

Environmental Imperatives Reconsidered:

Demographic Crises in Western North America During the Medieval Climatic Anomaly

Terry L. Jones

Janet L. McVickar

Andrew York

Gary M. Brown

W. Geoffrey Spaulding

Phillip L. Walker

L. Mark Raab

Douglas J. Kennett

Once there was a famine... there was no rain and no food. They ate bleached bones pounded in the mortar, and acorn mush made of manzanitas. There were no deer and no meat; it was a great famine. The poor people ate alfilerillo seeds. One old woman killed and roasted and ate her son... Then her brother came and killed her with three arrows because she had eaten her child. They did not bury her, but left her to be eaten by the coyotes. It was a great famine. But the people who lived on the shore did not die because they ate abalones. But even they were thin because they had nothing but seaweed to eat.—Maria Ocarpia, Salinan speaker, as reported by Mason 1918:120

The need to recognize paleoenvironmental variability in archaeological models is well established in the study of North American prehistory, but it can be argued that the role of environment as an influence on cultural change has in recent years been increasingly overlooked. Misgivings about environmental determinism—the highly flawed theory, rooted in Greek and Roman philosophy, that attempts to equate climatic regimes with personality types, and posits mechanistic responses to climatic change—have encouraged development of population-based explanations, first as part of cultural evolutionary constructions and most recently in the form of neo-Darwinism and models of economic intensification. Some have rejected ecological approaches altogether in favor of postmodernist foci on power, social conflict, elite conspiracies, and gender inequities, minimally influenced by environmental context (e.g., Bender 1985; Brumfiel 1992). Both postmodernists and neo-Darwinists further point to an overemphasis on adaptationism in many ecological studies which ignores the full spectrum of biological and behavioral variability involved in human evolution. Despite the recent disregard for environment as a cause underlying cultural change and the success of some neo-Darwinian models in which environmental causality is shunned, we suggest that the categorical rejection of environment as a potential cause of cultural change will lead to unsuccessful if not naive characterizations of prehistoric human behavior. This is not to say that other factors do not play pivotal roles, but we believe the linkages

between the physical/biotic environment and human subsistence and settlement are sufficiently tight to warrant serious consideration of environmental change as a potentially important factor in explanations of cultural change. Environment can and did cause cultural changes in the prehistoric past, and attribution of cause to environment in archaeological models need not be deterministic. A downturn in environmental productivity, in particular, can affect culture change by creating demographic imbalances that require some kind of response, but they do not dictate the character of response in a given area. Demographic stress can be felt in various ways, but more often than not its effects are negative (e.g., increased mortality, poor health, and decreased fecundity). Downturns related to climate can simultaneously affect large portions of a continent or similar latitudinal zones across continents, so that synchronous cultural changes may cross-cut vastly different subsistence regimes. As profoundly simple as these points may be, current theories of prehistoric human/environmental relationships increasingly fail to acknowledge circumstances of environmentally induced culture change, particularly those engendering negative human behaviors and outright cultural failures.

In western North America a theoretical amalgam has emerged from a long, complex history of thought in which hunter-gatherers and agriculturalists have been perceived very differently in their relationships with the physical environment. Cultural ecological theories from the early part of the twentieth century, based largely on ethnographic

observations, acknowledged subsistence difficulties for both foragers and agriculturalists in arid environments (e.g., Antevs 1948; Douglass 1929; Steward 1938; Wormington 1947) but envisioned a benign, complacent environmental past for hunter-gatherers in California (Kroeber 1925). In the 1950s and 1960s these perspectives gave way to models of adaptation in which environmental flux was routinely accommodated by simple cultural adjustments and/or migration (Kroeber 1955) that, with few exceptions (e.g., Moratto et al. 1978), involved no crises, stress, violence, or demographic or environmental problems. Much of western North American prehistory was linked to incremental population growth and unilinear cultural evolution (Chartkoff and Chartkoff 1984; Fredrickson 1974a). These perspectives have more recently been supplanted by neo-Darwinian constructs and models of economic intensification applied to both foragers (Baumhoff and Bettinger 1982; Basgall 1987; Bouey 1987; Hildebrandt 1997) and agriculturalists (Ezzo 1992) that ignore environmental flux as a cause of change and posit linear progressions in human subsistence and social complexity (Fredrickson 1994).

Some types of environmental events, however, provoke changes that simply cannot be ignored. Especially critical are those that impact the quality and abundance of basic subsistence resources, most obvious of which are high-intensity, rapidly transpiring environmental oscillations associated with natural disasters (e.g., floods, fires, hurricanes) and short-term ecological catastrophes (see Oliver-Smith 1996; Torrey 1978, 1979). Such events are commonly overlooked in adaptationist models. They may be hard to recognize in the archaeological record, particularly in the distant past, but intervals of sustained and/or repeated ecological and demographic instability should be detectable. The thesis we develop here is that the interval between A.D. 800 and 1350, known to climatologists alternately as the Medieval Warm period, the Secondary Climatic Optimum, the Little Optimum (Ingram et al. 1981; Sulman 1982), or the Medieval Climatic Anomaly (Stine 1994), was a time of increased aridity that coincides with a unique pattern of demographic stress and frequent economic crises across much of western North America. Large populations of agriculturalists and hunter-gatherers were confronted with serious and abrupt declines in productivity caused by repeated and prolonged droughts. This interval is increasingly recognized as a time of droughts and warm temperatures in many parts of the world (Hughes and Diaz 1994; Lamb 1977, 1982). The interval also witnessed a profusion of widespread cultural changes in the archaeological record, many of them quite extreme (e.g., increases in interpersonal violence, declines in health, deterioration of long-distance trade networks, population decrease and/or relocations, site and regional abandonments, and occupational hiatuses). We believe the

plethora of cultural changes and the negative character of many of them reflect widespread crises related to population/resource imbalances, drought-related environmental deterioration, and shortages of food and water. Many current interpretations of regional prehistories, with some exceptions (e.g., Arnold 1992a, 1992b), largely fail to consider the possibility of environmentally induced demographic stress in nondeterministic ways. This is particularly true in California, where the biotic environment has been portrayed as rich and complacent with no sustained intervals of resource shortage. Recent archaeological models (e.g., Basgall 1987; Bouey 1987; Hildebrandt 1997) associate relentless population growth with this perceived environmental richness but fail to consider that economic intensification could place hunter-gatherers in positions of demographic risk similar to those of sedentary agriculturalists.

Our thesis begins with paleoclimatic and paleohydrologic data demonstrating that the period between A.D. 800 and 1350 was punctuated by "epic droughts" (Stine 1994). These droughts, and the more broadly timed episodes of increased temperatures attendant on the Medieval Climatic Anomaly, had direct effects on terrestrial ecosystems by impacting water sources and reducing primary production and therefore harvestable biomass. The relationship between effective moisture and primary production is a well-documented phenomenon in the ecological literature (e.g., Barbour et al. 1987; Lieth 1975; Shmida et al. 1986). Equally important from the point of view of understanding the constraints on peoples in arid to semiarid regions is the steep relationship between incremental increases (or decreases) in precipitation and ecosystem productivity. The availability of harvestable plant resources in either agricultural or natural ecosystems is a direct function of productivity. The more severe and prolonged the drought, the greater its deleterious effect on ecosystem productivity and consequent terrestrial resource availability. These relationships are not hypothetical; they represent realities faced by traditional peoples in a variety of socioeconomic and political systems. At the same time, we acknowledge that various responses might be possible, as no environmental challenge forces a human population to change in a particular way.

Given the biological realities, we should expect that the prolonged droughts of the Medieval Climatic Anomaly impacted the availability of food and water to the degree that human societies experienced significant demographic stress. With this expectation, we turn to the archaeological records of four regions in western North America to determine whether important cultural changes can be explained as direct or indirect effects of stress. Because this study is concerned with the relatively recent past, the archaeological record ought to be sufficiently detailed to provide the information required to demonstrate synchrony, as well as

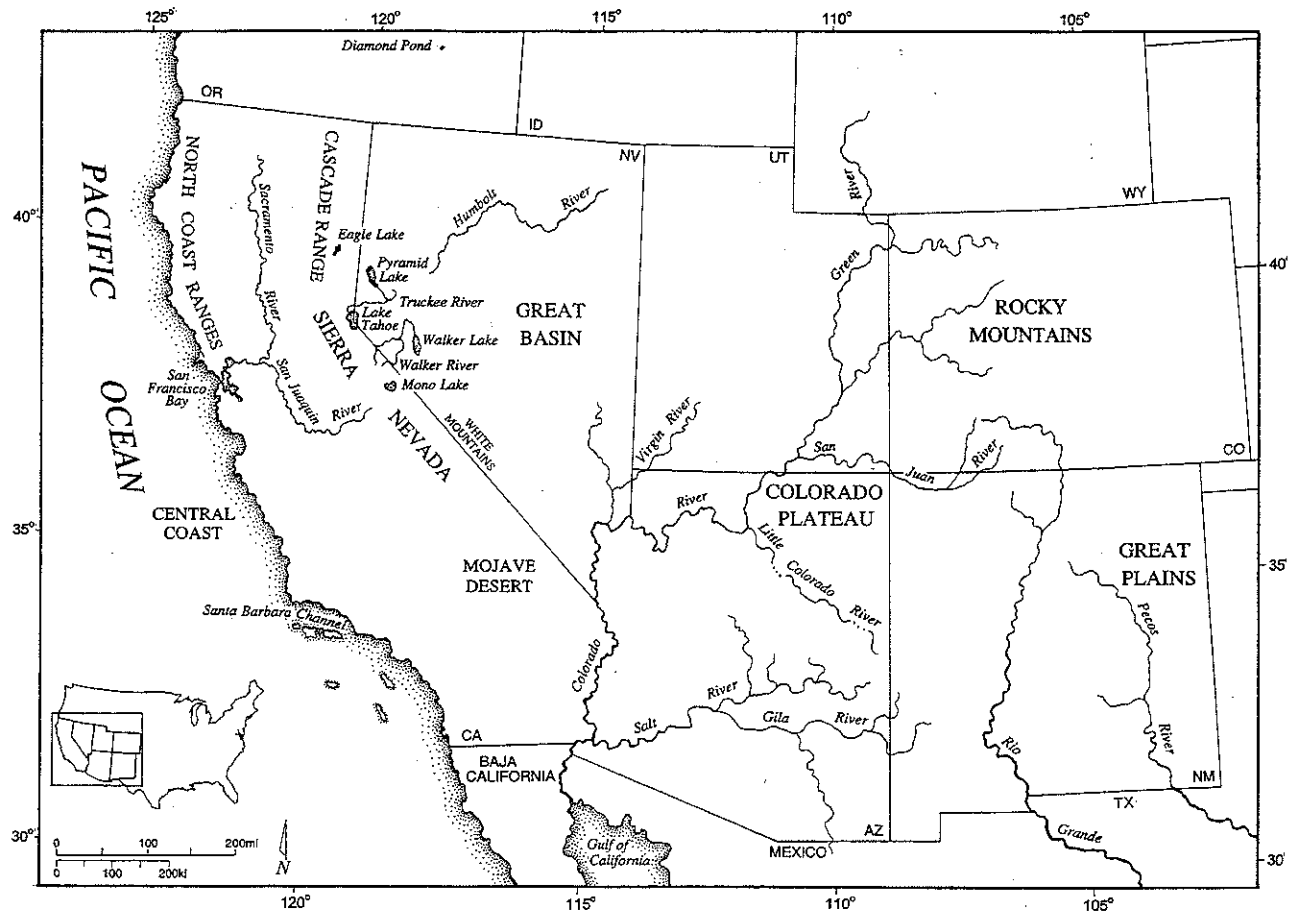


Figure 2.1. Major geographic regions of the southwestern United States.

to provide enough detail to determine whether changes are consistent with predicted responses to environmental stress and resource shortages. Given the differences in subsistence strategies, population density, social organization, and bioclimatic context in the regions we examine, we should expect to see a spectrum of human responses. Nevertheless, we can also anticipate evidence for population reductions resulting from reduced ecosystem carrying capacity, along with population shifts to areas with more predictable/productive resources. Sociopolitically, reduced resource availability should be reflected in increased competition between groups and social stress within groups. The alternative hypothesis based on adaptationist perspectives would posit little or no demographic stress and a less tumultuous past; as incremental population growth continued, simple adaptive adjustments would be made: for example, more low-ranked foods would be added to diets, new extractive technologies would be developed, and intergroup trade would increase.

Our chapter unfolds in four parts. After discussing past and current perceptions of prehistoric human ecology in western North America and reviewing late Holocene paleoenvironmental records showing the evidence for wide-

spread and prolonged aridity during the Medieval period, we present archaeological case studies from the Colorado Plateau, the central California coast, the southern California coast, and the Mojave Desert (Figure 2.1), all of which show signs of significant cultural flux synchronous with periods of drought. To establish these droughts as the sole cause of major cultural changes, however, is simply not tenable since, more often than not, human behavior is a response to multiple social and environmental variables (Moratto et al. 1978:151). In each case, attributing certain significant cultural changes to demographic stress resulting from severe downturns in environmental productivity is nonetheless warranted, since trends in the archaeological record are not consistent with predictions of economic intensification or simple adaptation.

ECOLOGICAL THEMES IN WESTERN NORTH AMERICAN PREHISTORY

The influence of environment has long been a theme in western North American prehistory and ethnology. In 1938 Julian Steward suggested that hunter-gatherer lifeways in the Great Basin were heavily influenced, but not

determined, by difficulties of local ecology: "This, however, must not be construed as 'environmental determinism,' which is generally understood to postulate some kind of automatic and inevitable effect of environment upon culture" (Steward 1938:2). Jesse Jennings's (1957) Desert Culture model was more deterministic. It envisioned a mobile, opportunistic hunter-gatherer lifeway that persisted largely unchanged in the Great Basin for more than 9,000 years as an effective, if not necessary, adaptation to extreme environmental conditions. A counterproposal was developed by Robert Heizer and his students (Baumhoff and Heizer 1965; Layton 1970), who argued that most of the Great Basin was abandoned because of hot, dry conditions during the Altithermal, a warm interval originally defined by Antevs (1948, 1953) and variously dated between ca. 8000 and 4000 years B.P. People were thought to have returned to the basin only when climate ameliorated. A measure of determinism is implied in the putative inability of hunter-gatherers to cope with these conditions for thousands of years. On the California coast Glassow et al. (1988) suggested that populations of maritime hunter-gatherers in the Santa Barbara Channel (Figure 2.1) were suppressed during the Altithermal but increased dramatically when marine productivity improved afterward. This model perpetuates deterministic thinking about the Altithermal, as it draws parallels between natural productivity and human population with an inevitable human adaptation to increased environmental productivity. Moratto (1984) likewise suggested that human numbers decreased in California during the peak of the Altithermal and that much of the region's settlement and language history can be related to climatic fluctuations, with warm intervals spawning retreat from the arid sectors. Moratto et al. (1978) were the first to suggest that the period between A.D. 600 and 1400 may have been marked by social disruption and violence related to stresses wrought by an intense warm/dry episode. However, the distinctiveness of the Medieval Climatic Anomaly as an interval of crisis unmatched during the late Holocene is lost in Moratto's overarching model of continuous climate change and population migration.

Other recent conceptualizations of human/environment relationships among western North American hunter-gatherers attribute limited measures of cause to environmental change. Larson et al. (1994) suggested that the final native retreat from San Miguel Island in the Santa Barbara Channel to mainland Spanish missions coincided with a severe El Niño that rendered the island's marine resource base inadequate. This study was unprecedented in California for its consideration of global climatic influences on local culture change, although it attributed ultimate causality to the historical phenomenon of Spanish missionization. Of more relevance to the current discussion is the debate in southern California over the

relationships of environmental variability, subsistence, and exchange during the Middle-to-Late transition (ca. A.D. 1200–1300). In two provocative papers Arnold (1992a, 1992b) linked a dramatic increase in production of exchange commodities (shell beads) on Santa Cruz Island to an interval of warm sea temperatures and depressed marine productivity. Borrowing Gould's (1984) concept of punctuated equilibrium from paleontology, Arnold explained this purported emergence of elite-managed craft specialization as a response to catastrophic environmental change. More recently, however, Arnold et al. (1997) downplayed the role of environment as a primary causal variable (Raab and Bradford 1997). Arnold's thesis helped precipitate our own interest in the early centuries of the last millennium and the possibility that environmental deterioration was a cause of change over a much wider area than Santa Cruz Island or the Santa Barbara Channel.

Conceptualizations of human/environment relationships in the American Southwest have taken a course more similar to that of the Great Basin, where explanations of culture change related to the arid and unpredictable physical environment have a long history. Beginning with Douglass's (1929) discovery of the "Great Drought" in the tree-ring record of the late thirteenth century, periods of sustained drought and corresponding local and regional abandonments have been observed in many cases on the Colorado Plateau. Early efforts (e.g., Fritts et al. 1965; Wormington 1947), positing somewhat mechanistic responses, were replaced by more sophisticated models (e.g., Dean et al. 1985; Dean 1988a; Euler et al. 1979; Gumerman 1988; Lipe 1995) that recognize climate change as a significant causal variable within a systemic perspective. Although these models emphasize the potential for adjustment to environmental flux, some hint at the possibility of crisis emerging when populations exceed carrying capacity. Lipe (1995) summarized abundant evidence for social turbulence, including warfare, decreased interregional trade, and sociopolitical disintegration preceding the abandonment of large portions of the Colorado Plateau. Haas and Creamer (1992) likewise suggested that interpersonal violence was among the behaviors exceeding simple cultural adjustment to environmental stress. A growing body of correlations between drought-related environmental stress and population dynamics indicates that simple adaptive adjustment cannot account for many diachronic patterns in southwestern prehistory (e.g., Larson and Michaelson 1990; Larsen et al. 1996). Arguments against drought-related causality have also been advanced (e.g., Allison 1996; Lightfoot and Upham 1989; Plog 1990), but as Larson et al. (1996:218) have pointed out, it is premature to dismiss the influence of drought on prehistoric southwestern population trajectories. This is particularly the case when the ecological effects of large,

sedentary populations are taken into account. At the extreme, paleoecological data have been argued to indicate that deforestation of Chaco Canyon was due to fuelwood and construction demands (Betancourt 1990; Betancourt et al. 1983; Betancourt and Van Devender 1981; Samuels and Betancourt 1982). If such ecosystems were already stressed by the intensive land use practices of a sedentary population, a rapid shift to increased aridity could have had a dramatic impact on both environment and human populations.

HUNTERS VERSUS FARMERS IN THE FACE OF SUBSISTENCE STRESS

Although assertions that drought-related environmental problems influenced Puebloan agriculturalists have been made for nearly a century, the possibility of similar problems experienced by hunter-gatherers in adjoining areas of the Great Basin and California has only recently been considered. In addition to the Salinan myth recounted above, reference to drought-related famines can be found in ethnographic accounts of the Chumash (Walker et al. 1989:351), Pomo (Kniffen 1939:366), and Shoshone (Steward 1938:20). Nonetheless, with few exceptions (e.g., Arnold 1992a, 1992b; Walker et al. 1989), there has been little attempt to consider the archaeological implications of such events. Food shortages are thought to have been relatively brief and predictable seasonal phenomena (see de Garine and Harrison 1988:vi). Such short-term famine and mortality would leave no lasting, large-scale archaeological signatures.

Though there appears to be little attempt to recognize crisis events outside the Southwest, there has been ample consideration of the effectiveness of hunter-gatherer subsistence practices relative to those of agriculturalists in fending off catastrophic famine. Most of these theories have been developed as explanations for the advent and/or acceptance of agriculture by some hunter-gatherers and the persistence of foraging lifeways among others (Shnirelman 1992; Testart 1988). Hunter-gatherers of western North America inhabited a full spectrum of environments, from the diverse terrestrial/marine ecotone of the Santa Barbara Channel to the depauperate, arid regions of the Mojave Desert and the Great Basin. An early opinion on resource diversity and famine was offered by Kroeber, who suggested that California's varied environment rendered its inhabitants immune to catastrophe:

The food resources of California were bountiful in their variety rather than in their overwhelming abundance. . . . If one supply failed, there were hundreds of others to fall back upon. If a drought withered the corn shoots, if the buffalo unaccountably shifted, or if the salmon failed to

run, the very existence of peoples in other regions was shaken to its foundations. But the manifold distribution of available foods in California and the working out of corresponding means of reclaiming them prevented a failure of the acorn crop from producing similar effects. It might produce short rations and racking hunger, but scarcely starvation. (Kroeber 1925:524)

For Indians in the resource-poor Great Basin, however, Steward (1938) felt that famine was an intrinsic part of their existence and that it contributed to low population density.

Kroeber's perspective has been replaced by the recognition that groups throughout western North America were dependent on storage (Testart 1982), including of acorns in California and pine nuts in the Great Basin. Acorn economies, in particular, are now seen as highly inefficient and labor-intensive (e.g., Basgall 1987). Dense, sedentary populations associated with them have repeatedly been likened to those supported by agriculture in the Southwest (Baumhoff 1978; Bean and Lawton 1976; Meighan 1959a). Nearly all archaeologists assume these storage-dependent economies arose from nonstoring, New World predecessors (see Basgall 1987; Glassow 1991b; Wills 1988). Testart (1988) makes a strong case that storage-dependent hunter-gatherers were more at risk from long-term shortfalls than were nonstoring foragers. Although storage is a mechanism for countering seasonal shortfalls, storage-reliant hunter-gatherers were inevitably dependent on a few staples suited for long-term storage, the failure of which could cause significant subsistence problems (Testart 1988:173). In these intensive economies, storage did not provide insurance against shortfalls that persisted longer than a few seasons. As a consequence, Testart (1988:173) suggested that the level of susceptibility of storage-reliant hunter-gatherers to food shortages and catastrophic famine was probably comparable to that of agriculturalists. It is worth mentioning Cohen's (1977) likening of the demographic stresses that precipitated the advent/acceptance of agriculture by hunter-gatherers to a crisis-like situation caused strictly by human population growth. If agricultural and intensive hunting and gathering economies incorporated or caused stresses under concomitant environmental circumstances, episodes of rapid environmental deterioration would have had the potential to cause serious subsistence stress.

Historic accounts reveal any number of environmentally induced crises among hunter-gatherers in different parts of the world (Shnirelman 1992:28). Among foragers living adjacent to agriculturalists or pastoralists, such crises often spawned shifts in subsistence. Some !Kung San, for example, engaged in farming during periods of abundant precipitation but mostly foraged during

normally dry and drought years (Shnirelman 1992:34). Upham (1982, 1984a) argued that a similar dynamic existed among Puebloan societies of the American Southwest, with drought-related crop failures precipitating increased hunting and gathering. In aboriginal economies unexposed to agriculture, economic orientation did not change in the face of periodic resource shortfalls, and death rates sharply increased (Shnirelman 1992:34). Hunter-gatherers can shift to food production under demographic pressure only where conditions allow farming and when the ecological transition is gradual enough to provide people with time to transform their subsistence practices and value systems (Shnirelman 1992:34). Without these factors a demographic crisis could result in disintegration of economies, interregional aggression, violence, and extinction of some groups. We believe the archaeological record of the Medieval Climatic Anomaly in western North America reflects a time when demographic crises of this type were widespread because of a convergence of growing populations and abrupt declines in biotic productivity caused by prolonged and severe droughts.

SYNCHRONY OF INTERREGIONAL PALEOENVIRONMENTAL CHANGE

Evidence for significant environmental variability during the Medieval Climatic Anomaly is now available from various locations beyond the limits of the Puebloan area, including the California coast and arid interior deserts in southern California and the Great Basin. During this interval there were widespread and prolonged periods of decreased precipitation and frequent drought (Stine 1990, 1994), warm summer temperatures (Graumlich 1993), and high incidence of fires (Swetnam 1993). Some (e.g., Arnold 1992a, 1992b; Colten 1993) argue that low marine productivity during an extended interval of warm sea temperatures (i.e., a 100-year El Niño [Arnold 1992b: 133]) contributed to problems along the California coast. However, more recent studies suggest the Medieval period was characterized by low frequency and intensity of El Niños (Anderson 1994) and that drought-related decreases in terrestrial productivity were much more significant than changes in the marine environment (Colten 1995). Evidence from a variety of interior settings suggests that the period between ca. A.D. 800 and 1350 was a time of generally warm climate (e.g., Hughes and Diaz 1994), but the entire 600-year period was not consistently warm and dry throughout western North America. Rather, it was punctuated by two intervals of extreme drought (Graumlich 1993; Stine 1994) with a shorter intervening period of high rainfall in some localities (Leavitt 1994). Although some researchers emphasize high climatic variability during the period (e.g., Dean 1994), a cursory

examination of high-resolution Holocene paleoenvironmental records (e.g., Graumlich 1993; Kreuz et al. 1997) reveals that variability is more the rule than the exception. Here we focus on the effects of what appear to have been severe and protracted droughts in the Great Basin, Sierra Nevada, Mojave Desert, and Colorado Plateau.

The Great Basin and Sierra Nevada

Significant dry intervals during the Medieval period are indicated by fine-grained records from the western Great Basin, where Stine (1994:549) produced compelling evidence for "epic" droughts ca. A.D. 892–1112 and 1209–1350 based on dating of drowned tree stumps at Mono Lake and several other locations. The stumps are derived from trees that grew when lake levels dropped. He contended that these droughts were anomalous in their severity relative to the rest of the Holocene and were much more severe and prolonged than anything known historically. Data from the bristlecone pine (*Pinus longaeva*) tree-ring sequence in the White Mountains (LaMarche 1974:1047) match the patterns identified by Stine. The early centuries (ca. A.D. 800–1050) of the Medieval period were marked by cool, dry conditions (overlapping Stine's first epic drought), followed by a warm, wet interval ca. A.D. 1050–1150 (also reported by Leavitt [1994]), followed by warm, dry conditions between A.D. 1150 and 1330 (approximating Stine's second drought). Relatively coarse-grained paleoenvironmental records from elsewhere in the western Great Basin (e.g., Lead Lake in western Nevada and Diamond Pond in eastern Oregon [Wigand et al. 1990]) indicate aridity between ca. A.D. 1 and 1400, with some equivocal suggestions of wet conditions between A.D. 500 and 1000 (Currey and James 1982; Davis 1982).

Clear evidence of warm and dry conditions during the Medieval Climatic Anomaly in the Sierra Nevada was reported by Graumlich (1993), based on a tree-ring sequence covering the last millennium. She argued that the period between A.D. 1100 and 1375 was highly unusual because of increased summer temperatures that peaked ca. A.D. 1150. Severe droughts were evident at ca. A.D. 1020–1070, 1197–1217, and 1249–1365, but Graumlich felt these were less anomalous relative to the precipitation cycle of the last millennium than were the high summer temperatures. She further argued that anomalous temperatures were a product of converging external climatic factors (e.g., volcanic ash, solar events) with internal oscillations (ocean circulation patterns) (Graumlich 1993: 254). Corroborating this portrait of Sierran conditions is a 2,000-year record of fire scars in giant sequoias (*Sequoia gigantea*). Citing earlier studies that demonstrated a correlation between areas burned in the United States and the

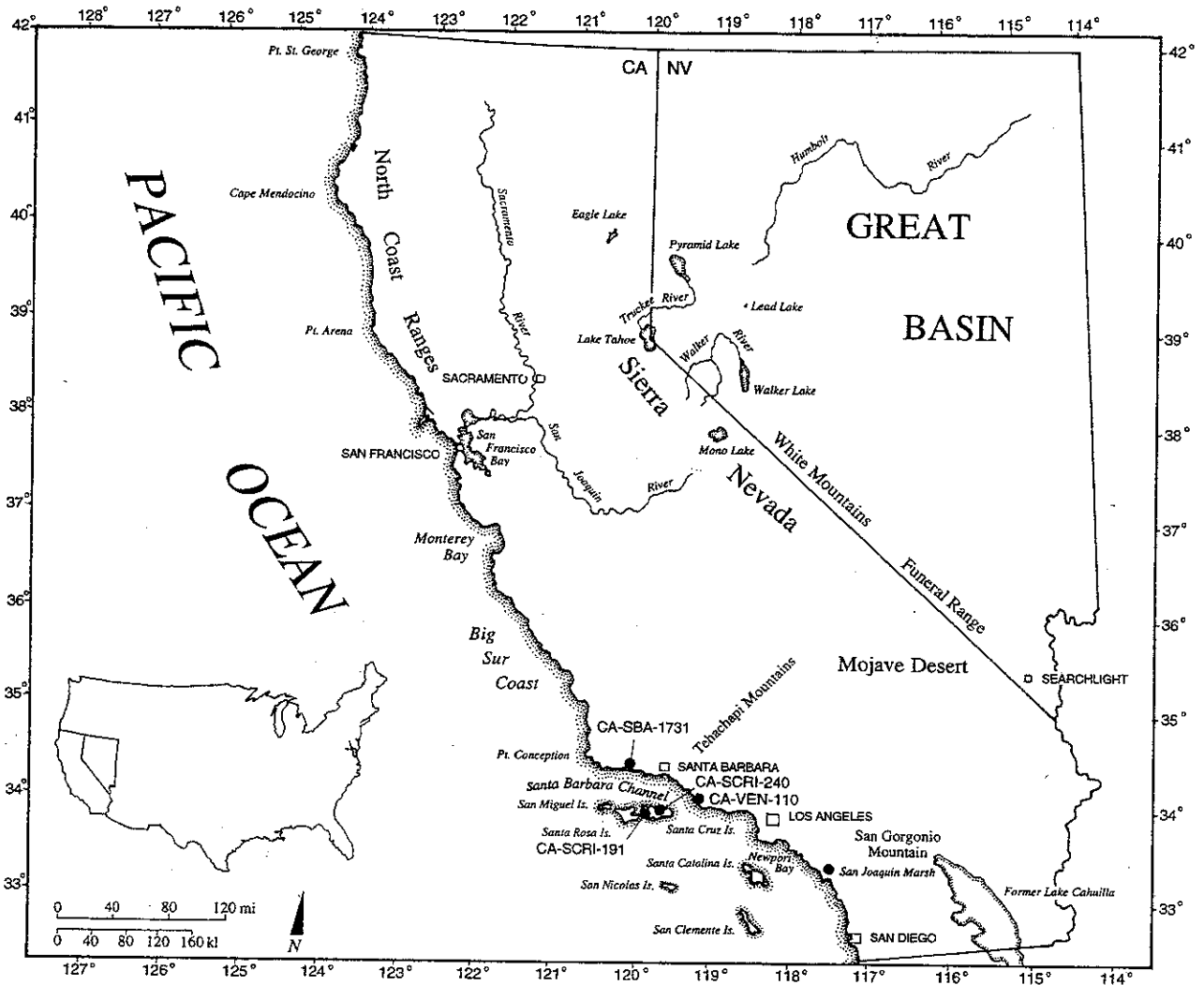


Figure 2.2. California, the western Great Basin, and selected sites.

El Niño Southern Oscillation (Swetnam and Betancourt 1992), Swetnam (1993:887) found that fire frequencies were higher in the southern Sierra between A.D. 1000 and 1300 than during any other interval in the last two millennia.

Southern California Coast

Larson and Michaelson (1989) and Larson et al. (1994) summarized a 1,600-year tree-ring record that elucidates the paleoclimate of coastal southern California. This sequence includes evidence for droughts between A.D. 750 and 770, followed by high rainfall between A.D. 800 and 980, then by rapidly developing drought between A.D. 980 and 1030. Conditions were wetter between A.D. 1030 and 1100, but the interval between A.D. 1100 and 1250 was one of sustained drought, with the period between A.D. 1120 and 1150 being particularly harsh (Larson and Michaelson 1989:23). This last drought partially overlaps

with warm, dry conditions in the Sierra Nevada and at Mono Lake, detected by Stine (1994) and Graumlich (1993).

A reconstruction of southern California coastal vegetation from a 7,000-year pollen core from San Joaquin Marsh (Figure 2.2), located 7 km from the Pacific Ocean at the head of Newport Bay (Davis 1992), also provides evidence for dry conditions during the Medieval Climatic Anomaly. The marsh is a paleo-estuary that has alternated between fresh- and saltwater conditions. Decreased stream flow and lower discharge of springs feeding the marsh caused saltwater incursions marked by lower pollen deposition and sedimentation rates, the presence of marine-estuarine organisms such as dinoflagellates and foraminifera, and the pollen of salt marsh plants (Davis 1992:93). Conversely, periods of high stream flow are marked by comparatively rapid sedimentation rates, abundant palynomorphs, and high percentages of Compositae pollen from terrestrial communities (Davis 1992:

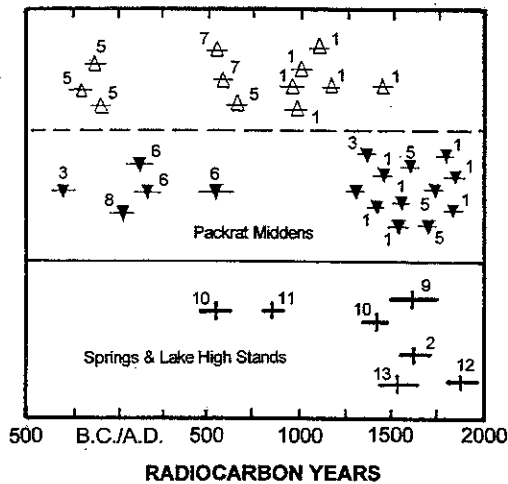


Figure 2.3. Paleoenvironmental records from the Mojave Desert and lower Colorado River Trough. Packrat midden records of xeric vegetation conditions (open triangles pointed up) and mesic vegetation conditions (closed triangles pointed down) are compared with paleohydrologic records from springs and lake high stands. Numbers refer to Table 2.1.

92–98). Before ca. 1000 B.C. Compositae dominates the pollen record, but ca. A.D. 200 composite pollen is supplanted by Chenopodiaceae-*Amaranthus*, indicating salt-water incursion and reduced freshwater runoff. These conditions persisted until ca. A.D. 1500. Although this record is one of low temporal resolution, suggesting a longer-lived phenomenon than indicated by tree rings, it is nonetheless chronologically consistent with other paleoenvironmental indicators from the central and southern California coast.

Mojave Desert

Although the Mojave Desert is part of the Great Basin culture area, we distinguish between the distinctly different bioclimatic realms of the two deserts. The Great Basin Desert is a largely semiarid, steppe environment with generally more productive valley-bottom and montane communities whereas the Mojave Desert is primarily arid and supports vast expanses of low-productivity desert scrub. Late Holocene paleoenvironmental records from the Mojave Desert and the trough of the Lower Colorado River were previously assessed for evidence of drought during the Medieval period. The clearest data come from packrat midden and paleohydrologic records that indicate enhanced aridity beginning by A.D. 600 and lasting until at least A.D. 1200 (Figure 2.3, Table 2.1). During this period packrat midden records of xeric vegetation are common, and there are few records of mesic vegetation. Furthermore, there are essentially no published records of increased spring activity or desert lake high stands between A.D. 900 and 1350 (Figure 2.3). One record (“12” in Figure 2.3) from that period is from a spring in the Las Vegas

Valley that remained active even after the local aquifer was significantly drawn down from heavy urban pumping in modern times (deNarvaez 1995). The absence of evidence for such paleohydrologic features during the Medieval period is significant, particularly in contrast with the following centuries of colder and wetter climate, referred to by some as the Little Ice Age (see Gribbin and Lamb 1978; Grove 1988). The autecology of plant species that were restricted to higher elevations during this period suggests that the Medieval Climatic Anomaly was characterized by warmer winter temperatures. The paleohydrologic data speak more directly to changes in precipitation and consequent recharge and runoff. General lack of evidence for spring activity and lacustrine events in the desert interior indicates less winter precipitation during the Medieval Climatic Anomaly than during succeeding centuries.

Blackbrush (*Coleogyne ramosissima*) desert scrub is a relatively high-productivity vegetation type currently restricted to elevations above 1,200 m by moisture deficits near its lower limit (Beatley 1975). Packrat midden studies clearly show descent of this vegetation into warmer habitats near the end of the Medieval period in the Mojave Desert. The downward migration of this mesic vegetation type suggests that conditions had previously been warmer and drier. Stratigraphic and archaeofaunal evidence for perennial lake stands in the currently hyperarid Mojave Sink (Figure 2.3, Table 2.1) provide strong contrast with the preceding Medieval Climatic Anomaly.

Immediately southwest of the Mojave Desert in the Salton Sink, the timing of the episodic filling and desiccation of Lake Cahuilla stands out as distinctly different from the chronologies of drought related above. Geomorphic analysis, as well as the historic record, demonstrates that these lake high stands were forced not by climate change but by the shifting of the Lower Colorado River channel (Fenneman 1931; Waters 1983). Although expansive, the deltaic cone of the Colorado River provides an alluvial barrier only about 15 m high between the river and the Salton Sink, and because the latter is below sea level, the river periodically breaches this barrier and fills the basin. This episodically created freshwater lake covered an area of approximately 5,700 km², with a maximum depth of about 96 m, in response to events that have no known relation to climatic change. The earlier chronology of Lake Cahuilla is not well known, but there are sufficient stratigraphic exposures to establish the timing of younger late Holocene lake episodes. The oldest lacustrine interval dates to about 350 B.C. After this time there were four closely spaced lacustrine intervals between ca. A.D. 550 and 1550, each punctuated by abrupt desiccation and refilling (Waters 1983). It appears that Lake Cahuilla was often full during the Medieval period, although not necessarily as a result of climatic factors.

Table 2.1. Sources of Data on Environmental Change in the Mojave Desert and the Lower Colorado River.

NO.	LOCALITY	INDICATOR	REFERENCE
1	Vicinity of Searchlight, extreme southern Nevada	<i>Coleogyne ramosissima</i> presence/absence	Hunter and McAuliffe 1994
2	Mojave Sink, central Mojave Desert	Lacustrine sediments indicating perennial lake stand	Enzel et al. 1992
3	Picacho Peak, vicinity of Yuma, extreme southeastern California	<i>Hilaria rigida</i> presence	Cole 1986
4	Hornaday Mountains, Sonora, immediately northeast of the head of the Gulf of California	<i>Cercidium floridum</i> , <i>Prosopis juliflora</i> presence/absence	Van Devender et al. 1990
5	Greenwater Valley, Funeral Range, immediately east of Death Valley, eastern California	<i>C. ramosissima</i> and <i>Eriogonum fasciculatum</i> presence/absence	Cole and Webb 1985
6	Fortymile Wash, eastern Amargosa Desert, southern central Nevada	<i>Purshia glandulosa</i> and <i>Larrea tridentata</i> covariance	Spaulding 1990
7	Granite Mountains, central Mojave Desert, California	<i>C. ramosissima</i> , <i>Salvia mohavensis</i> , and <i>Ephedra viridis</i> abundance	Spaulding 1995
8	Sheep Range, southern Nevada	<i>Pinus monophylla</i> and <i>Juniperus osteosperma</i> abundance	Spaulding 1981
9	Amargosa Desert, southern Nevada	Peat growth indicating spring discharge	Mehring and Warren 1976
10	Northern Las Vegas Valley, southern Nevada	Organic-rich spring-margin sediments	Haynes 1967
11	same as above	same as above	deNarvaez 1995
12	Mojave Sink, central Mojave Desert	Freshwater clam (<i>Anodonta californiana</i>) middens	Drover 1979
13	same as above	Tufa indicating lake high stand	Berger and Meek 1992

Note: Trough employed in the Figure 2.3 synthesis.

Colorado Plateau

Paleoclimatic reconstructions for the late Holocene on the Colorado Plateau are based on tree rings, pollen, plant macrofossils, faunal remains, and geomorphology. High-resolution dendrochronological data (Dean 1988a, 1988b; Dean and Robinson 1977; Euler et al. 1979) reveal a series of droughts during the first millennium A.D., with a major drought at least once every century, until ca. A.D. 750, when they decreased in magnitude until the late 900s. The latter period was dry but accompanied by pronounced temporal variability in effective moisture. After A.D. 1000 temporal variability declined, but spatial variability in moisture increased until ca. 1140. A long-term drought (ca. 1065–1100) occurred during this period, the effects of which were probably offset in some areas by spatial variability in effective moisture. A few decades later another long-term drought (ca. 1130–1150) was followed by a series of shorter, less intensive droughts that culminated in the Great Drought, dating from 1276 to 1299. These arid conditions were followed by a period of consistently above-average moisture from 1300 to 1350, after which dry conditions returned.

Changes in temperature, evaluated independently from

effective moisture reconstructions, are indicated by timberline fluctuations and pollen from montane sediments (Peterson 1987, 1988). Much of the last two millennia was cool, with warmer conditions prevailing from A.D. 800–900 and 1100–1200. Most of the prolonged droughts indicated by the tree rings coincided with cool temperatures, except for one that occurred during a twelfth-century warm interval. The Great Drought occurred after the onset of cooler conditions in the thirteenth century which persisted into the Little Ice Age.

Geomorphic studies indicate significant hydrological variability during the Medieval Climatic Anomaly. A study of several major rivers documented a prolonged period of regular flooding between 400 B.C. and A.D. 1200 with a peak in flood frequency and magnitude during the last 200 years of this period (Ely et al. 1993). A decline in flood frequency between 1200 and 1400 was followed by a second prolonged period of flooding that persisted to the present. In a study of hydrologic variability in intermittent drainages, a stable hydrologic regime was identified throughout the first millennium A.D., shifting to unstable conditions between A.D. 1100 and 1300 (Agenbroad et al. 1989). A return to stable hydrologic conditions followed, with brief intervals of instability occurring in the last 300

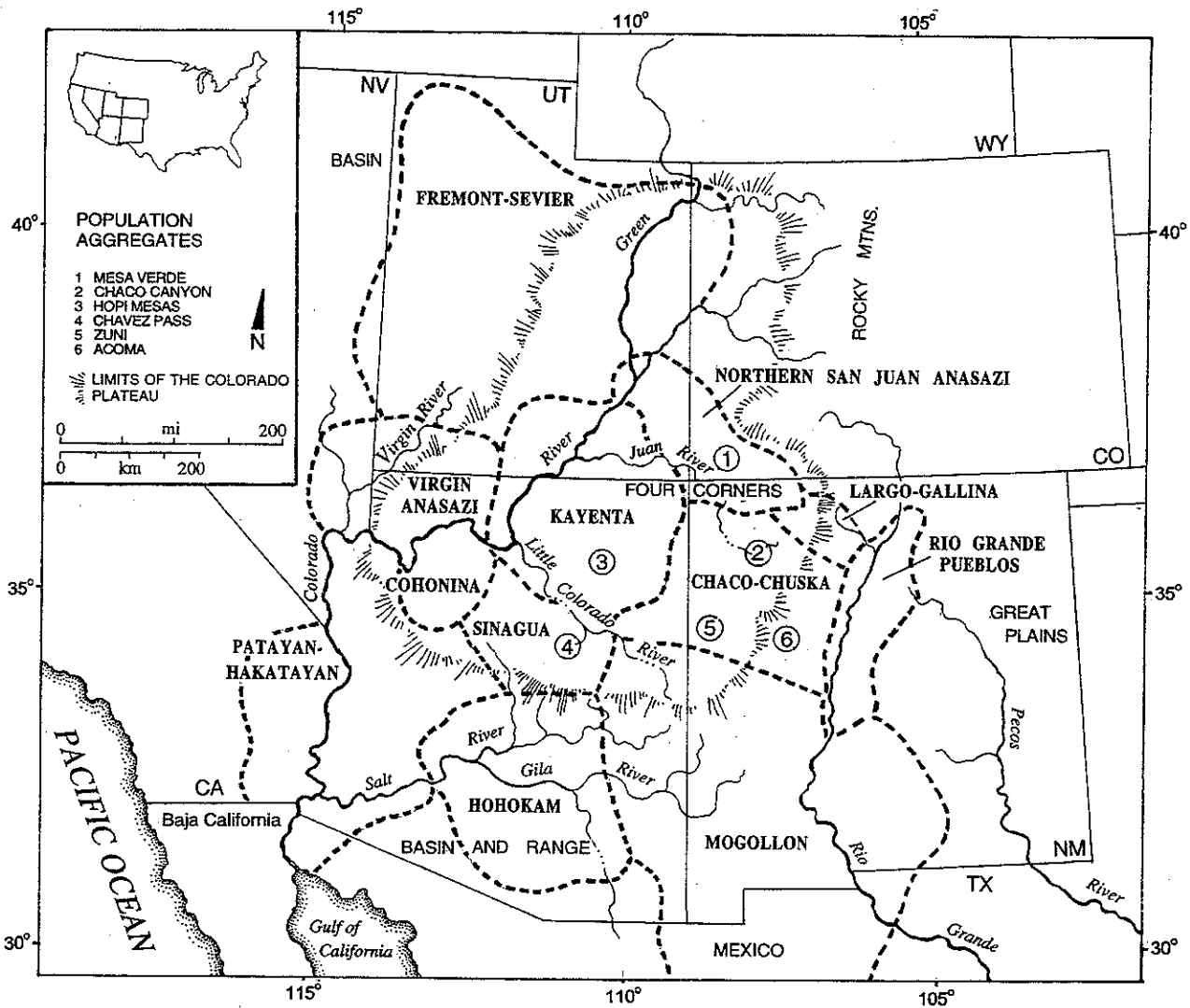


Figure 2.4. Major archaeological regions of the American Southwest.

years. The first shift to unstable hydrologic conditions occurred during peak flooding in the perennial drainages. For the most part, however, instability in intermittent drainages coincided with a decline in flood intensity on major rivers. The lowering of water tables along intermittent drainages during peak flooding of rivers may indicate a decline in summer precipitation and a possible increase in temperatures coinciding with increased winter moisture. However, summer and winter moisture both appear to have lowered dramatically between 1200 and 1300 and to have increased after that time.

Although the Colorado Plateau is generally semiarid, these studies show that from ca. A.D. 1050 to 1300 a series of significant changes occurred in the region: (1) major droughts became common, occasionally occurring as sustained intervals of substandard moisture on the order of a decade or more; (2) temperature increased, notably toward the middle of this arid period; and (3) unprecedented

hydrologic instability occurred in both primary and secondary drainages as water tables lowered and erosion increased.

CORRELATIONS WITH THE ARCHAEOLOGICAL RECORD: FOUR CASE STUDIES

Detailed consideration of late Holocene archaeological sequences from four regions of western North America shows striking correlations between changes in subsistence, interregional exchange, frequency of warfare and interpersonal violence, regional abandonments, and major population movements on the one hand and events in the paleoenvironmental record on the other. Specific cultural responses vary between regions, but each one shows diachronic changes that are difficult to attribute to simple adaptive adjustment or economic intensification. Rather, events in each of these regions are best explained as

responses to environmental deterioration and demographic stress. The most striking record comes from the Colorado Plateau, where fine-grained archaeological and paleoenvironmental sequences illuminate a convergence of growing populations with rapid drought-related environmental deterioration. The ecological effects of large sedentary populations on surrounding communities are likely to have exacerbated this situation. Other areas experienced contemporaneous deleterious effects. Diachronic patterns in three hunter-gatherer regions—the central California coast, the southern California coast, and the Mojave Desert—also show correlations that are not easily explained by incremental population growth, adaptive adjustment, or economic intensification.

Drought-Related Demographic Stress Among Agriculturalists: The Colorado Plateau

Correlation between the Great Drought (A.D. 1276–1299) and abandonment of the Four Corners area (Figure 2.4) is so close that many southwesternists have seen the two events as unquestionably linked, though others have emphasized the complexity of the process and variability in human responses. Major abandonments of portions of the Colorado Plateau show remarkable temporal and ecological correlation with paleoclimatic changes for the period examined here. The magnitude of these changes appears to have been considerable, especially between A.D. 1050 and 1300, when they were accompanied by alluvial instability and the beginning of a shift toward increased erosion and depressed water tables. This generally unstable period appears to have been significant enough to have impacted all traditional subsistence options, not just farming. Shifts from farming to hunting and gathering, as hypothesized by Upham (1984a), may have been theoretically feasible in favorable environments during times of relatively low population density but not when population reached the inflated levels common during the Medieval period (cf. Minnis 1985:146–150).

Agriculture was adopted about three millennia ago in much of the Southwest, but it took on real economic importance within the last two millennia as it spread throughout the Colorado Plateau (Ambler 1966; Berry 1982; Brown 1992; Hogan 1994; Larson and Michaelson 1990; Lindsay 1986; Wills 1988). Its spread during the first millennium A.D. occurred under conditions generally favorable to lowland farming (i.e., regular flooding in major river systems and stable alluvial systems in tributaries). Droughts may have periodically curtailed upland farming, but small populations could have concentrated their agricultural efforts in lowlands. After A.D. 1050 paleoclimatic data show more severe deterioration, including a variety of climatic, vegetational, and hydrologic processes.

The compounded impact on both farmers and hunter-gatherers must have been significant. However, another major reason that these paleoenvironmental changes had deleterious consequences was the great density of population across the Colorado Plateau by this time (Dean 1988b; Dean et al. 1985; Larson and Michaelson 1990; Plog et al. 1988; Van West and Lipe 1992).

It is widely recognized that during the Pueblo II period, from A.D. 900 to 1150, a population boom coincided with expansion into many new areas and a wide variety of habitats. Population density in most areas, and the regional population level throughout the Colorado Plateau, reached unprecedented highs during the late Pueblo II period (Cordell and Gumerman 1989; Euler 1988). This peak coincides with paleoenvironmental conditions conducive to hunting, gathering, and agriculture in both upland and lowland areas as indicated by high groundwater and geomorphic reconstructions (Brown 1996), followed by successive droughts toward the end of the eleventh century and early-mid twelfth century, preceding the Pueblo II–III transition. The period A.D. 1130–1150 marks a major decrease in effective moisture accompanied by heavy flooding and generally unstable alluvial systems, possibly marking a shift from summer-dominant toward winter-dominant precipitation. Puebloan occupation ended in major portions of the Colorado Plateau during the mid-1100s, especially in areas to the west and north. Termination of Virgin Anasazi settlement on the west is frequently attributed to long-term drought between A.D. 1120 and 1150 in the context of population growth (Larson 1987; Larson and Michaelson 1990; Schwartz et al. 1980, 1981); the end of occupation by many Fremont populations across the northern half of the Colorado Plateau may also be related to paleoclimatic change (Lindsay 1986). Although paleoenvironmental data suggest a temporary increase in effective moisture after A.D. 1150, this may have been too late to help many agricultural groups, particularly those inhabiting areas on the west and north characterized by winter-dominant precipitation patterns that were less beneficial to farmers.

Dean (1988b) cautioned against relating phase transitions to paleoenvironmental changes, yet the chronological correlations are compelling. Widespread abandonments toward the end of the Pueblo II period precede marked population aggregation, characteristic of the Pueblo III period (ca. A.D. 1150–1300), in the limited areas where Pueblo III sites are represented. Abandonment and concurrent aggregation might be linked as a single trend toward fundamental reorganization. In our view this transition is not just the kind of recognizable change in diagnostic material traits that Dean assumed to be typical of most phase transitions; it is a cultural transformation. The Pueblo III–IV transition is an even more remarkable in-

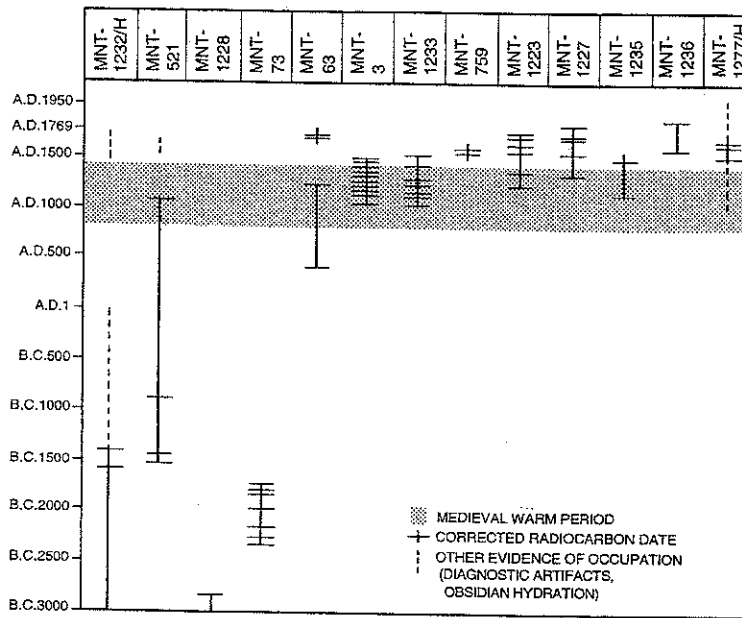


Figure 2.5. Settlement disruption during the Medieval Climatic Anomaly on the Big Sur coast of central California.

stance of organizational change that is at least partially attributable to environmental change. The Great Drought and the shift to cooler temperatures at the beginning of the Little Ice Age both put considerable stress on agricultural systems. Pueblo III population levels appear to have exceeded the carrying capacity of some areas; in conjunction with densely occupied neighboring areas, opportunities for relocating the large villages characteristic of this time were limited (Van West and Lipe 1992). In addition, many areas that were abandoned appear to have been undergoing a change toward relatively autonomous "tribal" polities characterized by intergroup warfare (Haas and Creamer 1992; Lipe 1995; Wilcox and Haas 1994), various kinds of sociopathic violence (Nickens 1975; Turner and Turner 1990, 1992; White 1992), and decreased interregional interaction (Green 1992; Neily 1983).

Why cultural systems across so much of the Southwest collapsed, instead of fissioning or implementing technological options such as agricultural intensification, remains an important issue. By A.D. 1300 all agricultural settlements in the northern Colorado Plateau and most in the central portion had been abandoned. The early Pueblo IV period (ca. A.D. 1300-1450) is represented in only a few parts of the southern edge of the Colorado Plateau, including the Hopi, Zuni, and Acoma areas, where Puebloan traditions persist to the present, and the Little Colorado drainage, where large towns were established during this period but abandoned during the fifteenth century. Although these areas could have absorbed some population from the Four Corners region, evidence of migrations is limited. The Rio Grande Valley east of the

Colorado Plateau and the transitional zone to the south are the most widely accepted recipients of major populations from the Four Corners region. The areas where significant Pueblo IV populations were located thus occur almost exclusively toward the south and east, in the directions of greater summer precipitation.

In addition to both agricultural intensification and diversification, Pueblo IV is characterized by some of the greatest evidence for exchange and specialized production of nonsubsistence commodities in the Southwest. Chavez Pass, on the southwestern margin of the Colorado Plateau, appears to have functioned as a gateway community that facilitated exchanges between the Colorado Plateau and groups inhabiting different environmental zones to the south (Upham 1982; Upham and Plog 1986). Communities such as Chavez Pass may have specialized in nonsubsistence economic activities such as production and exchange of pottery, obsidian, marine shell jewelry, and other exotic items (Brown 1982, 1990; Cordell and Plog 1979; Upham 1982). Such activities would have been crucial to the survival of groups in the area since they also appear to have exceeded the local carrying capacity (Upham 1984b). Systems of economic interdependence, typical of this period, may have provided alternative forms of organization to the autonomous tribal societies characteristic of many areas that had been abandoned by the end of the Pueblo III period (compare Upham 1982 with Haas and Creamer 1992). Where the issue has been examined, such alternative interregional economies appear to have developed initially about the same time as provincial tribal organizations elsewhere on the Colorado Plateau, that is,

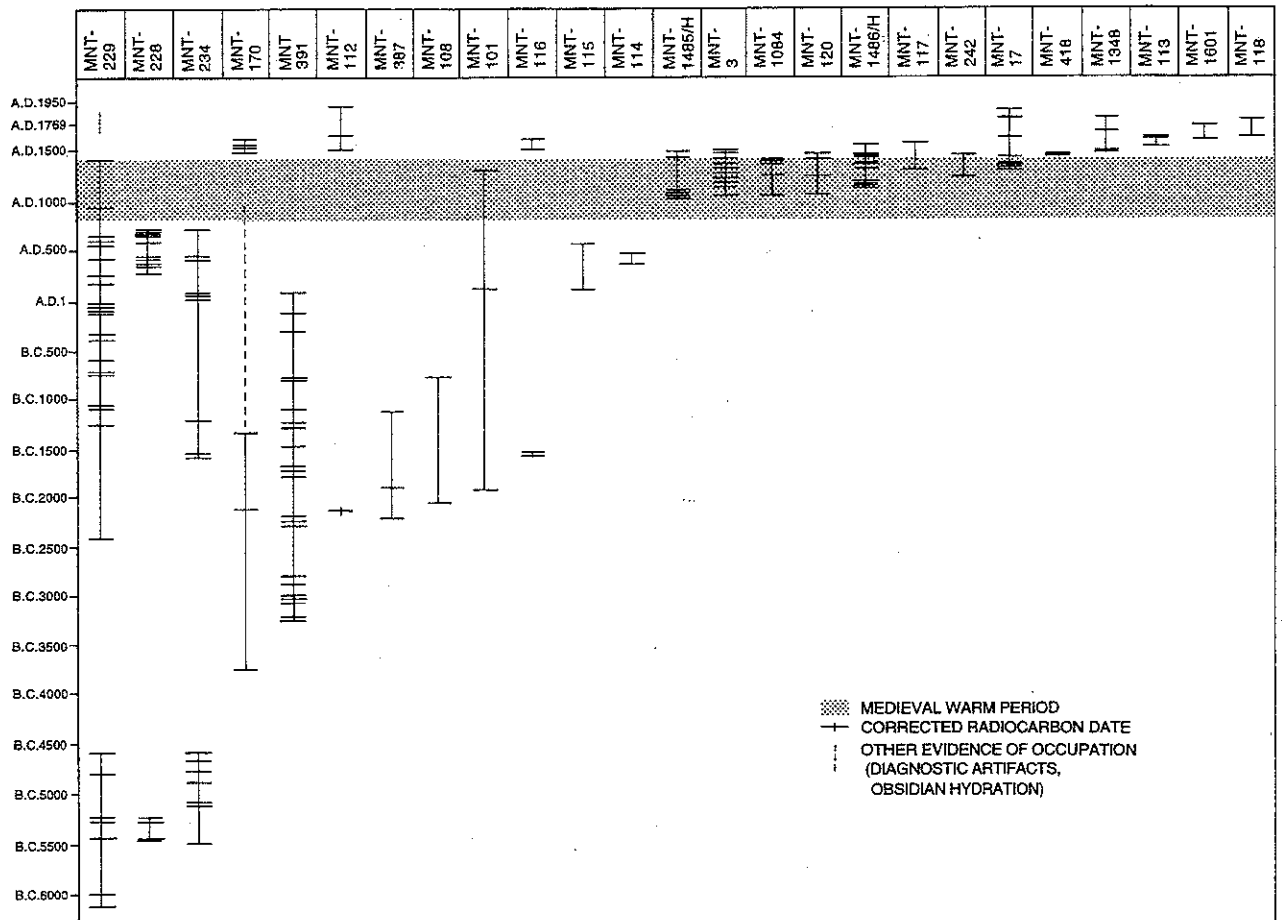


Figure 2.6. Settlement disruption during the Medieval Climatic Anomaly in the Monterey Bay area of central California.

during the Pueblo III period (Brown 1982, 1990). Thus, these two types of organization might represent differing means of coping with environmental stress, one that suffered widespread failure (abandonment) and the other developing into classic Pueblo IV regional systems.

Settlement Disruption and Exchange Deterioration Among Hunter-Gatherers: The Central California Coast

The suggestion that drought-related problems occurred in central California during the late Holocene was first advanced by Moratto et al. (1978), who associated signs of social disruption in the southern Sierra Nevada foothills between A.D. 600 and 1500 with warm, dry climatic conditions. The central California coast also shows changes in technology, settlement, and exchange during the Medieval Climatic Anomaly inconsistent with progressive social evolution or economic intensification. Rather, diachronic patterns show some similarities with parts of the Colorado Plateau, as the regional economy apparently reached peak intensity and sophistication during the early Medieval period and declined thereafter. The punctuated nature of

technological change in this region is striking, as is the chronological correlation with the interval of Medieval droughts. Artifact assemblages show little typological or stylistic change between 3500 B.C. and approximately A.D. 500, after which time smaller projectile points associated with the bow and arrow begin to appear in low numbers alongside large dart and/or spear points. Between A.D. 1200 and 1400, however, bow technology overwhelmed the earlier weaponry, as arrow points dominate assemblages thereafter (Jones 1995). This technological transition is coeval with a major disruption in settlement indicated by radiocarbon-based occupation sequences that show that few, if any, sites were continuously occupied through the Medieval Climatic Anomaly (Figures 2.5 and 2.6). Sites occupied earlier than A.D. 1200 show signs of abandonment, and settlements first inhabited ca. A.D. 1200-1400 are single components with no signs of earlier use.

Obsidian frequency profiles show that sites postdating A.D. 1000 yield far less of this trade commodity than earlier deposits. From 3500 B.C. until A.D. 1000 obsidian bifaces were regularly imported to the central coast from

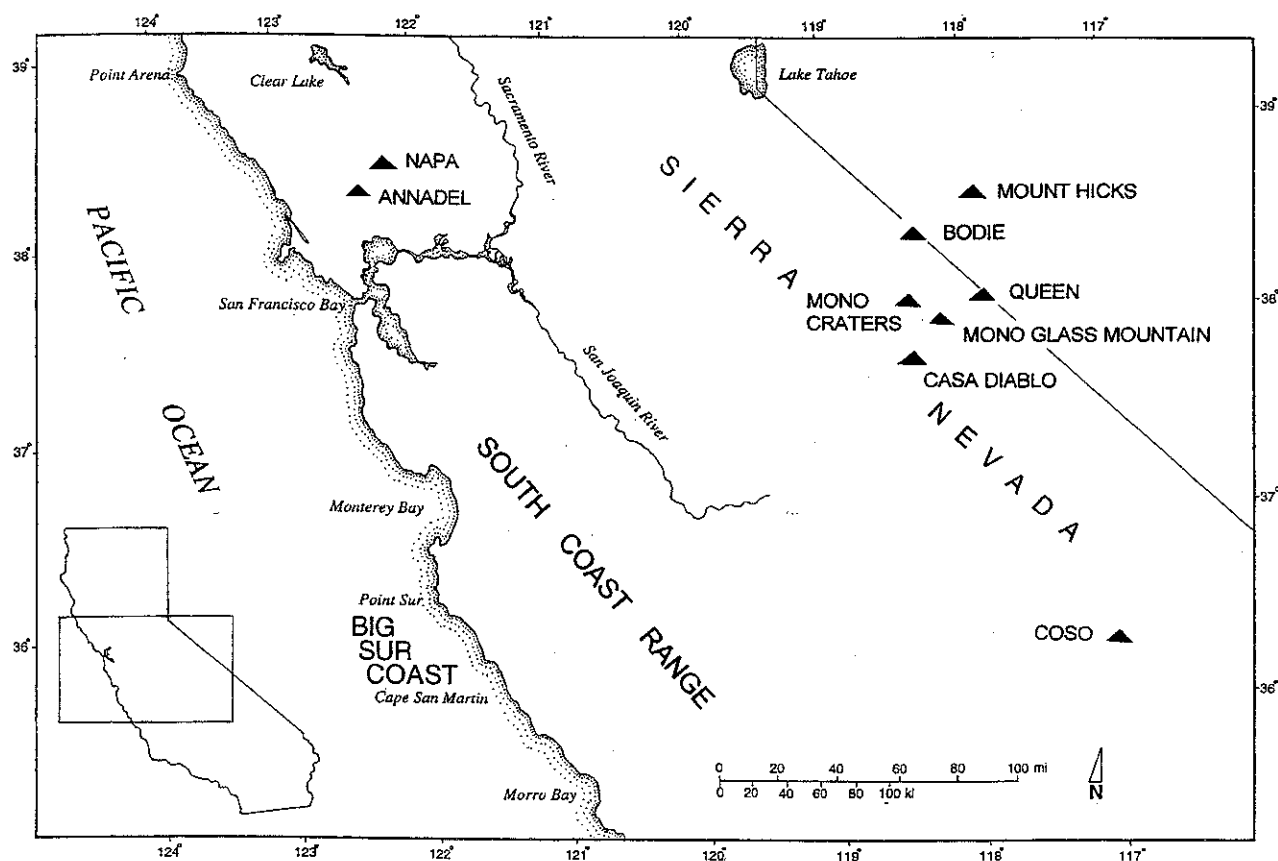


Figure 2.7. Obsidian sources represented at archaeological sites on the central California coast (from Jones 1995).

nine distant locations (Figure 2.7). Appearing in small quantities during the Early period (3500–600 B.C.), this commodity was increasingly abundant until A.D. 1000, after which time it disappeared from the record and never reappeared in significant quantities. An obsidian-hydration profile depicting results from more than 50 excavated sites shows the pattern clearly, as high frequencies of hydration readings fall into the Early and Middle period micron spans but almost none represent the Late period (Figure 2.8). Interregional exchange networks apparently deteriorated between ca. A.D. 1000 and 1300. A study of one of the obsidian quarries (Coso in the Mojave Desert) shows that production declined markedly after ca. A.D. 1275 (Gilreath and Hildebrandt 1995).

Chronological correlations between these archaeological transitions and droughts during the Medieval period do not prove environmental causality. Nonetheless, they are difficult to overlook inasmuch as the abrupt changes in settlement and exchange are inconsistent with the predictions of incremental population growth and subsistence intensification. Intensification models predict decreases in efficiency as labor-intensive commodities such as acorns and fish increase in dietary significance (Basgall 1987 [Chapter 6, this volume]), more diminutive quarry

are pursued (Broughton 1994b; Hildebrandt and Jones 1992 [Chapter 4, this volume]), exchange networks expand, and complex social structures evolve to complement increasingly sophisticated intergroup relationships (Jackson 1986). On the central coast many diachronic patterns leading up to the Medieval Climatic Anomaly are consistent with these predictions, but changes occurring between A.D. 1000 and 1400 are different in that diets did not continue to broaden and trade horizons contracted. It seems likely that these changes reflect demographic problems that could not be solved by simple adaptive adjustment or further intensification, and that settlement shifts and deterioration of exchange reflect large-scale population movements akin to those on the Colorado Plateau. The complex distribution of language stocks in California at the time of historic contact has long been recognized as a reflection of multiple prehistoric population movements (Kroeber 1955; Moratto 1984). Although the history of these movements is debated, there is growing evidence for massive shifts in central California during the Medieval period (Moratto 1984:560). This again reflects a correlation between environment and cultural change that suggests a causal relationship between the two processes.

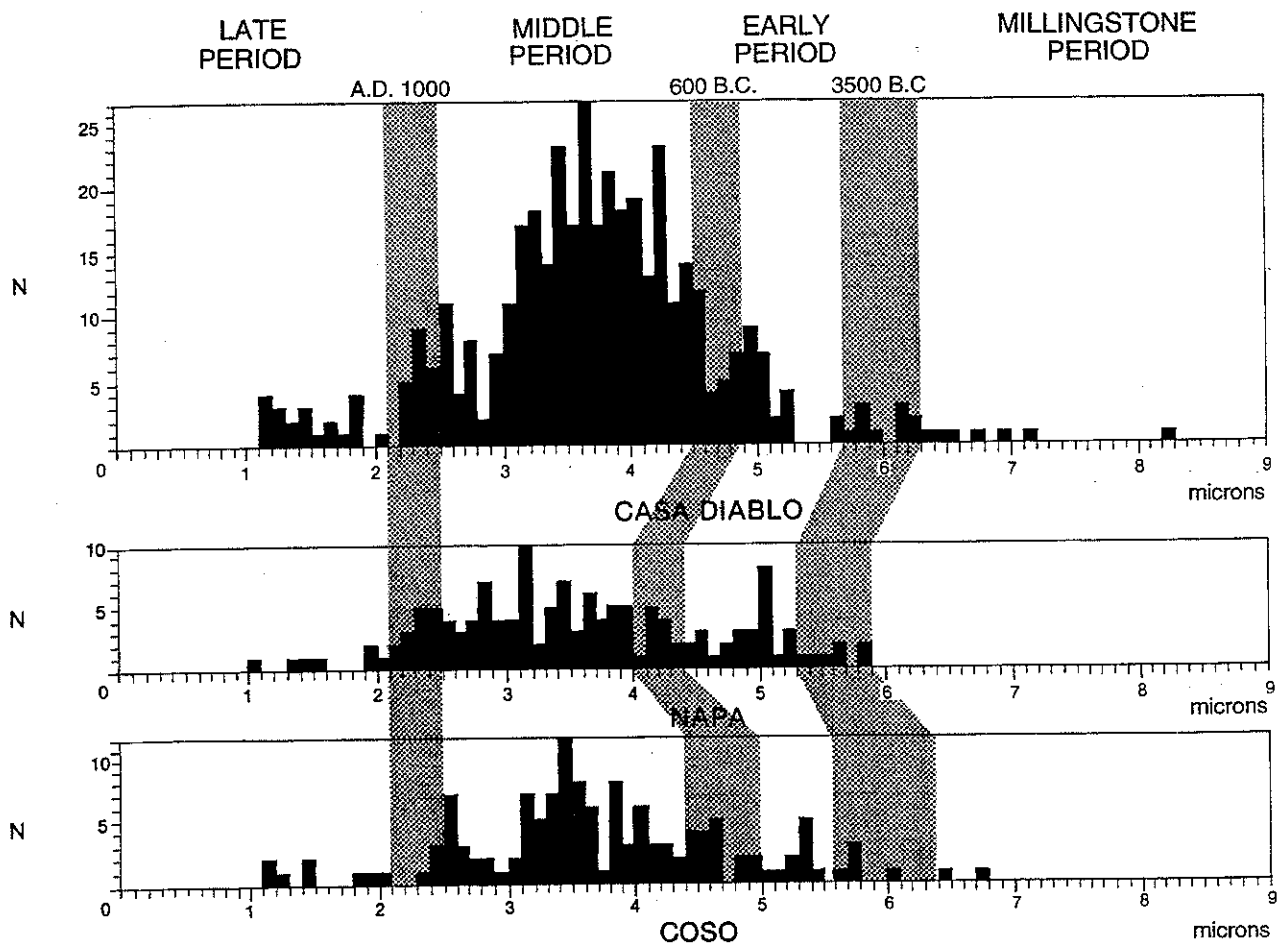


Figure 2.8. Obsidian-hydration profiles from the central California coast (from Jones and Waugh 1995).

Violence and Settlement Disruption Along the Southern California Coast

Evidence for abrupt cultural changes during the Middle/Late Transition (ca. A.D. 1200–1300), not readily accommodated by economic intensification or gradualist adaptive models, is also apparent along the southern California Bight. Like the Salinan myth recounted in the epigraph, ethnohistoric accounts of drought conditions have also been recorded for the Chumash (Walker et al. 1989:351). In the archaeological record, trends in settlement patterns, health conditions, violence, and regional trade are correlated with demographic stress during the Middle/Late Transition. Lambert and Walker (1991) and Arnold (1987, 1992a, 1992b) were among the first to call attention to these patterns, and Arnold (1992a, 1992b) specifically attributed changes during the Middle/Late transition to major climatic shifts. She reported distinctive signs of settlement disruption on Santa Cruz Island ca. A.D. 1200–1300, where many sites exhibit either an occupational hiatus or abandonment (Arnold 1992b:134). Detailed stratigraphic studies at sites CA-SCRI-191 (Cristy Ranch) and CA-SCRI-240 (Prisoner's Harbor) date occupational

hiatuses ca. A.D. 1250–1300 (Arnold 1992a:76). Islands such as Santa Cruz contain small rain catchments relative to the mainland; persistent drought conditions are likely to have had devastating impacts.

On the mainland a major settlement shift ca. A.D. 1000 in the San Diego area (Christenson 1992) is generally attributed to migration of Yuman and Shoshonean speakers from the interior (Warren 1968), although Moratto (1984:560) argued that this intrusion took place earlier. Marine foods seem to have increased in significance relative to terrestrial resources during the Middle/Late Transition, in contrast to Arnold's findings from Santa Cruz Island, but this trend is consistent with the mainland of the central coast. Faunal remains from CA-SBA-1731 suggest that marine resources provided an average of at least 76 percent of the animal protein consumed (Erlandson 1993b:191). At the same time that many sites on Santa Cruz Island were being abandoned, the inhabitants of this mainland site apparently turned to the sea for most of their protein needs, consistent with depressed terrestrial productivity during an interval of persistent drought.

Competition for scarce food resources, both marine

and terrestrial, was another apparent outgrowth of the Medieval Climatic Anomaly, as the needs to control food sources and remain in proximity to reliable sources of freshwater seem to have solidified boundaries and fostered a territorial settlement pattern (True 1990). High population density around water sources is also likely to promote disease (Walker 1986). Violent encounters between groups competing for vital resources would be another anticipated outgrowth of resource scarcity. Osteological signs of poor health and violence reached an all-time peak in the Santa Barbara Channel between A.D. 300 and 1150 (Lambert 1993 [Chapter 7, this volume]; Lambert and Walker 1991; Walker 1986, 1989; Walker and Lambert 1989; Walker et al. 1989). High levels of interpersonal violence are evident at CA-VEN-110 (Calleguas Creek) on the mainland coast near Point Mugu, where a large cemetery was established in the thirteenth century (Raab 1994). Whereas Walker (1989) interpreted compression fractures of the skull as products of ritualized, sublethal combat, arrow wounds in the individuals interred in the Calleguas Creek cemetery attest to warfare intended to inflict death. Documented projectile wounds are rare in most prehistoric burial populations on the south coast—with the exception of burial populations from the Middle/Late Transition. In a study of four prehistoric cemeteries in the Santa Monica Mountains dating as early as 400 B.C., Martz (1984) did not describe a single definite projectile wound. At Medea Creek, a historic period cemetery, King (1982:151–185) found that only 1.3 percent of more than 300 burials showed evidence of violence, including possible arrow wounds, skull fractures, dismemberment, and cannibalism. In sharp contrast, up to 10 percent of the burials at Calleguas Creek (A.D. 1200–1300) showed arrow wounds (Walker and Lambert 1989:210). Moreover, both males and females were victims, suggesting an unrestricted style of warfare or raiding in which entire communities were exposed.

Arnold (1992a, 1992b) linked emergent social complexity with environmental stress during the Middle/Late Transition in the Santa Barbara Channel. She contended that during this critical transition shell bead manufacture by specialists was brought under the control of chiefs in a system designed to buffer subsistence failures by providing a commodity that could be traded to groups on the mainland for food. Study of local mortuary patterns confirms that important shifts in social complexity took place ca. A.D. 1100 among the Chumash (Martz 1984:489–490), as a decline in the importance of the religious leaders was initiated coincident with an increase in the importance of the hereditary political group. This shift in status, and a corresponding increase in the proportion of subadults in burials with status objects, suggests the development of a nobility with an emphasis on lineage and ascription.

Trade relationships show significant evidence for

change during the Middle/Late Transition as well. Although *Olivella* and abalone shells were imported from the California coast to the Puebloan area at least as early as A.D. 500, the volume of trade increased significantly after A.D. 1000. Between A.D. 500 and 1150 Anasazi settlements on the lower Virgin River were importing large quantities of Pacific coast shells that are found as burial offerings, but this trade relationship ended when the Virgin River was abandoned ca. A.D. 1150. Between A.D. 900 and 1150 shells, steatite, and asphaltum from the Pacific coast were being imported by people living at the Willow Beach site near Hoover Dam on the Colorado River (Schroeder 1961). This expanded trade with Yuman peoples probably accounts for the presence of pottery of Anasazi and Hohokam manufacture in late Middle period sites around the Santa Barbara Channel, including Sacaton Red-on-buff sherds from the Gila River found at CA-LAN-267 (dating ca. A.D. 900–1100) (Ruby and Blackburn 1964; Walker 1951) and Cibola White Ware found at the Century Ranch site (CA-LAN-227) that probably was manufactured ca. A.D. 1000 (King et al. 1968:73). Southwestern pottery disappeared from the southern California coast after A.D. 1150.

Arnold (1987, 1992a, 1992b) documented a major increase in shell bead manufacture on Santa Cruz Island as an apparent strategy for buffering food shortages in this vulnerable insular setting. Manufacture and exportation of steatite artifacts also increased markedly ca. A.D. 1200 on Santa Catalina Island (Wlodarski et al. 1984). This increase in trade activities contrasts with the central California coast and seems to reflect geographically limited exchange tied directly to subsistence, as the goods produced on the islands are not found in large numbers away from the south coast mainland.

Hunter-Gatherers in Arid Environments: Population Decline and Aggregation in the Mojave Desert

The effects of climatic shifts on aboriginal populations in the Mojave Desert have been debated for decades. It has frequently been argued that since the biotic regime was, with minor variation, constant during the Holocene, human use of the region was little influenced by climate change (Basgall and Hall 1992). Water, not food, may have been the critical factor in foraging decisions under extremely arid conditions (Kelly 1995:126). In Australia's desert interior, for example, potential water shortfalls are a major risk factor, and decisions regarding group movement are often based on close monitoring of weather patterns (Gould 1980:60, 69–70; Yellen 1976; cf. Kelly 1995). In response to uncertainty, hunter-gatherers may "tether" themselves to reliable water sources, sometimes sacrificing foraging efficiency (Cane 1987; Kelly 1995). Extended droughts in the Mojave Desert during the Medieval Climatic

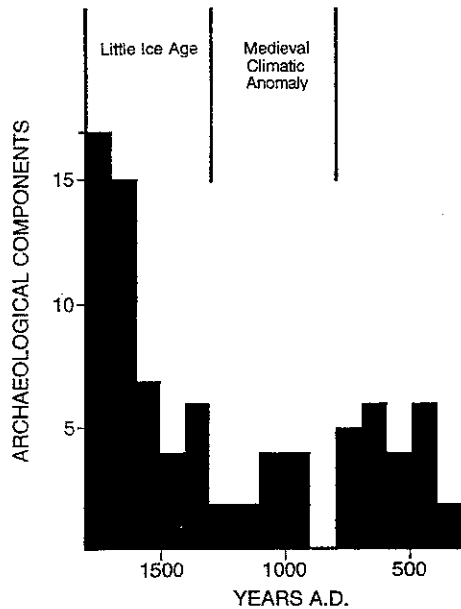


Figure 2.9. Radiocarbon-dated archaeological components from the Mojave Desert, California.

Anomaly are likely to have substantially reduced the number of water sources. Spring discharge and seasonal flooding of the Mojave River would have declined, and high stands in desert playa lakes would have been infrequent. As a result, sources of water would have been widely dispersed and less predictable, and the risk associated with forays into the desert interior would have been greater.

Occupations in the Mojave Desert during the 500-year period preceding the Medieval Climatic Anomaly (ca. A.D. 300–800), the Medieval Climatic Anomaly itself (A.D. 800–1300), and the following 500-year period (A.D. 1300–1800) show signs of significantly reduced use of the desert during the Medieval period, probably due to decreased availability of water. Of 84 radiocarbon dated archaeological components spanning A.D. 300–1800, 25 date to A.D. 300–800, 12 date to the Medieval Climatic Anomaly, and 47 date to A.D. 1300–1800 (Figure 2.9). Spatial distribution of components also shows that Medieval components are closely associated with a few perennial water sources—major springs and perennial oases along the Mojave River (such as Oro Grande [CA-SBR-72], Afton Canyon [CA-SBR-85], and Bitter Spring) (Figure 2.10). Oro Grande and Afton Canyon lie along the Mojave River drainage with its vast catchment area (Enzel et al. 1992). Shallow groundwater flow in this drainage would have been among the most persistent during dry periods. Similarly, Bitter Spring is the largest and most reliable spring in the Tiefert Basin area. These patterns suggest that hunter-gatherers of the central Mojave Desert, who were free from the type of climatic dependence that agriculturalists experienced, were nevertheless affected by the unusual aridity of the Medieval Climatic Anomaly.

That fewer dated components from this period exist suggests a reduction in population size as well as a tighter focus on reliable water sources. In the Mojave Desert a decline in annual rainfall would have led to a reduction in the number and reliability of water sources, a critical factor in a region characterized by vast waterless expanses. Moreover, droughts such as those demonstrated by Stine (1994) would have led to a reduction of ecosystem productivity in all habitats (Spaulding 1995). Although these data do not demonstrate that there was a decline in human carrying capacity during the Medieval Climatic Anomaly, the regional decrease in dated components suggests that this may indeed have been the case.

The area in the immediate vicinity of the Salton Sink, however, witnessed a very different sequence of environmental events with the intermittent formation of Lake Cahuilla. As noted above, episodic filling of the lake does not appear to be directly related to climatic changes. The lake's late Holocene chronology clearly shows that it was full during much of the Medieval Climatic Anomaly (Waters 1983). The sudden appearance of a 5,700-km² body of freshwater in this hyperarid basin must have been a significant draw for hunter-gatherers throughout the region, particularly during a time of persistent drought. The archaeological record of the Salton Sink provides strong evidence for human presence around the lake during the Medieval period. Some researchers (Aschmann 1959b; Wilke 1978) posit a relatively dense, sedentary occupation. Others (Schaefer 1986, 1988; Weide 1976) believe that most lakeshore sites represent short-term temporary camps.

Several factors may have rendered the Lake Cahuilla shoreline more suitable for short-term use and perhaps limited its value as a refuge from Medieval drought. First, throughout much of each lacustrine episode its shorelines would have been either rapidly advancing or rapidly receding, which would probably not have allowed the formation of stable or highly productive shore-margin biotic communities. Second, the lake's salinity may have been too high for much of this time to provide a suitable source of drinking water, even to populations with few options. Laylander's (1994) estimates of Lake Cahuilla salinity suggest that dissolved solids in the water would have exceeded the current municipal limit of 330 ppm within a few months and reached 1,000 ppm within 25 years. Thus, although the lake may have provided a productive environment for certain resources such as fish or waterfowl, its effect as a magnet for regional populations during the Medieval Climatic Anomaly was probably limited.

SUMMARY

A growing body of paleoenvironmental information shows evidence for significant periods of drought during

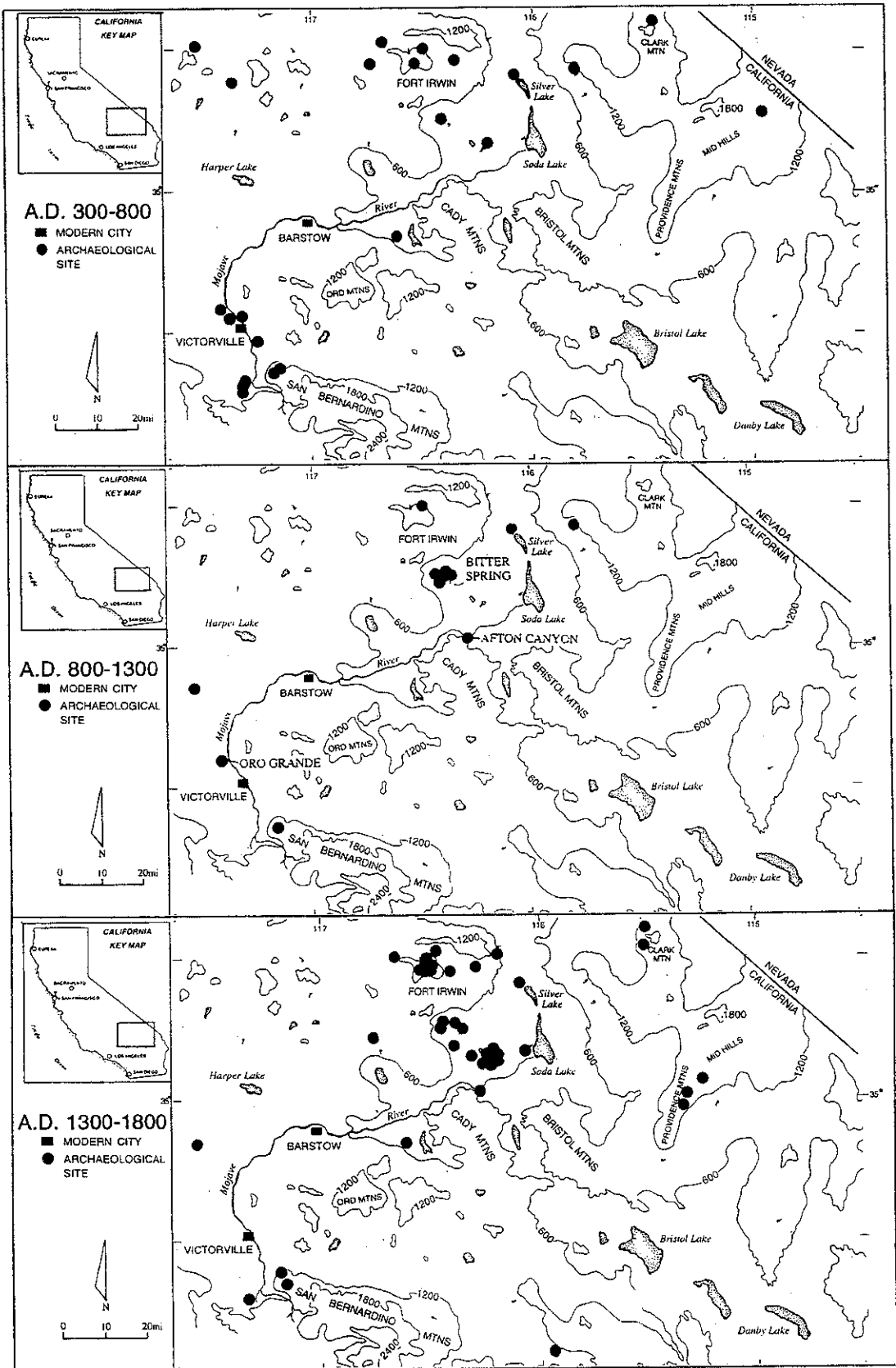


Figure 2.10. Site component locations before, during, and after the Medieval Climatic Anomaly in the Mojave Desert, California.

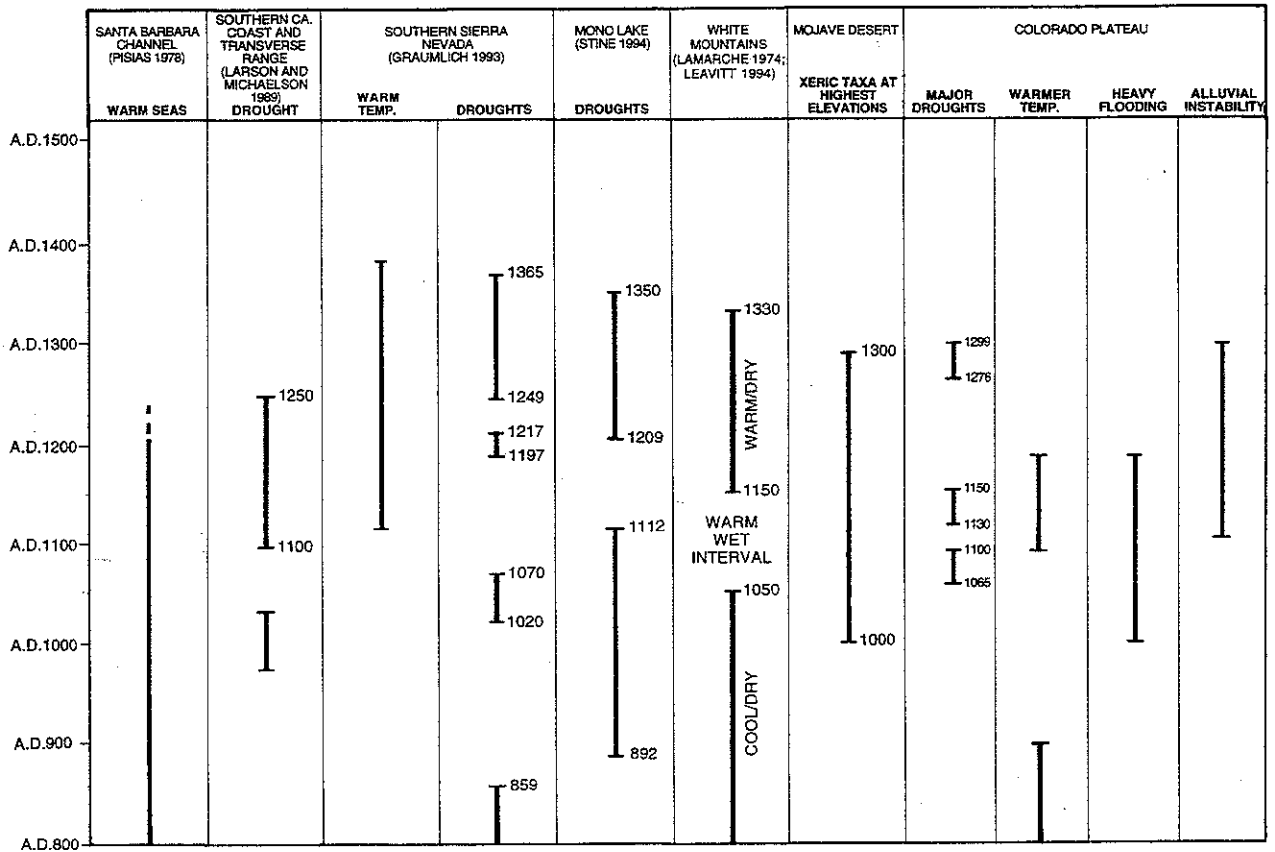


Figure 2.11. Comparison of regional paleoenvironmental sequences in western North America, a.d. 800–1500.

the Medieval Climatic Anomaly. Although the chronology of drought-related environmental deterioration is not fully synchronous throughout all of western North America, most areas show evidence for two intervals of decreased precipitation (early Medieval, A.D. 900–1100, and late Medieval, A.D. 1150–1350) separated by a period of amelioration. Chronological disparity is greatest for the earlier period, although some interregional synchrony is also evident (Figure 2.11). There are also some intriguing complementary comparisons such as the occurrence of two successive epic droughts on the Colorado Plateau during a period of increased effective moisture in the White Mountains. The late Medieval corresponds with the latter of Stine's (1994) and Graumlich's (1993) two epic droughts in the Sierra Nevada and western Great Basin and includes the Great Drought (A.D. 1276–1299) on the Colorado Plateau. Depressed environmental productivity seems to have been a much broader problem during this period in western North America than has ever been previously recognized. Scale and severity conform with Stine's (1994) characterization of climate during the Medieval period as anomalous in comparison with much of the late Holocene.

Chronological resolution for the archaeological record of human responses to these dry intervals varies significantly across western North America, but the late Me-

dieval droughts seem to have caused more dramatic responses than the first. Temporal control is best on the Colorado Plateau, where most populations survived an epic drought between A.D. 1065 and 1100 through agricultural intensification that continued into the mid-1100s. Agricultural settlements across much of the northern Colorado Plateau were abandoned during a subsequent epic drought between A.D. 1130 and 1150 as populations aggregated to the south and east. Nucleation was ultimately curtailed during the Great Drought with the final collapse of settlements across most of the central Colorado Plateau. Centuries of population growth limited the subsistence options that were formerly available to dispersed farming groups, and during the later droughts many Puebloan populations were beyond a carrying capacity that had declined as a result of extended drought. Throughout the late Medieval period there is mounting evidence for intergroup warfare and interpersonal violence in this context of food stress. Interregional commerce and interaction declined in many places but intensified in a few areas.

Forager populations in three regions of California seem also to have weathered the early droughts of the Medieval Climatic Anomaly, although chronological resolution is much poorer in those areas. Human exploitation of the Mojave Desert seems to have been suppressed throughout

most of the Medieval Climatic Anomaly. Depletion of water sources (particularly springs) rendered much of the desert uninhabitable and forced people to congregate at locations with reliable water. Such depletion would have serious implications for food availability and social relationships. Shrinking foraging radii would combine with depressed biotic productivity to exacerbate competition for food near the few sources of reliable water. On the coast there is significant evidence for settlement instability, population movement, exchange breakdown, and interpersonal violence during the terminal centuries of the Medieval Climatic Anomaly. Research of the last several decades has emphasized the high population density of California hunter-gatherers, their intensified economies, and their relatively complex sociopolitical systems. Still, the dependence by these people on a few ubiquitous, labor-intensive, storable resources put them in a position of ecological jeopardy. Although much of the Holocene archaeological record may reflect a process of intensification and population growth among California foragers, these economies were at risk from the type of high-intensity environmental change that impacted Puebloan cultures. Widespread and/or repeated failures of the acorn crop, the fundamental subsistence staple of Native California, could have readily precipitated major subsistence problems. Settlement disruption and interpersonal violence represented in the archaeological record are consistent with demographic stress. These trends are not compatible with the predicted outcomes of ongoing intensification or simple adaptive adjustment. Synchrony with the late Medieval drought suggests that decreased availability of food and water due to significantly lowered environmental productivity was a major cause underlying these shifts.

Central and southern California and portions of the Colorado Plateau show complex changes in exchange practices during the Medieval Climatic Anomaly. These changes seem to signal deterioration of broad-scale inter-regional social/trade networks and their replacement, in some instances, by localized cells of intensive, short-distance trading. Intergroup social relationships that facilitated the movement of Puebloan pottery from the Southwest to the shores of southern California and obsidian from distant sources in the western Great Basin to the central California coast apparently broke down during the late Medieval period. On the islands off southern California and at certain nucleated settlements on the southern margin of the Colorado Plateau, however, production of trade goods increased dramatically during this same period. Arnold (1992a, 1992b) provided strong evidence for increased production of shell beads and bead drills on Santa Cruz Island ca. A.D. 1250. On the Colorado Plateau there is ample evidence for a specialized network of lithic production and exchange that also intensified after A.D. 1250 (Brown 1982, 1991). Many exchange models based

on the premises of unilinear cultural evolution and/or adaptationism (e.g., Chartkoff 1989; Chartkoff and Chartkoff 1984; Fredrickson 1974a) posit simple increases through time in exchange concurrent with incremental population growth. Jackson and Ericson (1994) posed a revised "incremental" model for prehistoric California, in which, through time, greater numbers of goods were exchanged over shorter distances, but even such a revision (see Hughes 1994) does not accommodate the punctuated nature of changes in trade during the Medieval Climatic Anomaly. Rather, demographic stress caused by drought-related declines in environmental productivity seems to have fostered deterioration of formerly wide-reaching and amiable social relations that facilitated movement of goods across great distances. However, localized intensification of exchange during a period generally characterized by breakdowns in social relationships may have been reliant on individualized sociopolitical situations and opportunities. Environmentally induced stress can be useful for explaining the timing of changes but not the character of all human responses.

CONCLUSIONS

In our opinion many patterns in settlement, exchange, human health, and intergroup relations during the Medieval Climatic Anomaly (A.D. 800–1350) in the four regions examined—the Colorado Plateau, the central California coast, the southern California coast, and the Mojave Desert—can be explained with a model of decreased environmental productivity caused by severe, prolonged, and widespread droughts. The archaeological records in these four cases fail to match the predicted outcomes of unilinear cultural evolution, incremental population growth, adaptive adjustment, or economic intensification. There are too many abrupt changes and too many signs of desperation for these to represent simple and gradual population-based progressions. Human health and social relations were better and settlements were more stable at the onset of the Medieval Climatic Anomaly than they were at its conclusion. In contrast with evolutionary theories that posit different environmental relationships for agriculturalists than for foragers, the late Medieval droughts seem to have caused severe ecological imbalances among both groups. While drought-related problems have been acknowledged for agriculturalists of the Colorado Plateau, most models of western North American hunter-gatherer prehistory, based on theories of cultural ecology, adaptation, and economic intensification, fail to recognize signs of widespread demographic crises during the twelfth to fourteenth centuries or the possibility that hunter-gatherers and agriculturalists could have been simultaneously impacted by environmental change.

The paleoenvironmental record for western North

America shows evidence for two intervals of prolonged drought during the Medieval Climatic Anomaly, but the effects of the second are more readily apparent in the archaeological record than those of the first. A nondeterministic perspective on human/environmental relationships acknowledges that not all environmental oscillations will force human responses. The latter Medieval drought seems to have been unusually severe and widespread, but the important point is that it occurred at a unique juncture in the demographic history of western North America when populations were unusually high. The impact of a sustained drought of this magnitude on the low-density, more widely scattered populations of the early Holocene would probably have been much less profound. Because so many attempts to evoke environment as a primary cause of cultural change have fallen to charges of mechanistic determinism (e.g., linking the Altithermal to events in North American prehistory), many ecologically oriented archaeologists have come to equate environmental causality

with determinism and look to other forces for explaining cultural change. Nonetheless, severe environmental downturns should not be ignored as potential causes of demographic stress because human populations do not exist in an ecological vacuum. Situations in the cases studies considered here are best explained relative to a convergence of rapidly growing human populations and precipitous declines in environmental productivity. To recognize the potential for crises spawned by such factors and to incorporate them into models of change is hardly deterministic; it is simply realistic.

Reprinted with changes from Terry L. Jones, Gary M. Brown, L. Mark Raab, Janet L. McVickar, W. Geoffrey Spaulding, Douglas J. Kennett, Andrew York, and Phillip L. Walker, "Environmental Imperatives Reconsidered: Demographic Crises in Western North America During the Medieval Climatic Anomaly," *Current Anthropology* 40 (1999): 137-170.



PREHISTORIC CALIFORNIA

Archaeology and the Myth of Paradise



Edited by

L. Mark Raab and Terry L. Jones

2004
—



THE UNIVERSITY OF UTAH PRESS

Salt Lake City