became established. While most ancient farmers lived in small groups loosely linked with others, on occasions more integrated regional polities with specialized economies and controlled by a small elite class developed. Chaco Canyon in northwestern New Mexico, Casas Grandes in northwestern Chihuahua, and the Hohokam of the Sonoran Desert are the clearest examples of such complex societies in the SW/NW. To avoid undue overlap, the first section of this volume dealing with prehistory are divided geographically; Cordell focuses on the northern SW/NW, while I emphasize the southern portion.

I do not argue that lessons from the past are directly applicable to the present, that modern industrial and post-industrial nations with ever-intensifying global connections are directly analogous to the prehistoric societies of the SW/NW, small groups numbering in the hundreds and sometimes the thousands with subsistence economies tied closely to their local settings. Still, I believe that there are four ways by which knowledge of prehistoric human ecology of the SW/NW can be used to help create a sustainable future. The four relevancies considered here are 1) reconstructing natural environments and understanding the effects of people on their environments; 2) inventorying crops, including now extinct cultigens; 3) studying ancient agricultural techniques, many of which are particularly well adapted to the environments of the SW/NW; and 4) an awareness of the deep past.

Environmental Dynamics

To maintain ecosystems, one must know what is to be maintained, and to do that it is necessary to understand the history of ecological dynamics. This includes both "natural" change and fluctuations and the effects of prehistoric peoples on their environments. Archaeology can contribute to this goal in two ways. First, archaeological data have been used to document past environmental conditions. Although perhaps not as worthwhile for this purpose as pack rat middens (e.g., Betancourt, et al. 1990) and palynological sequences from nonarchaeological deposits, nonetheless, environmental data from archaeological sites have been a valuable adjunct to primary data sources for examining environmental change (e.g., Hall 1985).

One example from the Mimbres River Valley in southwestern New Mexico will provide a case study of documenting environmental conditions through archaeological research (for a full description, see LeBlanc 1983; Minnis 1985). Although this region is one of the most heavily looted archaeological traditions in North America, work by the Mimbres Foundation in 1970s (as well as continuing research by other institutions) has advanced our knowledge of this region's prehistory.

The ancient Puebloan Mimbreños during the Classic Mimbres period, AD 1000–1130, are best known for exquisite black-on-white pottery. Their center of population was the Mimbres River Valley itself. Multiple lines of environmental data suggest that the stream flow of the modern Mimbres River is different than it was in the past. Today, the Mimbres is a fast-moving, highly channelized river. We recovered the remains of several species (specifically muskrat bones, cattail pollen, common reed stem fragments, and bulrush seeds) that are indicators of a slower, more ponded flow with a marshier flood plain that are absent or rare today. So assuming that the hydrology of the Mimbres River has always been as it is today, is incorrect.

Archaeology is of special value for modeling a second aspect of environmental dynamics: anthropogenic ecology. The common assumption that indigenous peoples did not affect their environments is no longer tenable (e.g., Minnis and Elisens, in press). As George Collier points out:

> Because of popular conceptions of "primitives" as mystically more "natural" than "civilized" peoples, anthropological literature is often cited as evidence that human society is capable of a finely tuned, balanced harmony with its environment, comparable to that achieved in a successional climax. Unfortunately, it is all too easy to discover examples of native populations living in obvious disequilibrium with their environment (Collier 1975, p 12).

Since prehistoric peoples lived in every part of the SW/NW, usually for millennia, it is likely that anthropogenic effects were common. The most widely known example of prehistoric anthropogenic ecology is the possibility that early Native Americans played a role in Pleistocene faunal extinctions (e.g., Martin and Klein 1984; Stahl 1996). Unfortunately, other aspects of human-induced environmental change have not been examined to the degree necessary. Anthropogenic fire ecology of grasslands, as an example, is well known (e.g., Kay 1995; Hunter 1996), but to my knowledge the effects of prehistoric humans on the desert grasslands of the southern SW/NW have not been investigated systematically.

The Mimbres River, again, provides an illustration, this time of anthropogenic ecology in the southern SW/NW. Here the population expanded from the Early and Late Pithouse periods (AD 200–550 and AD 550–1000, respectively). The human population then peaked during the Classic Mimbres period (AD 1000–1130). Two later prehistoric occupations, Black Mountain and Salado, were smaller, and their cultural relationship to the Early Pithouse through Classic Mimbres tradition is not well known.

Estimates of human population, farming acreage requirements, and the locations of prehistoric villages suggest that the available flood plains (the best locations for farming) were becoming filled to support the expanded population and that outlying communities increased in number and size and became more dependent on risk-prone, non–flood plain farming. Based on precipitation reconstructions from tree-ring data, it seems that the first half to two-thirds of the Classic Mimbres period was one of the most favorable times for agriculture, with both fewer droughts and less precipitation variation. Consequently, farming would have been more bountiful and predictable during this time.

Population growth probably occurred during the first part of the Classic Mimbres period. The later half to third, in contrast, was a time of more average precipitation. At this time, outlying villages would have likely had far more serious crop failures. With the larger population, the traditional means of surviving crop failures would not have been as effective. Around AD 1130, the Mimbres tradition as it was known ended. I have argued that the inability of the greatly expanded Classic Mimbres population to sustain itself under these trying conditions contributed to the dramatic changes.

The dynamic cultural history of the Mimbres is matched by its anthropogenic ecology. Pollen and wood charcoal remains from sites indicate a severe reduction in riparian vegetation, particularly willow and cottonwood but also ash, walnut, box elder, and sycamore, during the Classic Mimbres period compared to both earlier and later times.

This pattern is best explained as a result of the flood plain trees being eliminated as fields expanded to support the enlarged population of the Classic Mimbres period. Consistent with the reduction of flood plain vegetation was an increase in jackrabbits (which prefer open terrain) compared with cottontails (which prefer more closed vegetation). The pollen of weedy species, especially cheno-am (*Chenopodium* and *Amaranthus*) and purslane (*Portulaca*) is highest with the largest human population, suggesting substantial soil disturbance. Complicating this interpretation, however, is the fact that although weed seeds were the most ubiquitous seeds from all time periods, their presence from Classic Mimbres deposits is no greater than during other time periods. Nonetheless, both the pollen and seed data clearly indicate that the ancient Mimbreños affected their environment in substantial ways. This one case study from the Mimbres River Valley is only a single example of anthropogenic ecology of the southern SW/NW.

Ancient and Extinct Crops

The loss of crop diversity, both of crop species and cultigen diversity, has become a serious problem (e.g., Nabhan 1989; Fowler and Mooney 1990). The thousands of domesticated species and tens of thousands of crop varieties developed during the past 10 thousand years of farming is a vital legacy necessary for a sustainable food supply. Governmental agencies and nongovernmental organizations, such as Native Seed/SEARCH in the SW/NW, have programs to acquire and preserve this germplasm. Indigenous cultigens have been a focus of these efforts. North America is not considered a major center of domestication. Nevertheless, Native Americans of the SW/NW domesticated some indigenous crops. These include extant crops such as Sonoran panic grass (*Panicum sonorum*), devil's claw (*Proboscidea parviflora*), various species of the century plant or mescal (*Agave* spp.), and possibly the tepary bean (*Phaseolus acutifolius* var. *acutifolius*) (Nabhan et al. 1981; Nabhan and de Wet 1984; Fish et al. 1985; Nabhan 1989). Some assume that indigenous peoples are now so closely assimilated with modern nation states that they no longer maintain traditional landraces, but this is not the case, as the efforts of Native Seed/SEARCH demonstrate.

What about prehistoric crops that no longer exist as crops? There is a ever-growing record of North American crops domesticated in prehistory, but which no longer exist in their domesticated form and are known only from the archaeological record. One of the major accomplishments of paleo-ethnobotanists in eastern North America (where this topic has been studied most thoroughly) is the documentation of a whole suite of such domesticates including knotweed (*Polygonum erectum*), goosefoot (*Chenopodium berlandieri* "*jonesianum*"), sumpweed (*Iva annua* var. *macrocarpa*), gourdy squash (*Cucurbita pepo* var. *ovifera*), maygrass (*Phalaris caroliniana*), and little barley (*Hordeum pusillum*) (e.g., Yarnell 1987; Smith 1992; Scarry 1993).

The possibility of extinct cultigens in western North American, including the SW/NW, has not been studied as fully as for eastern North America. Suzanne Fish, Paul Fish, and colleagues first showed that at least one century plant (*Agave*) was cultivated in the Sonoran Desert, and some of these still exist as relict stands (Adams and Adams 1998; Fish et al. 1985). Recent research in northwestern Chihuahua near the great site of Casas Grandes documents for the first time the probable cultivation of *Agave* in the Chihuahuan Desert (Whalen and Minnis 1995; Minnis et al. 1999). In light of the recent documentation that agave cultivation was not restricted to the low Sonoran Desert, it is certainly possible that the century plant was cultivated prehistorically in the Chihuahuan Desert north of the international border in Arizona and New Mexico.

In addition to agave, there are dozens of other species that may have been domesticated (or at least highly managed) by prehistoric people in western North America. These plants include Rocky Mountain beeweed (*Cleome serrulata*), tobacco (*Nicotiana attenuata*, *N. trigonophylla*, and *N. rustica*), wild potato (*Solanum jamesii*), nightshade (*S. trifolum*), wolfberry (*Lycium pallidum*), groundcherry (*Physalis longifolia*, *P. hederaefolia*, *P. foetnens* var. *neomexicana*), curley dock (*Rumex hymenosepalus*), milkweed (*Ascelpias* spp.), thistle (*Cirsium neomexicana*), Mexican crucillo (*Condalia warnockii* var. *kearneyi*), cholla (*Opuntia* spp.), globemallow (*Sphaeralcea coccinea*), pepperweed (*Lepidium* spp.), onion (*Allium* spp.), jimson weed (*Datura* spp.), amaranths/pigweeds (*Amaranthus powelli*, *A. hypochondriacus*, and *A. lecocarpus*), four-o'-clock (*Mirabilis mutliflora*), sunflower (*Helianthus* spp.), locoweed (*Astragalus* spp.), goosefoot (*Chenopodium berlandieri*), saltbush (*Atriplex argentea*), blue dick (*Dichelostemma pulchella*), sedge (*Cyperus* spp.), lovegrass (*Eragostis orcuttiana*), tansy mustard (*Descuriania* spp.), wheatgrass (*Agropyron trachycaulum*), wild rye (*Elymus* spp.), yellow cress (*Rorippa curvisliqua*), cockspur (*Echnochloa* spp.), sophia (*Descurainia*?), Parry's agave (*Agave parryi*), and Indian ricegrass (*Oryzopsis hymenoides*) (Yarnell 1965, 1977; Winter 1974; Minnis and Plog 1976; Nabhan 1985; Fowler 1986; Winter and Hogan 1986; Bohrer 1991).

The rapidly expanding list of now extinct crops may have substantial practical utility. Could some of these plants be redomesticated? These crops may now be extinct, but we know that their extant wild progenitors are amenable to domestication by the best evidence possible: they once were crops. And we know that any redomesticated species would be well adapted to the semi-arid to arid conditions of the SW/NW.

Agricultural Techniques and Strategies

Agriculture is more than crops; it is agroecology, including strategies and techniques (e.g., Vecsey and Venables 1980; Hurt 1987; Altieri 1995). Native Americans of the SW/NW devised ways of growing crops in places that were marginal or unfit for highly mechanized agriculture. Many of these techniques are known from archaeology (Fish and Fish 1984; Toll 1995). While traditional agriculture by living Native American groups in the northern SW/NW has been studied [especially Hopi agriculture (Hack 1942; Bradfield 1971)], the dislocation and extinction of the vast majority of indigenous peoples of the southern SW/NW [with the exception of those in the Sonoran desert (e.g., Castetter and Bell 1942, 1952) and the Tarahumara of Chihuahua] have left a void of information about native farming. This void can only be filled by archaeological research.

Prehistoric humans farmed the SW/NM for millennia, and, not surprisingly, they developed a wide range of techniques and strategies to grow crops under difficult circumstances. Techniques most easily seen in the archaeological record are irrigation (e.g., Doolittle 1990), terracing (e.g., Donkin 1979), and rock mulching (e.g., Lightfoot 1996). For this discussion, I will divide agricultural techniques into four simple general categories: irrigation, floodwater farming, rain-fed farming, and rock mulching.

Irrigation Farming

Irrigation was widely practiced throughout the SW/NW. Its origins are earlier than previously thought (Doolittle 1990), and the frequency of irrigation agriculture increased through time. The largest and most famous irrigation system, with more than 500 km (311 miles) of canals, was built by the Hohokam of the Salt and Gila River basins and "in terms of complexity it simply had no rival anywhere in Mexico" (Doolittle 1990, p 79). Most irrigation systems in the SW/NW seem to have been small, organized at a familial level of production (see articles in Fish and Fish 1984 and Toll 1995).

Floodwater Farming

Floodwater farming locations are commonly found throughout the SW/NW and are used in some communities today (e.g., Nabhan 1979). Usually temporary features divert surface water runoff immediately following rains. At times floodwater strategies blend into irrigation systems, and there is no point in making a sharply drawn distinction between the two. Again, most floodwater systems are rather small, lacking evidence of substantial super-familial coordination.

Some of the most widely distributed prehistoric agricultural features in the SW/NW are checkdams or *trincheras*, rock walls following contours that catch water and soil (e.g., Woodbury

1961; Cordell 1975; Donkin 1979; Woosley 1980; Toll 1995). Such systems are common in the SW/NW including the southern portion of this region. Woodbury (1961), working in the mountains of east-central Arizona, as an example, provided one of the first systematic studies of *trincheras* agriculture in the SW/NW. Perhaps the best known example of *trincheras* in the southern SW/NW are those around Casas Grandes in Chihuahua. Here geographers have published several classic studies of checkdams in the Sierra Madres (Howard and Griffiths 1966; Herold 1970; Di Peso 1974; Schmidt and Gerald 1988). A current archaeological project continues this interest and notes that *trincheras* are also common archaeological features in the foothills and plains directly east of the Sierra Madres in northwestern Chihuahua (Whalen and Minnis 1996; Minnis et al. 1999).

Rain-Fed Farming

Many areas of the SW/NW can be farmed with direct precipitation, but it is difficult to detect prehistoric rain-fed farming unless features were constructed or soil was modified sufficiently to leave archaeological remains. Gridded gardens (without irrigation) are such modifications and have been located from many areas in the southern SW/NW such as in southeastern Arizona, (Gilman and Sherman 1975; Homburg and Sandor 1999) as well as the northern SW/NW in northern New Mexico (see Maxwell and Anschuetz 1992; Cordell, this volume; Ford, in press).

Rain-fed agriculture is risky farming in light of the SW/NW's marginal precipitation for maize-based farming, the documented fluctuation in annual precipitation, and the apparent vulnerability of some SW/NW soils to nutrient depletion after sustained cropping (e.g., Kohler 1992; Sandor 1992; Van West 1994; Kohler et al., in press). While we do not know the frequency of crop failures with prehistoric rain-fed farming, rain-fed maize farming in eastern New Mexico at the turn of the 20th century suffered a failure rate of one in four years (Staten et al. 1939). It is reasonable to suggest that prehistoric rain-fed agriculture was a risky enterprise in light of precipitation variation common to the SW/NW, and that success and failure of rain-fed farming may have been especially important in understanding ancient population migration and conflict.

Rock Mulch Farming

Rock (or lithic) mulching involves planting crops in piles of stones and is used worldwide (Lightfoot 1996). The rocks conserve moisture and provide other benefits, such as protecting roots from rodent predation and increasing soil temperature at the beginning of the growing season. Like the other agricultural techniques mentioned here, rock mulching is found in many areas of the SW/NW for a number of different crops.

Such fields are found in the northern SW/NW (see Maxwell and Anschuetz 1992; Anschuetz 1995; Maxwell 1995; Lightfoot 1996; Cordell, this volume; Ford, in press), but they are best known from the Sonoran Desert (Fish et al. 1985). There, the Fishes estimate that up to 50,000 such piles are present in the foothills north of Tucson near Marana, indicative of the substantial cultivation of agave, a resource previously thought to have been gathered only from naturally propagated stands. Colleagues and I recently discovered similar rock mulch fields in Chihuahua (Whalen and Minnis 1996; Minnis et al. 1999), although the number and density is far less than in the Tucson area. Quite likely, rock mulching is more common in the southern SW/NW but has been overlooked by archaeologists, as I have done in the past. The fact that rock mulching has now been found in the high Chihuahuan Desert, not just the low Sonoran Desert, adds hope that such fields were present in southern Arizona and New Mexico as well.

Although the SW/NW is a small area of the world, its prehistoric people used a great diversity of agricultural methods, so much so that ancient people may well have been able to farm much of the region with the exception of higher elevations and the most desolate desert plains. Knowledge of this agriculture has practical value. For example, Kolata (1996) and colleagues have helped reintroduce a prehistoric farming technique to peasant communities in South America. While it is unlikely that prehistoric techniques will be employed directly in industrial food production of North America, techniques such as terracing or rock mulching might prove productive for small-scale farming, specialty horticulture, or gardening. This is especially true as gardeners homestead uplands and other locations less suited for modern agricultural and gardening practices.

An Awareness of the Past

The first three relevancies all can offer "hard," useful data that scientists can use to design sustainable development. An awareness of the past, in contrast, may seem "soft," less valuable. But such is not the case, because over time people develop a connection to their environment that affects how they behave toward it.

People's interactions with their environments are conditioned by their emotional connections to and perception of natural environments (e.g., Anderson 1996). E.O. Wilson in *Biophilia* (1986) recognizes the importance of this affinity. While one can easily disagree with Wilson about the source of the emotional connection that he proposes, his main point is well taken. The closer people feel tied to their local environment, the more likely they will support reasonable environmental policies that may require short-term sacrifices or inconveniences.

This may especially be the case for the SW/NW, as more and more people from outside the region settle here, most of whom have no long-term connections to the area and are unfamiliar with arid to semi-arid environments. An awareness of the intricate and long-term relationships between humans and natural environments spanning thousands of years provides a context for people to view their actions over the long run. As well, some environments of the SW/NW can be fragile, and a long-term

view of human ecology helps make this point to the public. Examples of the effects of prehistoric peoples on their environments and the sometimes dire consequences of these interactions, such as the Classic Mimbres example as well as others (e.g., Euler et al. 1979; Dean et al. 1985; Gumerman 1988; Petersen 1988), may well temper some behaviors.

Concluding Thoughts

Study of the ancient past has real consequences for building a sustainable future. I have outlined four simple ways by which this may be so: 1) studying paleo-environments and anthropogenic ecology, 2) recognizing ancient crops, 3) documenting prehistoric farming techniques, and 4) developing a long-term awareness of human/environmental interconnections in the SW/NW.

While the past has relevance for the present and future, likewise the present and future have relevance for understanding the past. Modern indigenous groups are critical for archaeological interpretation, both as ethnographic analogies for interpreting the past and for providing traditional historical narratives (unfortunately known as "myths"). Thus, maintaining biodiversity and building sustainability—whether organismic, ecological, or agricultural—necessitates a concomitant concern for the loss of cultural and linguistic diversity (Oldfield and Alcorn 1991; Kemf 1993; Johnson 1995; Brush 1996; Orlove and Brush 1996; Salmón 1996; Stevens 1997). This is as true for Native Americans of the SW/NW as it is for groups throughout the world.

In much of the southern SW/NW except the Sonoran Desert, indigenous groups such as the Janos, Jumanos, and Mansos are either extinct or relocated. One could, therefore, conclude that the issue of cultural diversity does not apply, as it clearly does in the northern SW/NW with its strong Puebloan and Navajo communities.

Two considerations, however, argue against this view. First, the SW/NW does not stop at the international border; there are many traditional peoples in northwestern Mexico. The Tarahumara (or Rarámuri) number in the tens of thousands, and many live traditional lives. Unfortunately, they are now facing increasing pressure by outside groups to drastically modify their lifestyle. Second, there are cultural affinities between archaeological remains of the southern SW/NW with Native Americans of the northern SW/NW. In ways not now clear, the Mimbres and other prehistoric groups of the southern SW/NW probably are ancestors of the Puebloans to the north. Large parts of the southern SW/NW are part of the geographic legacy of Native Americans to the north. Thus, ethnographic information about these groups has use for the southern SW/NW.

The point is not to dictate that indigenous peoples live frozen in time and in ways assumed by outsiders to be "traditional," but rather to acknowledge their self-determination and the dynamic nature of human and biological adaptations. This can present challenges when the goals of indigenous peoples and conservationists do not mesh completely (e.g., Prybyla and Barth 1996; Redford and Mansour 1996). These occasional disagreements should not hinder cooperation to fashion a sustainable future. Acknowledging the value of indigenous ecology must also include the deep past, since the majority of humanity lived before written history.

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