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Prehistoric Anthropogenic Ecology of the North American Southwest

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Understanding the prehistoric human ecology of arid regions has practical as well as academic benefits. Ironically, the value of these environmental data are being slighted in archaeology at the same time that most biologists do not realize the importance of prehistoric human ecology for resource conservation and economic development. The result, unfortunately, is irrelevant archaeology and historically unaware environmental management. We can use the past for the present, and here I will briefly consider two examples. First, ancient peoples throughout the world have farmed semi-arid to arid regions for millennia, and as a consequence, they developed an astounding range of agricultural strategies suited to difficult farming situations. Knowledge of prehistoric agroecology may well be useful in a variety of modern situations where food production must be expanded into unfamiliar and unfavorable locations. Second, documenting how prehistoric humans affected their biotic

environments will help design environmental management programs better suited to ecological and cultural sustainability. Both of these topics will be considered through an examination of the North American Southwest.

The North American Southwest--the southwestern United States and northwestern Mexico and termed here the Southwest/Northwest (SW/NW)--is an excellent location to address issues of prehistoric human ecology. As one of the most intensely studied semi-arid to arid regions in the world, we have in some locations surprising precision in paleoenvireonmental reconstruction and awareness of the region's prehistory.

The SW/NW prehistory is first summarized. l then sketch the nature of prehistoric agricultural strategies in the regions and turn to a consideration of anthropogenic ecology of the SW/NW. I will argue that the environmental effects of humans in the region were localized and that it was not until the European conquest starting in the 1500s, especially with the introduction of livestock, that severe human-induced environmental modifications became widespread.

Environmental and Culture Historical Background

Environment. The SW/NW is an environmentally diverse region. The two hot deserts of the southern SW/NW, the Sonoran and Chihuahuan, are interspersed with isolated mountains, and major mountain ranges tower up to nearly 4,000 m. The northern SW/NW is dominated by the Colorado Plateau with cool deserts and semi-arid grasslands. Substantial rivers, such as the Gila, Colorado, and Rio Grande\Rio Bravo are infrequent but were foci of prehistoric human occupation. Annual rainfall

ranges from 127 mm in the lowest deserts to 700 mm in the mid-level mountains (Sellers and Hill 1974; Tuan et al. 1973), and precipitation is bimodally distributed with large winter storms and more localized summer monsoons. Thus, crops usually require supplemental water to yield adequate harvests, and precipitation fluctuations seem to have had profound effects on ancient farmers (e.g., Dean et al. 1985; Euler et al. 1989; Gumerman 1988; Minnis 1985, Petersen 1988; Van West 1994).

Deserts now support grasslands and shrub communities with occasional ribbons of robust riparian vegetation (see Brown 1982 for the best summary the region's biotic communities; for Mexico, consult Rzedowski 1986). Low elevation montane vegetation is dominated by oaks, pines, and junipers in various combinations with higher montane vegetation dominated by gymnosperms such as firs, spruces, and pines.

Ecology is dynamic, and there is evidence of substantial environmental change, especially in vegetation, during the historic period. In fact, great environmental changes have been noted during the past century. The best documented change is expansion of desert shrubs, such as mesquite *(Prosopis* spp.) and juniper *(Juniperus* spp.) at the expense of desert grasslands. The best explanation for these changes involve fire suppression, drought, and intensive livestock grazing, especially in the 1880s (Bahre 1991; Hastings and Turner 1965; Humphrey 1987).

Prehistory. Many millennia of human occupation preceded the use of cultivated plants in the SW/NW (for general accounts of the region's prehistory see Cordell 1997; Plog 1997). The first Post-Pleistocene peoples seemed to live in classic small hunter-gatherer bands until about 1000 B.C. Starting around this time more

aggregated populations practicing some agriculture appeared in at least two locations: around Tucson, Arizona, (Mabry et al. 1997) and in northwestern Chihuahua (Hard and Roney 1998). Yet, sedentary village agriculture seems not to have become widespread throughout the SW/NW until A.D. 200-700. While population size, degree of aggregation, and settlement locations fluctuated through time, due in part to environmental perturbations, agriculture has been the economic mainstay until and after European contact in the late 1500s . Prehistoric domesticated animals were restricted to the turkey and dog; the lack of domesticated herbivores had much ecological significance.

Prehistoric Agricultural Technology

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. The most difficult, but not the only problem, was insufficient precipitation. Adding to a large corpus of research on ancient farming in the SW/NW, are excellent ethnographic studies of indigenous farming, especially of the Hopi (Bradfield 1971; Hack 1942) and of Sonoran desert peoples (e.g., Castetter and Bell 1942, 1952). Not wishing to become bogged down in unnecessary taxonomic complexities, I will divide agricultural techniques into four simple general categories: irrigation, floodwater farming, dryland (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; Mabry et al. 1997), and the frequency of irrigation agriculture increased through time. The largest and most

famous irrigation system was built by the prehistoric peoples of the Salt and Gila river basins where the modern city of Phoenix is now located, and " in terms of complexity it simply had no rival anywhere in Mexico" (Doolittle 1990:79). A complicated set of canals totalling over 500 km was constructed, although the destruction of canals by modern agriculture and substantial urban development have obliterated most of the prehistoric canals (e.g., Dart 1989; Fish and Nabhan 1991; Howard 1993). Numerous scholars have noted the relationship between the organization of the irrigation systems and the socio-political landscape; those who controlled flow presumably had some power over downstream villages (e.g., Gumerman 1991). Furthermore, the probable destruction of the canals by flooding in the mid-1400s may have been a significant contributor to the collapse of the political relationships in the Sonoran desert (Graybill and Nials 1989). Most irrigation systems in the SW/NW seem to have been quite small, organized at a familial level of production (see articles in Fish and Fish 1985 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. One possible well-known exception is a nine hectare gridded field at Chaco Canyon, the center of a remarkably complex regional polity (Vivian 1991).

Some of the best known and easily seen archaeological remains of floodwater farming are trincheras, rock walls across the contour that catch water and soil (Donkin

1979; Toll 1995; Woodbury 1961). Well-known examples include trincheras from the northern SW/NW at Mesa Verde (e.g., Cordell 1977) to the southern part of the region, such as around Casas Grandes in Chihuahua (Di Peso 1974; Herold 1970; Howard and Griffiths 1966; Schmidt and Gerald 1988). I have co-direct a long-term archaeological project in the Casas Grandes area for nine years. Trincheras are common archaeological features, even though it is clear that the irrigated flood plains were the primary prehistoric farming locations; we have recorded hundreds of trincheras (Minnis and Whalen 1995; Whalen and Minnis 1996). With the exception of one series of trincheras that covered at least 100,000 m^2 next to a regional ceremonial center which may well represent organized surplus production, most are quite small, the largest was 8,000 m^2.

Dryland (Rain-Fed) Farming. Many areas of the SW/NW can be farmed with only direct precipitation under optimal conditions, but it is difficult to detect prehistoric dryland farming unless soil is modified sufficiently to leave archaeological remains. Gridded gardens (without irrigation) are such modifications and have been located from many areas in the SW/NW such as in southeastern Arizona, (Gilman and Sherman 1975) and northern New Mexico (Ford, in press; Maxwell and Anschuetz 1992). Scholars working in the Dolores area of southwestern Colorado have used settlement locations to argue that dryland farming was especially important for determining population and settlement dynamics through time in their study area even though observable soil modifications were not present (e.g., Van West 1994; Kohler et al., 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 et al., in press; Sandor 1992). In fact, dryland maize farming in eastern New Mexico at the turn of the twentieth century suffered a failure rate of one out of four years (Stanten, Burnham, and Carter 1939). Thus, the success and failure of dryland farming may have been especially critical important in prehistoric cultural dynamics.

Rock Mulch Farming. Rock mulching involves planting crops in piles of stones and is used worldwide (Lightfoot 1996). The rocks conserve moisture and can have other benefits such as protecting roots from rodent predation. Like the other agricultural types mentioned here, rock mulching is found in many areas of the SW/NW, Some are found in the northern SW/NW near Santa fe,new Mexico, (e.g., Anschuetz 1995; Ford, in press; Lightfoot 1996; Maxwell 1995; Maxwell and Anschuetz 1992), but they are best known from the Sonoran desert of central Arizona where Suzanne and Paul Fish and their collaborators have documented the wide-spread cultivation of the century plant/maguey (*Agave* sp.) in rock mulch piles (Fish et al. 1985). They estimate that up to 50,000 such piles are present in the foothills north of Tucson, indicative of the substantial cultivation of a plant previously thought to have been gathered only from naturally propagated stands. We recently discovered similar rock mulch fields in Chihuahua (Minnis and Whalen 1996), although the number and density is far less that in the Tucson area.

Despite being a small area of the world, a century of intensive archaeological research combined with an excellent ethnographic record have lead to the

documentation of tremendous diversity in agroecological strategies, so much so that prehistoric people may well have been able to farm much of the SW/NW with the exception of higher elevations. The sophisticated suite of agricultural techniques allowed farming a wide range of locations, but yields of irrigated flood plain with permanent water and fertile soils would, not surprisingly, have been the economic foundation for communities with highest population density.

Anthropogenic Environmental Change

Humans affect their natural environments and such alteration can range from the subtle to substantial. Even some modern Native American groups still manage their environments (Minnis and Elisens, in press). Examples of the small scale alterations from the prehistoric SW/NW include expanding the range of some plants such as Parry's agave *(Agave parryi)* (Minnis and Plog 1976), pruning of Douglas-fir (*Pseudotsuga menziesii*) to yield beams at Mesa Verde (Nichols and Smith 1965), and manipulation of squawbush (*Rhus trilobata*) to produce unusually elongated stems for basketry (Bohrer 1983). An example of a more substantial effect is the possibility of soil fertility depletion due to prehistoric agriculture in portions of southwestern Colorado (e.g., Kohler et al., in press). I will suggest here that although humans occupied the SW/NW for many millennia, it appears that their ecological effects were very localized until recently. This not an argument for the naive myth that somehow indigenous peoples lived in completely harmonious balance with their biotic environment. Rather, for a variety of reasons, Native Americans did not have the ecological impacts that later national states had in North America.

Three potentially widespread ecological consequences of human occupation are briefly outlined here: deforestation, fire, and salinization. Other well-documented examples of the environmental effects of prehistoric human occupation, such as the increase in weedy species (mostly *Chenopodium*, *Amaranthus*, and *Portulaca*) with increase sedentism and use of agriculture, while interesting in their own right, probably did not have long-term consequences.

Deforestation. Humans use wood and often lots of it for fuel and material culture. In addition, woodland agriculturalists remove tree cover for fields. Deforestation is a severe ecological problems in some regions today. There are documented cases of deforestation by various prehistoric peoples in the SW/NW. Wyckoff (1977) noted a significant increase in arboreal pollen, particularly pine, juniper, and oak (*Quercus* spp.) following the area's abandonment by prehistoric peoples. This change, he suggests, is best explained as a woodland recovery once human wood harvesting pressures were relaxed or ended. I documented a dramatic decline in riparian wood (mostly cottonwood/willow [*Populus/Salix*]) during the time of highest population density in the Mimbres Valley of southwestern New Mexico. The frequency of these woods recovered with later, less dense prehistoric human occupations (Minnis 1985).

The Chaco Canyon area of northwestern New Mexico offers another possible example of deforestation. Betancourt (1990) noted a clear reduction of piñon pine (*Pinus edulis*) wood from packrat middens during the height of the human population in the Chaco Canyon area of northwestern New Mexico. He interprets this pattern as decimation of local woodlands though human wood harvest, and, unlike the previous

cases, he argues that there was no documented recovery of piñon after human abandonment of the region. Hall (1985) reviewed the pollen records from Chaco Canyon and suggests that the Chacoan area of northwestern New Mexico was shrub and grasslands with only scattered, low density piñon and juniper populations, species already growing in suboptimal conditions. While humans may well have reduced the woody plants, these conifers were not major components of the vegetation. Furthermore, Hall sees a slight increase in pine pollen after prehistoric abandonment of the region. Consequently, further research is need to better understand the human ecology of the Chaco Canyon area.

In each of these cases, with the possible exception of Chaco Canyon, significant anthropogenic changes are documented, but there is no evidence that these changes were long-lived. Once the human pressures were reduced, the environments returned to a previous ecological state.

Fire. The ethnographic record of North American, including the SW/NW, demonstrates that Native Americans used fire to affect the abundance of resources and to drive game animals (e.g., Dobyns 1981). It has been presumed that suppression of both naturally set fires and human set fires was a major factor leading to the modern invasion of shrubs into desert grasslands (Hastings and Turner 1965; Humphrey 1987). While I suspect that this model is correct and that prehistoric peoples did, in fact, set fires for a variety of reasons, there is no current evidence that prehistoric anthropogenic fire was a major ecological factor. Bohrer (1992) discussed evidence that the prehistoric Hohokam of the Sonoran deserts did relatively small scale vegetation burning. Yet the effects of this burning are modest in the archaeological

record. If the evidence is weak for prehistoric anthropogenic fires, there is none that there were long-term, wide spread deleterious effects of such fires.

Salinization. If salinization was a problem prehistorically, it would have been most significant in the large irrigation systems of the hottest desert near Phoenix, Arizona, where there was intensive crop production and very high evaporation rates. There has been some speculation that sporadic fields in the Sonoran desert were affected by salinization, largely based on historic records of such problems in a few locations (S. Fish, personal communication, 1998). Yet, there is no archaeological evidence that large areas were abandoned nor crops changed because of salinization.

Concluding Thoughts

The prehistoric human ecology of the SW/NW has valuable lessons. It is obvious that there is a great diversity of prehistoric agricultural strategies in the prehistoric record of the SW/NW suited for a wide range of environmental conditions. What is less obvious is how these data might be of practical use in the area where industrial scale agriculture is articulated with a capitalist economy; indigenous agriculture has not been as concerned with the scale of production. It is unlikely that the prehistoric techniques will fit directly into this context, although the principles underlying traditional agriculture may be useful. One could conceive, for example, of how rock mulching might be used in modern aridland farming. More likely, indigenous farming strategies may well find some use in household gardening or boutique farming, even in densely urban settings within the SW/NW. And, of course, indigenous SW/NW agricultural techniques might be transferable to other arid to semi-arid locations where smaller-scale crop production is economical viable.

Painting in the broadest strokes, I have argued that prehistoric populations of the region affected their biotic environments. As severe as these impacts may have been for the indigenous peoples and for the local ecology of the time--and no doubt there were serious problems on occasion--no lasting ecological alterations occurred. I say this with the caveat that more study of desert grassland fire frequency and the causes for it would be useful. Therefore, modern environmental planners in the SW/NW would be advised to focus upon possible small-scale anthropogenic ecology, rather than wide spread, general changes due to prehistoric humans.

Still we should not conclude, as some would like, that indigenous peoples were environmentally neutral. After all, Dobyns (1981) suggests that ecologically harmful effects of livestock occurred among indigenous peoples once they acquired exotic domestic livestock, especially cattle, horses, and sheep. Rather lack evidence for substantial ecological consequences of the prehistoric human occupation is due more to its relatively low population density, the infrequency of stratified societies with economies geared toward substantial surplus production, and the rather high level of residential relocation in prehistory. In short, few people staying in locations for relatively short periods of time with a familial mode of production simply did not impact the environment as much as historical populations with relatively high population densities in cities and in the countryside, industrial development, large scale mechanized agriculture, introduction of exotic species, and effective fire suppression. Human ecology is not a matter of mystic and romantic ideology, or simply of indigenous cosmology, it must be grounded in an understanding of historical ecology and biology.

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