California
th Carolina, Chapel Hill,

ON

ATMENTS IN ANCIENT

IES BY AMERINDIANS

ler will bring delivery of
upon actual shipment.

R. Kelly

Case Studies in Environmental Archaeology

Second Edition

Edited by

ELIZABETH J. REITZ
University of Georgia
Athens, Georgia

and

C. MARGARET SCARRY
University of North Carolina
Chapel Hill, North Carolina

and

SYLVIA J. SCUDDER
University of Florida
Gainesville, Florida

Springer

Chapter 9

Living on the Margins: Biobehavioral Adaptations in the Western Great Basin

CLARK SPENCER LARSEN, ROBERT L. KELLY, CHRISTOPHER B. RUFF, MARGARET J. SCHOENINGER, DALE L. HUTCHINSON, AND BRIAN E. HEMPHILL

Since the founding of anthropology, a great deal of attention has been paid to characterizing the adaptive "efficiency" or "affluence" of human populations dependent upon hunting and gathering as a primary means of acquiring sustenance. For many years, the Hobbesian portrayal of hunter–gatherer lifeways as "nasty, brutish, and short" dominated much of the scientific and popular perceptions of foraging human groups. In his widely used archaeology textbook, Braidwood (1967:113) depicted the hunter-gatherer lifestyle as "a savage's existence, and a very tough one . . .following animals just to kill them to eat, or moving from one berry patch to another [and] living just like an animal." However, within a short time following the epic "Man the Hunter" conference in 1966 (Lee and DeVore 1968), this image of hunter-gatherers took an about-face in response to data suggesting that far from being nutritionally deprived and subject to excessive demands of work devoted principally to the food quest, hunter-gatherers apparently have adequate nutrition. Nor are they subject to overbearing amounts of work; in fact, their lives are leisurely, and food is plentiful. According to Sahlins (1972:1–39), they are the "original affluent society."

Stimulated by the 1966 conference and especially by the provocative observations of Lee (1979) on the Ju/'hoansi of southern Africa, researchers initiated ecologically-oriented projects among extant foragers in diverse settings. These studies examined affluence and quality of life among the world's foraging societies (see Hill and Hurtado 1989; Kelly 1995a). Contrary to earlier assessments, these studies pointed to a high degree of variability in hunter-gatherer lifestyles. Far from demonstrating uniformity, they showed that by virtually any measure–food selection, food preference, nutritional quality, mobility pattern, workload, disease stress, and demography–foraging populations do not fit into a single pattern. The only common theme appeared to be a reliance on nondomesticated plants and animals as the primary food source.

The archaeological record contributes an important perspective on hunter-gatherer lifeways. This record gives a crucial diachronic perspective. Archaeologists working in the North American Great Basin have revealed key aspects of human foraging behavior because of the availability of a rich archaeological record (e.g., Bettinger 1989; Heizer and Krieger 1956; Jennings 1957, 1978; Kelly 2001; Simms 1999; Thomas 1985, 1988; see reviews by Grayson 1993; Kelly 1997) supplemented by accounts of native groups written by 19th-century pioneers and explorers (e.g., Simpson 1876) and by 20th-century ethnographers (e.g., Fowler 1992; Lowie 1924; Steward 1938; Wheat 1967).

Throughout many regions of the world, biological anthropologists have made important contributions to studies of adaptive processes in human societies (see Cohen and Armelagos 1984; Katzenberg and Saunders 2000; Larsen 1997; Larsen and Milner 1994; Steckel and Rose 2002; Wing and Brown 1979). Skeletal and dental tissues are remarkably sensitive indicators of human interaction with the environment, providing a cumulative biological history or "memory" of an individual's lifetime, including dietary stress, nutritional quality, disease history, mobility pattern, and physical activity. Many regional studies across the globe rely upon human remains for biocultural inferences about extinct lifeways (e.g., Buikstra 1988; Cybulski 1992; Domett 2001; Hodges 1989; Hutchinson 2002; Lambert 2000; Larsen 2001; Martin et al. 2001; Papathanasiou 2001; Peterson 2002; Pietrusewsky and Douglas 2001; Steckel and Rose 2002; Ubelaker 1994; Whittington and Reed 1997; Williamson and Pfeiffer 2003).

Compared to other regions of North America, few human remains are found in the Great Basin (see Larsen 2006). Consequently, few researchers have attempted to use this source in the investigation of Great Basin hunter-gatherer lifeways. The meager record for mortuary behavior changed dramatically in the mid-1980s. Between 1982 and 1986, record high winter precipitation caused massive floods in several Great Basin wetlands (Hemphill and Larsen 1999), including the Stillwater Marsh, located in the Carson Desert of western Nevada (Figure 9-1). The retreating floodwaters exposed dozens of previously unknown archaeological sites and hundreds of human skeletal remains. From 1985 to 1987, two separate teams collected human remains in danger of destruction in the Stillwater Marsh (see Larsen and Kelly 1995; Tuohy et al. 1987).

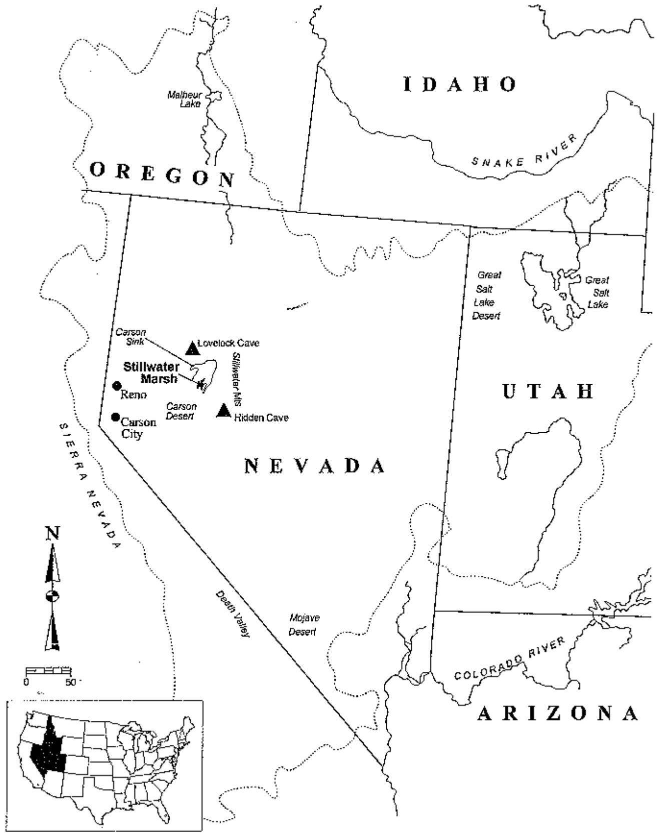

Figure 9-1. North American Great Basin, showing location of Stillwater Marsh and other Great Basin settings discussed in this chapter (adapted from Hemphill and Larsen 1999:Figure 1.1; reproduced courtesy of The University of Utah Press). Dotted line shows the Great Basin.

The study of this unprecedented collection of human remains allows us to characterize hunter-gatherer lifeways in a geographic setting that was relatively unknown from a bioarchaeological perspective. In this case study, we use skeletal and dental data to address competing reconstructions of the pre-Columbian use of wetland resources in the Stillwater Marsh and to document some general aspects of the human condition in this region.

Previously, researchers argued over two reconstructions of ancient lifeways in the Stillwater Marsh. Proponents of one reconstruction, called the *limnosedentary* model, argue that wetland resources could provide sufficient food and other resources to support a sedentary hunter-gatherer population (Heizer and Napton 1970). Alternatively, proponents of the *limnomobile* model assert that although wetlands may have anchored a settlement system, fluctuations in the availability of food in the wetlands in comparison with resources in other valleys, the nearby uplands (e.g., Stillwater Mountains), or in both would have resulted in a more mobile lifeway regardless of the relative productivity of the marsh habitats (Kelly 1995b, 2001; Thomas 1985). Thus, supporters of the first model maintain that sedentary populations obtained most dietary resources from lacustrine contexts of the marsh wetlands. Supporters of the second model contend that populations, although relying partly on marsh resources, spent significant amounts of time and effort in the collection and transport of uplands resources, sometimes over great distances (for alternative viewpoints, see Janetski and Madsen 1990; Kelly 1992, 1995b; Raven 1990). New research suggests that the wetlands, when present, provided the best foraging opportunities for women in most seasons and most years; and that men may have profited by traveling farther afield to seek game, such as bighorn sheep (*Ovis canadensis*), in the mountains (Kelly 2001; Zeannah 1996, 2004; Zeannah et al. 1995). The dialog among Great Basin archaeologists is couched within the larger problem of the role of environment in hunter-gatherer adaptations (see Mandryk 1993) as well as the archaeological documentation of mobility (see Kelly 1992, 1995a; Kent 1992; Rafferty 1985). The question still remains, however, as to how this settlement pattern and division of labor affected the quality of life of those hunter-gatherers who inhabited the Stillwater Marsh.

We will show that land-use patterns and resource procurement as well as the overall quality of life in this region can be investigated by the study of human skeletal remains. In so doing, we underscore the value of osteological samples and their morphological and pathological correlates of behavior, diet, and health to critically inform debates in this region in particular and to analyses of behavioral patterns and adaptive efficiency in hunter-gatherers in general.

BIOARCHAEOLOGICAL APPROACHES TO BEHAVIOR, DIET, AND HEALTH

The primary objective of this study is to test hypotheses about patterns of physical behavior associated with a highly challenging lifeway. Written accounts indicate that populations of the Toedökadö ("Cattail eaters") band of the Northern Paiute occupying the Stillwater Marsh, frequently engaged in long-distance travel to gather resources and led a physically demanding lifeway overall (Fowler 1992; Kelly 1995b). We use two complementary approaches to the study of biomechanical adaptation in order to characterize the physical activity patterns experienced by members of these populations. These approaches include study of osteoarthritis, a degenerative articular joint disorder caused by excessive and repetitive mechanical loading of articular joints (e.g., hip, knee, elbow), and structural analysis of long bone morphology.

The first approach uses pathological changes on joint articular margins and surfaces that are commonly associated with the disorder. These changes include bony lipping along joint margins, joint surface porosity, and polishing (eburnation) of joint surfaces due to direct bone-bone contact following destruction of articular cartilage (Hough 2001). Osteoarthritis develops over the course of an individual's lifetime from daily wear and tear on the joints arising from physically demanding, repetitive activities (Radin et al. 1972; Sharma 2001).

The second approach involves the application of beam theory as developed by civil and mechanical engineers for structural analysis of building materials (Lanyon and Rubin 1985; Ruff 2000). One can model human long bones (e.g., femur, humerus) as hollow beams and measure the structure of these beams via a series of properties called *cross-sectional geometric properties*. These properties measure the strength or resistance of bone to bending and torsion (twisting), the two primary forces to which human long bones are subject in life. Hence, physically active individuals will display higher values of cross-sectional geometric properties in their long bones than those individuals who are not.

The second objective of this study is to reconstruct diet. With this information in hand, inferences about nutritional quality can be made and place of origin of particular foods consumed by native groups can be identified. Some foods in the Carson Desert are available primarily in the marsh and lowlands. These include Indian rice grass (*Oryzopsis hymenoides*), bulrush (*Scripus* sp.), cattail (*Typha latifolia*), needle and thread (*Stipa comata*), water birds, fishes, and aquatic mammals. Other foods are available in the uplands, such as pinyon nuts (*Pinus monophylla*) and mammals, especially bighorn sheep. A few grasses, such as wild rye (*Elymus* sp.), are available in both marsh and nonmarsh areas. Therefore, the central question for this discussion is: What foods were consumed in the Great Basin and were those foods extracted primarily from marsh settings, uplands settings, or some combination of both? This question is closely linked to with our inquiry about the degree of mobility of hunter-gatherers in the region. If it can be demonstrated that a significant component of the dietary regime was obtained from both marsh and uplands habitats, then these populations, or at least a particular component (e.g., adult males), were necessarily mobile.

There is a long history of interest in Great Basin foodways, but aside from documenting the kinds of foods eaten through archaeobotany, zooarchaeology, and ethnographic observation, knowledge of the actual menu of foods consumed and the relative proportions of these foods to overall diet composition is elusive. Food remains often are not preserved, or not preserved in the proportion consumed, thus limiting understanding of diet and nutrition in archaeological settings. The vagaries of qualitative approaches to dietary reconstruction via the identification of plant and animal remains are partly alleviated by stable carbon and nitrogen isotope analysis (Katzenberg 2000; Schoeninger 1995).

Stable isotope analysis is based on the assumption that the isotopic composition of human bone reflects the isotopic composition of the foods consumed. In other regions of North America, isotopic studies for plant and animal communities have produced diagnostic signatures of nitrogen and carbon stable isotope ratios ($^{15}N/^{14}N$ and $^{13}C/^{12}C$, respectively). The bimodal distribution of stable carbon isotope ratios (expressed in parts per mil ‰ relative to a standard) in terrestrial plants is the most familiar and is instrumental in tracking the introduction and intensification of maize (*Zea mays*) in the Americas. The distribution reflects the manner in which plants fix carbon in photosynthesis: Maize fixes carbon through the C_4-photosynthetic pathway, although most other economically important plants fix carbon through the C_3 and, to a lesser extent, CAM pathways. Worldwide, marine and terrestrial organisms express a bimodal pattern of stable nitrogen isotope ratios. This pattern facilitates the identification of human consumption patterns relating to sea versus land-based foods as well as other settings (Schoeninger 1995; Schoeninger et al. 1983; Schoeninger and Moore 1992). Data for freshwater marshes are not available, however. Nevertheless, it is possible that carbon and nitrogen cycling in the Carson Desert marshes could be different from that in the surrounding desert and nearby uplands and that these differences could be detected in human skeletal remains.

As our third and final objective, we hope to provide new information about health status inferred from evidence for physiological stress in Stillwater hunter-gatherers. The study of stress, physiological disruption resulting from impoverished circumstances, has taken on increasing importance in interpreting adaptive efficiency in human populations, both living and extinct (see overview in Larsen 1997). We utilize a stress indicator that reflects growth disruption and is known as *linear enamel hypoplasia*. Hypoplasias are deficiencies or defects of enamel that are manifested as circumferential pitting, linear furrowing, or, in extreme cases, lack of enamel (Larsen 1997). The result of a cessation of activity in the cells that lay down enamel during the development of the tooth crown (called ameloblasts), these defects are linked to a plethora of stressors in living and archaeological settings, including, but not limited to, starvation, malnutrition, and various infectious diseases (Larsen 1997).

For this discussion, we present data on the width of these enamel defects. Because hypoplasias arise during the process of the growth and development of the enamel, from the tip of the crown to the junction between the crown and root, widths of defects represent an approximation of stress-episode duration or degree of severity or some combination of both (Blakey and Armelagos 1985; Guita 1984; Larsen and Hutchinson 1992; Suckling et al. 1986). Hypoplastic activity appears to be largely restricted to incisors and canines (Goodman and Armelagos 1985).

The number of Stillwater skeletons is about 35, depending on the type of study. For a fuller accounting of methods of analysis of osteoarthritis, cross-sectional geometric properties, stable isotopes, and dental defects, see Larsen and Kelly (1995) and various papers in Hemphill and Larsen (1999).

THE REGIONAL AND MORTUARY CONTEXT

The Carson Desert is an extensive area of sand dunes, alkali flats, and slightly alkaline marshes covering an area of about 2800 km^2 in west central Nevada. Forming one of the lowest points in this area of the Great Basin, it represents the sink or drainage terminus of the Carson River. The Stillwater Marsh, an ecologically rich area, is the most significant feature of the region (Figure 9-1; Kelly 2001).

Archaeological survey and testing revealed that most mortuary sites were located within a 16 km^2 area of the marsh (Larsen and Kelly 1995; Tuohy et al. 1987). Field reconnaissance identified at least 38 sites with human remains. Human remains were excavated from mostly isolated graves scattered throughout the marsh area rather than cemeteries containing a group or groups of skeletons. This noncemetery burial pattern indicates that these populations did not bury deceased individuals in formal areas. On the other hand, some of the sites containing human remains yielded a large number of skeletons. Brooks et al. (1988), for example, list some 58 individuals in varying states of completeness from a single site (26CH1043). The Stillwater mortuary pattern is likely characteristic of many ethnographically known foraging groups worldwide, although this pattern has not been observed universally (see Charles and Buikstra 1983; Charles et al. 1986), especially when archaeological cases are considered.

The precise length of time that the Stillwater Marsh was used for burial is incompletely understood. Only six skeletons are radiocarbon-dated and they encompass a period of time that spans nearly two millennia, from circa 270 B.C. to A.D. 1644 (corrected dates) (see Brooks and Brooks 1990; Larsen and Kelly 1995). Moreover, few temporally diagnostic artifacts (i.e., projectile points) are associated with human remains. Chronological evidence based on other classes of archaeological sites (e.g., middens), however, suggests that the region was most heavily utilized by populations from two sequential phases, the latter half of the Reveille phase (1300 B.C.–A.D. 700) and the succeeding Underdown phase (A.D. 700–1300) (Raymond and Parks 1990).

This discussion highlights the problems besetting the analysis of human remains found in the Stillwater Marsh, especially regarding the lack of precise temporal control and cemeteries. Because the Stillwater human remains are drawn from many sites that span hundreds (if not thousands) of years of native use of the region, it is possible that they are not representative of the populations from which they were drawn. Brooks et al. (1988) and we (Larsen and Kelly 1995), however, have noted the homogeneity of skeletal measurements as well as cranial morphology in the Stillwater series. These findings suggest that the series can be regarded as a biologically or culturally cohesive unit of study amenable to analysis and comparison.

OSTEOLOGICAL ANALYSIS OF ACTIVITY, DIET, AND STRESS

Activity

Analysis of osteoarthritis and cross-sectional geometric properties indicates a lifeway that was physically demanding. Over three quarters (76%) of individuals in the series are affected by osteoarthritis; all individuals older than 30 years are arthritic. Consideration by specific joint region shows that the lowest prevalences occur in the hands (13%) and the highest in the lumbar vertebrae (67%). The cervical vertebrae and the elbow have frequencies of 50% or more. In males, arthritis frequencies range from the lowest values for the hand (18%) to the highest values for the cervical, shoulder, and elbow joints (all are 61%). In females, values range from none in the ankle to 75% in the lumbar vertebrae. The overall high prevalence of osteoarthritis in the Stillwater series is borne out by comparison with other populations. For example, the prevalence is higher than either hunter-gatherer or agricultural populations in the southeastern United States, where most values are under 20% (cf., Bridges 1992).

Analysis of cross-sectional geometric properties of Stillwater femora and humeri reveals a number of important tendencies. Cortical area (CA) and percent cortical area (PCCA) measure the *amount* or mass of bone in a cross section. Compared with other populations, Stillwater bone mass is at the low end of the range (Figure 9-2). Total subperiosteal area (TA), however, a measure of the outer dimension of a long bone in cross section, is on the upper end of the range of comparative samples. The latter indicates that the bones of Stillwater individuals are very large and robust despite low values of CA and PCCA.

The meaning of large values of TA is clarified by comparing cross-sectional geometric properties called *second moments of area*. These values measure the cross-sectional *distribution* of bone around an imaginary central (or "neutral") axis corresponding to the longitudinal axis of the bone shaft. Low values of second moments of area reflect a distribution of bone close to this central axis; conversely, high values reflect a distribution of bone located far from the central axis. According to beam theory, the higher the value of second moments of area, the greater the strength of the bone, and hence the greater ability of the bone to resist high levels of mechanical loading, particularly bending (*I*) and torsion (*J*) that occur during walking, running, and other physical activities. Simply stated, greater values of second moments of area represent stronger bones that develop in response to a lifetime of physically demanding activities. In general, the Stillwater *J* values, representing an overall average of bending strength in a cross section, are quite high for Holocene human populations, especially for males (Figure 9-3) (e.g., see Bridges et al. 2000; Holt 2003; Ledger et al. 2000; Ruff 1991, 1994, 1999; Ruff and Larsen 2001; Ruff et al. 1993; Stock and Pfeiffer 2001, 2004).

The biomechanical shape of the femoral midshaft in cross-section as denoted by a ratio or index of I_x/I_y (the ratio of bending strength in anteroposterior to

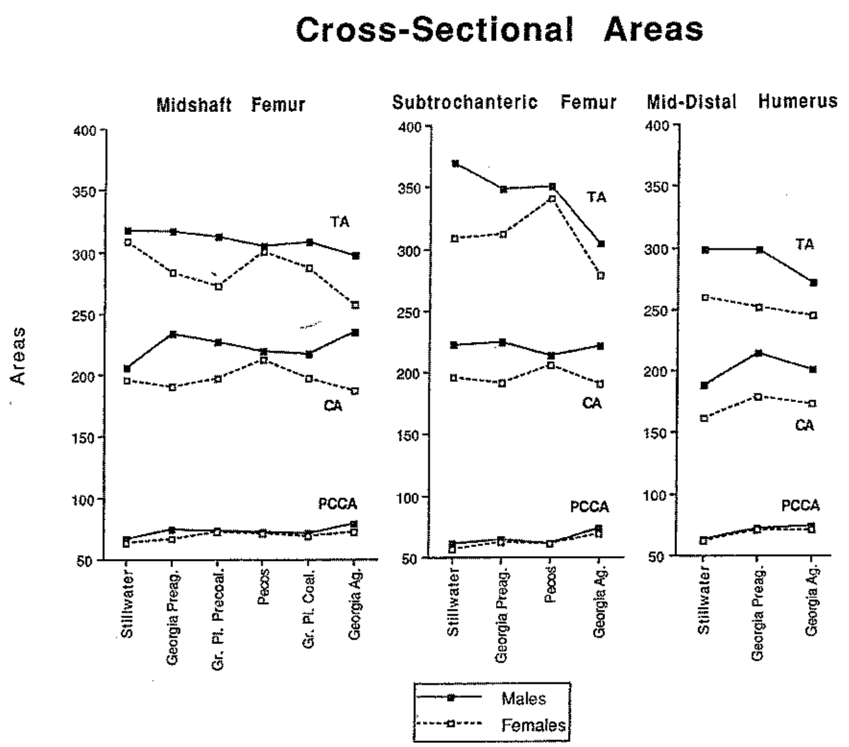

Figure 9-2. Comparison of cross-sectional areas of Stillwater femora and humeri with other skeletal series. Key: (CA) cortical area; (PCCA) percent cortical area; (TA) total subperiosteal area. Cultural units: Stillwater (1300 B.C.–A.D. 1300); Georgia Preagricultural (500 B.C.–A.D. 1150); Great Plains Precoalescent (A.D. 400–1600); Pecos Pueblo (A.D. 1300–1650); Great Plains Coalescent (A.D. 1600–A.D. 1850); Georgia Agricultural (A.D. 1150–1550) (Data from Ruff 1994, 1999; Ruff and Larsen 2001).

mediolateral planes) represents an approximation of degree of mobility in human populations (Ruff 1987). Ruff (1987) has found a decline in the index from hunter-gatherers to agriculturists to Western industrial populations. Agriculturists have values closer to 1 (reflecting a perfectly round cross section, or relatively little mechanical stress) than hunter-gatherers, thus indicating greater anteroposterior orientation of bending strength in femora of hunter-gatherers. Not surprisingly, 20th-century Americans have very low ratios, reflecting their highly sedentary nature. The Stillwater I_x/I_y ratio shows that males are on the high end of the range in comparison with other populations, while females are less so (Larsen et al. 1995; Ruff 1999). Consistent with the great difference in the ratio and the great difference in degree of mobility between males and females, Stillwater and other Great Basin populations express a very high level of

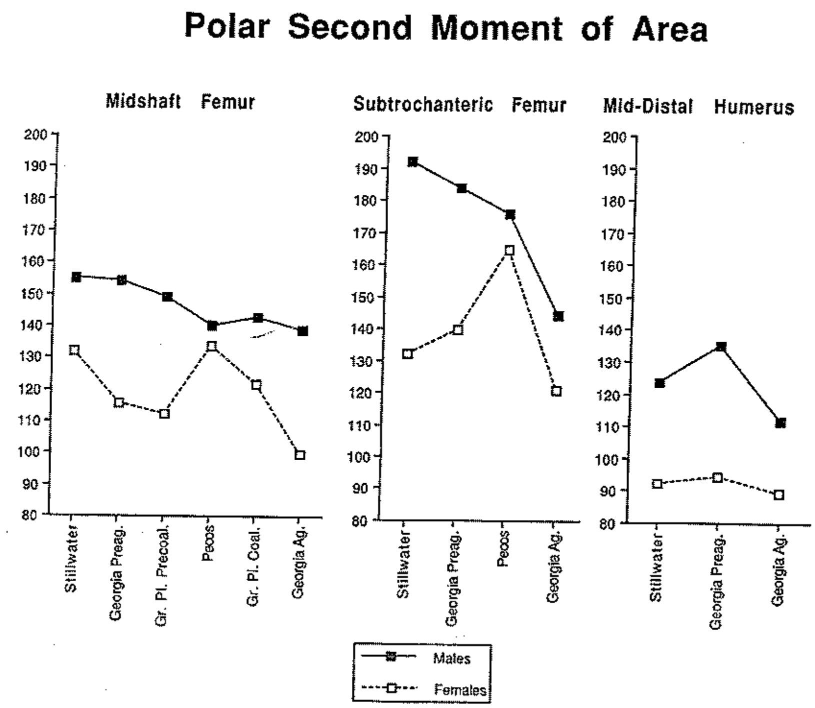

Figure 9-3. Comparison of polar second moment of area in torsional analysis (*J*) in Stillwater femora and humeri with other skeletal series. Cultural units: Stillwater (1300 B.C.–A.D. 1300); Georgia Preagricultural (500 B.C.–A.D. 1150); Great Plains Precoalescent (A.D. 400–1600); Pecos Pueblo (A.D. 1300–1650); Great Plains Coalescent (A.D. 1600–1850); and Georgia Agricultural (A.D. 1150–1550) (Data from Ruff 1994, 1999; Ruff and Larsen 2001).

sexual dimorphism (Figure 9-4). Indeed, these populations are the most sexually dimorphic from any archaeological setting studied by physical anthropologists.

Diet

Stable carbon and nitrogen isotopic analysis of human skeletal samples reveals that a variety of foods were likely consumed by aboriginal populations in this region. To summarize these data, $\delta^{13}C$ values range from –18.9‰ to –14.4‰ (average: –17.1‰), and $\delta^{15}N$ values range from 8.7‰ to 16.7‰ (average: 11.4‰). Several key findings emerge. The juvenile samples analyzed fall completely within the range of adults, suggesting that there are no detectable age-related differences in diet (juvenile average $\delta^{13}C$: –17.6‰ juvenile average $\delta^{15}N$: 12.7‰).

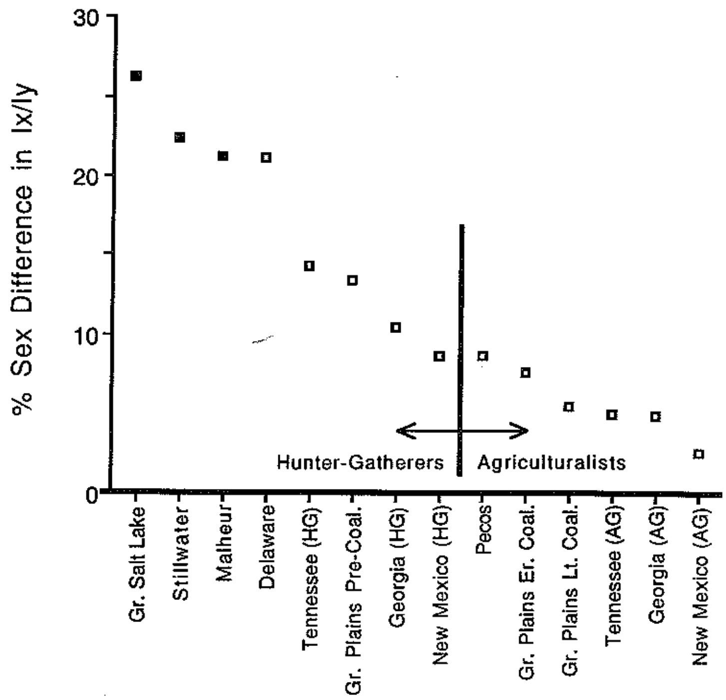

Figure 9-4. Comparison of sexual dimorphism in "shape" (I_x/I_y ratio) of Great Basin (Great Salt Lake, Stillwater Marsh, Malheur Lake in black boxes) midshaft section of femora compared with other skeletal series arranged in descending order (HG: hunter-gatherers; AG: agriculturalists). Cultural units: Great Salt Lake (A.D. 600–1380); Stillwater (1300 B.C.–A.D. 1300); Malheur (A.D. 1000–1700); Delaware (A.D. 750–950); Tennessee (6000–1000 B.C.); Great Plains Precoalescent (A.D. 400–1600); Georgia (500 B.C.–A.D. 1150); New Mexico (A.D. 500–1150); Pecos (A.D. 1300–1650; Great Plains Early Coalescent (A.D. 1600–1740); Great Plains Late Coalescent (A.D. 1740–1850); Tennessee (A.D. 1200–1500); Georgia (A.D. 1150–1550), New Mexico (A.D. 1150–1540) (data from Bridges 1989; Brock and Ruff 1988; Robbins et al. 1989; Ruff 1994, 1999; Ruff and Larsen 2001) (adapted from Ruff 1999:Figure 14.6; reproduced courtesy of The University of Utah Press).

For adults of known sex, the female and male means for both carbon and nitrogen are within 0.1‰ of each other (female average $\delta^{13}C$: –17.2‰ male average $\delta^{13}C$: –17.1‰ female average $\delta^{15}N$: 11.0‰ male average $\delta^{15}N$: 11.0‰). There are no differences by site (Schoeninger 1995, 1999). Thus, there are no apparent differences in food consumption by age, sex, or burial location, at least as they are represented by stable isotope values.

On the other hand, the wide dispersion of isotopic values of the series as a whole indicates that a variety of plants and animals were consumed by people in the Stillwater Marsh. Experimental laboratory animals fed monotonous diets show a range of less than 2‰ in carbon and nitrogen (DeNiro and Schoeninger 1983), far less than the samples analyzed here. On the basis of comparisons with known data of C_3 and C_4 plants and their animal consumers, some Stillwater individuals could have eaten only C_3 plants and their consumers, while others ate a significant amount of foods with a C_4 signature. The nitrogen isotope data suggest a similar variety foods eaten.

Physiological Stress

Two-thirds (64%) of the individuals examined possessed at least one hypoplastic defect. Measurement of widths of hypoplastic events for maxillary and mandibular incisors and canines reveals that they ranged from an average of 0.23 mm (mandibular first incisor) to 0.60 mm (mandibular second incisor). In order to evaluate the relative degree of stress, it is necessary to compare the sample with other dental series. We have measured pre-Columbian dentitions from the Georgia coast and northern Florida, including the hunter-gatherers and agriculturists (Hutchinson and Larsen 2001; Larsen and Hutchinson 1992). Generally, our findings show that the Stillwater hypoplasias are narrower than Georgia coast hypoplasias (e.g., maxillary canine: Stillwater = 0.40 mm; Georgia preagriculturists = 0.56 mm; Georgia agriculturists = 0.70 mm). All other teeth show a similar pattern (see Hutchinson and Larsen 1995, 2001).

BIOCULTURAL IMPLICATIONS OF BEHAVIOR AND HEALTH

Activity

Osteoarthritis. Analysis of osteoarthritis in the Stillwater series indicates that these foragers engaged in physically demanding activities. This level of demand is reflected in the high frequency of osteoarthritis, particularly in the spine. The spine is subjected to high levels of mechanical loading. A number of Stillwater individuals exhibit, in addition to extensive lipping, other pathological changes reflecting mechanical demand. For example, several individuals have vertebral compression fractures, most of which are restricted to the lower thoracic and lumbar vertebrae. In addition, several individuals have depressions on the vertebrae arising from herniated intervertebral disks (called Shmorl's nodes). These pathological modifications are consistent with a population experiencing pronounced levels of mechanical stress, probably generated by the frequent transportation of heavy loads on foot.

The Stillwater remains exhibit a pattern of sexual dimorphism in osteoarthritis prevalence; males are generally more affected than females. In archaeological skeletal series, there is a surprising amount of variation in sexual dimorphism (reviewed in Bridges 1992). Only rarely, however, do females in archaeological populations show more osteoarthritis than males, except with regard to specific joints. For example, one might find osteoarthritis in the temporomandibular joint in communities where females were responsible for hide processing (e.g., Eskimos [see Merbs 1983]). For the most part, however, Stillwater males show more osteoarthritis than females. The statistically significant or near-significant levels of sex differences were revealed for the shoulder (females: 23%; males: 61%), hip (females: 6%; males: 40%), and ankle (females: 0%; males: 45%) joints (chi-square, p 0.05). Considering the kinds of foods eaten in the region as documented by ethnographic and other observations (e.g., Fowler 1992), this pattern probably reflects sex differences in mechanical demands related to resource procurement in general and hunting in particular. In this setting, excessive use of the shoulder in males may have arisen from thrusting activity, perhaps in spear throwing.

Osteoarthritic involvement of the hip and ankle likely reflects the mechanical demands associated with running and walking. The presence of significantly greater osteoarthritis prevalence in males than in females suggests that it was acquired through a lifetime of activity, perhaps in difficult terrain, such as in the uplands surrounding the Stillwater Marsh. It is exceedingly difficult to traverse the muddy areas of the marsh, and this, too, would have placed demands on the lower limbs in ambulatory activities. It is probably not the sole factor, however, because it would have affected males and females equally.

One of the outstanding characteristics regarding the presence of osteoarthritis is the unusually high prevalence in comparison with that in other skeletal samples (cf., Bridges 1992 and studies in Cohen and Armelagos 1984; Steckel and Rose 2002). Some insight into the behavioral context of the high prevalence is provided in the ethnographic literature. For example, Brooks et al. (1988) summarize the various activities recounted by Steward (1938) and Wheat (1967) in their ethnographic studies of Great Basin native populations. Among other behaviors that could lead to articular joint deterioration, activities they reported include carrying heavy loads, cutting animal hides, seed grinding and pounding with mortars and pestles, stone tool production, and the use of the bow and arrow. Given the ubiquity of osteoarthritis in the Stillwater remains, we are not able to say what specific behaviors were responsible, but clearly the Stillwater peoples were highly active. In sum, these findings suggest that the Carson Desert groups may have traversed many kinds of terrain, probably including the nearby mountains. On the other hand, it is our impression that slogging through the marsh on a daily basis over the course of a lifetime could increase the prevalence of the disorder. We must therefore turn to structural analysis in seeking answers to the question surrounding the degree of mobility.

Cross-Sectional Geometric Properties. Comparisons of cross-sectional geometric properties in various archaeological samples show a consistent pattern of elevated bone strength in the Stillwater series relative to comparative samples, which we interpret to reflect high bending and torsional loading modes. Low values of CA and PCCA are somewhat more difficult to interpret. Humans begin to lose bone mass after about age 40, resulting in osteoporosis in older adulthood (Garn et al. 1964). The Stillwater series contains a number of older adults (>40 years), which suggests the presence of age-related bone loss in the sample and, hence, low values of CA and PCCA. However, the average age at death for a number of the North American comparative samples used here is actually greater than that for the Stillwater group (Larsen et al. 1995). Thus, age at death is likely not a significant factor in interpreting these results.

Aside from age, a very important factor in determination of adult bone mass is nutritional quality. In human populations experiencing protein-calorie malnutrition, the growth spurt associated with adolescence is delayed, resulting in reduced amounts of bone, which is reflected by low CA and PCCA values in adults (Garn 1966; Garn et al. 1964). Therefore, in the absence of age factors for interpreting lower bone mass relative to other archaeological samples, we suggest that suboptimal nutrition may explain these values. We speculate that periods of reduced availability of some plants and animals during drought years or during winter months in the Carson Desert contributed to recurrent bouts of episodic undernutrition. More important periods of stress may have been in the early Spring, when foods collected during the previous year began to run out.

A functional/mechanical interpretation for the distribution of bone tissue in Stillwater long bone cross-sections is supported by the presence of consistently greater differences in femur midshaft robusticity compared to humerus middistal robusticity. Especially important in these observations is the presence of low robusticity (low values of TA and second moments of area) and low values of CA and PCCA in the Stillwater humeri. In other words, limitation of high robusticity to the femur indicates a localized effect, that is, a functional interpretation (increased mechanical loading on the lower limb); whereas, the low CA and PCCA values for both the femur and the humerus are more likely related to the effects of nutritional quality.

These findings, by themselves, do not provide additional insight into degree of mobility in the Stillwater populations. They basically show that the bones from Stillwater reflect a physically robust and highly active population. Comparison of the index I_x/I_y, however, reveals some key differences that shed light on the problem. Shape of the femoral shaft is expressed as the ratio of I_x to I_y, which measures the relative anteroposterior-to-mediolateral bending strength. Greater femoral midshaft I_x/I_y values match the conclusion of Ruff (1987) that hunter-gatherers, especially males, have the highest ratio values, reflecting greater bone strength in the anteroposterior direction in foragers due to mobile behaviors, which includes long distance travel. Moreover, comparison of Stillwater males and females shows that the Stillwater populations are highly dimorphic (Figure 9-4), which is consistent with his comparison of hunter-gatherers, agriculturists, and Western industrial populations (see also Ruff 2000). That is, males have higher I_x/I_y ratios than females, indicating that males were more mobile than females. These findings reflect a pronounced degree of sexual division of labor, with males engaged in long-distance activities such as hunting excursions and other types of forays. Females, on the other hand, were likely less mobile and were perhaps relatively more "tethered" to the marsh setting. This particular sexual division of labor is quite common among living hunter-gatherers (Kelly 1995a).

As such, we contend that the limnosedentary and limnomobile hypotheses are oversimplifications because they assume that the mobility patterns of females and males were similar, if not identical. Our findings indicate that this is not the case, and that males were more mobile than females.

Dietary Reconstruction: Stable Carbon and Nitrogen Isotopes

Similarly, stable isotope analysis reveals that diet was probably quite variable. The more general question, however, is whether the resources in the Stillwater Marsh could have fully supported the native groups or whether supplements from outside the marsh were necessary. Examination of stable isotope values suggests that nonmarsh foods were used by some portion of the population. The $\delta^{13}C$ values for the human samples have a range of −18.9 to −14.4. Individuals with the less negative values must have eaten a significant amount of C_4 foods throughout their lifetimes, yet a nonsystematic survey of the plants available in the marsh (Schoeninger 1995, 1999 [based on Raven and Elston 1989]) revealed that the majority are C_3. Of the 10 plants ranked highest by Raven and Elston (1989), the first-ranked plant, cattail, is C_3; of the remaining nine plants, three are C_4 and six are C_3. Although it is not possible to estimate the relative contributions of these plants to overall diet, the presence of such marsh-based C_4 plants does not contradict the use of upland C_4 plants as an explanation for the C_4 signature of these individuals. In addition, two animal samples used as a comparison with the human samples have $\delta^{13}C$ values of −12.7 (hare [*Lepus* sp.]) and −11.2 (diving duck [*Aythya* spp.]), indicating that up to 70% of the diets of these animals was one or more C_4 plants or one or more CAM plants with a C_4 signature. This estimate is based on the assumptions that a value in bone of –21 represents a 100% C_3 diet, that a value in bone of –7 represents a 100% C_4 diet, and that there is a linear relationship between diet composition and the $\delta^{13}C$ values (Schwarcz and Schoeninger 1991; Tieszen 1991). This result suggests that these animals were selectively eating C_4 plants, that they migrated into the marsh from the uplands, or that they were hunted in areas away from the marsh. The more negative $\delta^{13}C$ values in the humans can be accounted for by resources found in the marsh.

The variability in plant $\delta^{15}N$ stable nitrogen values provides important insight into reconstruction of foodways. The $\delta^{15}N$ values for the bulk of the human samples have a range of 8.7–14.4 (with an outlier value of 16.7). These values are more positive than those reported for people eating non-marine-based diets. Interestingly, analysis of cattail and desert-blite (*Suaeda* sp.) reveals very positive values (12.1 and 11.4, respectively) even though other marsh plants (e.g., bulrush) have values of around 6.0 (Schoeninger 1995). Large ranges of variation also are found in environments such as South Africa (Vogel et al. 1990) and Isle Royale in Lake Superior, Michigan (Bada, Schimmelmann, Peterson, and Schoeninger 1990, unpublished data; see Figure 9-1, Chapter 2, this volume). These data suggest that there is variation in the isotopic ratio of the nitrogen that is available to different plants. Kuhlbusch et al. (1991) report, for example, that up to 50% of organically-bound nitrogen is lost as nitrogen gas (N_2) during biomass burning. The remaining nitrogen would presumably be enriched in the heavier isotope (^{15}N) because the lighter isotope (^{14}N) would be lost first. The mechanism of fire followed by plant uptake of soil with enriched organically bound nitrogen could account for the very positive nitrogen isotope values observed in some of the plants discussed here, but it is simply not known whether a fire had occurred in the area where these plants were collected.

In any case, the presence of relatively positive $\delta^{15}N$ values in the Stillwater samples (9 and higher) argues against the use of pinyon as a major component of diet because the $\delta^{15}N$ value for pinyon itself is close to zero. That is to say, if pinyon contributed a major portion of diet, then the $\delta^{15}N$ values for the human skeletal samples analyzed should be much lower than those observed in the series analyzed. In contrast, cattail and desert-blite had very positive $\delta^{15}N$ values (12.1, and 11.4, respectively). Both plants are considered highly valued foods (see Raven and Elston 1989), suggesting that they were the source of the high $\delta^{15}N$ values in the Stillwater Marsh human samples.

In general, then, comparison of data derived from human skeletal remains with data from living and archaeological plants and animals from the region indicates that the diet of the majority of the Stillwater individuals depended on plants and animals similar to those analyzed for this study. These data do not refute a model suggesting that people remained year-round in the vicinity of the marsh. On the other hand, they certainly do not argue against forays into surrounding regions, perhaps for lengthy periods of time on a frequent basis. Indeed, the variation we observed in the isotope values argues for a highly varied diet derived from a combination of both marsh and nonmarsh habitats. Specifically, the more negative human bone collagen $\delta^{13}C$ values (–19 to –17) can be accounted for by a combination of plants and animals from the immediate marsh region. These data support archaeological reports that the majority of identifiable quids found at Hidden Cave are bulrush and cattail (see Thomas 1985), both of which are C_3 plants. This finding is consistent with ethnographic observations indicating that these plants were chewed like celery, especially during the spring (see Fowler 1990).

The small group of individuals with the least negative $\delta^{13}C$ values is not easily interpreted in light of the food items available to them. Perhaps foods consumed that resulted in these isotope values were from exclusively non-marsh (e.g., uplands) areas. Certainly the skeletal structural analysis indicates that the Great Basin populations in general were very mobile, particularly males. Thus, it would be expected that at least some of the individuals would have values reflecting non-marsh food consumption.

Physiological Stress: Enamel Defects

Observations of physiological stress in the Stillwater population indicate that environmental perturbation was not, on one hand, rampant or, on the other hand, infrequent. This finding is supported by comparisons of hypoplasia frequencies in other populations (e.g., Guatelli-Steinberg et al. 2004; Mack and Coppa 1992; Ubelaker 1992). Moreover, compared with the Georgia coastal samples representing subsistence strategies ranging from exclusively hunting and gathering to partial agricultural dependence, the Stillwater series shows relatively low levels of hypoplasia prevalence. Taken as a whole, however, the Stillwater prevalence (64%) is moderately high and even exceeds that in some modern populations from the eastern United States with elevated stress (cf., Steckel and Rose 2002). Thus, although physiological stress was not severe in the Stillwater Marsh populations, it was present at appreciable levels.

A variety of causes are linked to hypoplasia, including nutritional disorders, disease, or other factors predisposing individuals to physiological stress, such as low birthweight and socioeconomic status (see reviews in Ten Cate 1994; Larsen 1997). Laboratory studies show that hypoplasia can be induced by alloxan diabetes (Kreshover and Clough 1953a), fever (Kreshover and Clough 1953b), and parasitic infection (Suckling et al. 1986; Suckling and Thurley 1984), among other factors. Both malnutrition and disease likely lead to hypoplasia owing to their synergistic relationship.

As with living populations, most attempts to link specific diseases or dietary insufficiencies to hypoplasias in archaeological human populations are only marginally successful (see Goodman and Rose 1990, 1991; Larsen 1997). Consequently, researchers generally follow the conservative approach taken by Kreshover (1960), interpreting hypoplasias as nonspecific or general indicators of metabolic stress. Despite the nonspecificity of hypoplasia, however, careful consideration of potential stressors can provide insights into specific causes. In archaeological settings like the Stillwater Marsh, it is unlikely that genetic disorders (which are linked to hypoplastic activity [Witkop 1970]) would be important factors because the individual would likely not have survived much beyond birth. Localized trauma to the oral cavity is associated with hypoplasia (e.g., Skinner and Hung 1989), but facial trauma possibly resulting in hypoplastic activity has not been observed in the Stillwater remains. A number of instances of fractured nasal bones are found (see Brooks et al. 1988), but these fractures are likely not linked with hypoplasia.

A wide range of infectious diseases are linked to hypoplasias (Pindborg 1982). In the Stillwater series, however, skeletal pathologies reflecting infectious conditions are infrequent. Only 16% of individuals (10 of 61) have some form of periosteal inflammation, mostly associated with tibiae. This prevalence is either lower than or equal to that in most other North American hunter–gatherer series (e.g., Rose et al. 1984). The inflammations are largely localized periosteal reactions on single bones caused by pathogenic organisms (e.g., the bacterium *Staphylococcus aureus*) introduced into the bloodstream via skin penetration or by localized trauma (see Steinbock 1976). It is highly unlikely that these infections contributed to the kinds of systemic insults that could result in enamel defects.

It is possible that parasitic infections may be a causal factor in hypoplasia. Parasites are present in coprolites excavated from the nearby Lovelock Cave as well as from other areas of the Great Basin (Reinhard 1990). It remains unclear, however, what the link between hypoplasias and parasites, if any, might be for this region.

A number of studies report a causal link between enamel hypoplasias and protein–calorie malnutrition in living populations. In this regard, Goodman et al. (1991) have compared two groups of individuals from the State of Puebla, Mexico; one group received supplemental diets and the other group received nonsupplemental diets. The latter group had generally more hypoplasias than the former. This finding strongly implicates the linkage between nutritional quality and likelihood of having enamel defects.

Given that genetic factors, trauma, and infectious disease were likely not important factors in explaining the presence of hypoplastic teeth in the Stillwater series, it seems that nutritional deficiencies were potentially the more common sources of metabolic insult. In the Carson Desert setting, the availability of edible plants and animals is closely tied to precipitation levels, which average less than 10 cm/yr (see Raven and Elston 1989). Thus, most water supplying the Stillwater Marsh is from snowpack melt from the Sierra Nevada Mountains to the west. The availability of water fluctuates widely. In instances of excessive water, there can be loss of valuable plants and animals in the marsh due to inundation (as documented in the 1980s floods). In the other extreme, precipitation shortages can result in drying of the lakes resulting in a similar reduction of edible plants, waterbirds, and other fauna. Therefore, we suggest that hypoplasia in the Stillwater series is linked to occasional food shortages perhaps caused by water fluctuations and availability of plants and animals as well as seasonal shortages.

Stillwater hypoplasias are relatively frequent and narrow, especially compared to the Georgia coast. Some investigators suggest that width of hypoplasias provides a reasonable quantification of duration of stress events (Blakey and Armelagos 1985; Hutchinson and Larsen 1988, 1990; Sarnat and Schour 1941, 1942). Guita (1984) links the width of hypoplasia to the length of the period of stress. On the basis of research with laboratory animals, Suckling and coworkers (Suckling 1989; Suckling et al. 1986) argue, however, that severity of stress plays a vital role in determination of hypoplasia width.

Growth disruption duration has been studied via the analysis of growth increments called perikymata (Guatelli-Steinberg et al. 2004). Counting these increments provides a more detailed picture of growth stress duration than does measurement of the hypoplasia. Nonetheless, the overall size of the hypoplasia provides an indication of the stress magnitude in the affected individual. Our findings suggest that the magnitude of stress was relatively low in these populations.

A nutritional interpretation for the presence of hypoplasia is consistent with the measurement of bone mass (CA and PCCA) in the Stillwater remains. Bone mass values provide an important index of nutritional status in living human populations (see Garn et al. 1964). The relatively low values in the Stillwater series suggest that these populations likely experienced some nutritional deprivation. Although numerous factors enter into the etiology of hypoplasias, our assessment argues for nutrition or nutrition-related causes. The hypoplasias are narrow, however, indicating that if nutritional problems were involved, they were of short duration or severity or both.

COMPARISONS WITH OTHER GREAT BASIN SETTINGS: MALHEUR LAKE, OREGON, AND GREAT SALT LAKE, UTAH

The flooding in the mid-1980s exposed archaeological sites in at least two other Great Basin settings, namely Malheur Lake in the Harney Basin in Oregon (Hemphill 1992; Nelson 1999; Oetting 1999) and the Great Salt Lake in Utah (Bright and Loveland 1999; Simms 1999). Comparison of health and lifestyle based on the study of human remains for the three regions shows a number of important similarities and differences. The similarities suggest a common adaptive system for the vast region of the Great Basin, yet with some local response and adaptation unique to the particular settings of Stillwater Marsh, Malheur Lake, and Great Salt Lake (see various chapters in Hemphill and Larsen 1999). In particular, physical behavior and activity appears broadly similar for the three regions of the Great Basin. Osteoarthritis prevalence is high for all settings (Hemphill 1999, 2005), indicating a demanding lifestyle for all three regions. Similarly, analysis of cross-sectional geometry of long bones for all three regions reveals high and homogeneous robusticity (Ruff 1999). On the other hand, relatively low I_x/I_y ratios for Malheur indicates less long distance travel in this setting compared to Stillwater and Great Salt Lake. Regardless, the three groups are all highly sexually dimorphic, indicating very different patterns and degree of mobility in comparing males and females.

Stable isotope data are available for Stillwater and Great Salt Lake only. The differences between the two regions are striking (cf., Coltrain and Leavitt 2002; Coltrain and Stafford 1999; Schoeninger 1999). In this regard, the Great Salt Lake populations representing the Fremont Culture were not exclusive foragers. That is, after A.D. 400, stable carbon isotope ratios are less negative, but become more negative after A.D. 1150. The less negative values between A.D. 400 and A.D. 1150 reflect the period of time when the native populations occupying the region were engaged in maize agriculture. Following the twelfth century, however, the maize-dependent populations reverted to a hunter-gatherer lifeway (or abandoned the region and were replaced by a foraging population). Although the reasons for the disappearance of agriculture are not well understood, a widespread drought in the region likely contributed to the adaptive shift.

Evidence for health status variation shows a general pattern of low prevalence of indicators of poor health and physiological stress. In this regard, all three settings show low prevalence of periosteal reactions. Only in the late prehistoric (pre-A.D. 1800) component from Malheur does there appear to be elevated frequency of periosteal reactions. In this setting, it appears that an increase in infection coincided with increased population size and concentration (Nelson 1999). Across all three settings, the incidence of dental caries is remarkably low, reflecting the low carbohydrate diet (except for the maize agriculturalists in Great Salt Lake; see Bright and Loveland 1999). Stress indicators reveal a pattern of little evidence of iron deficiency anemia (low prevalence of cranial porosities), but relatively high prevalence of systemic stress (high prevalence of hypoplasias) for all three regions. The greater systemic stress is likely linked to seasonal variation in food availability, a common theme of life in marginal settings like the Great Basin (Hutchinson and Larsen 1995; Larsen 2006).

CONCLUSION

The fortuitous exposure and subsequent recovery of human skeletal remains from the west central and other settings in the Great Basin has allowed bioarchaeological research to address some long-standing questions about the relationship between hunter–gatherers and their environment. Several principal findings emerge from this study. First, the human populations inhabiting this region were physically robust, reflecting a demanding lifestyle. Analysis of cross-sectional geometric properties of bone reveals that these populations were mobile, particularly males. It is difficult to envision this mobility as being entirely restricted to the marsh setting. These populations, then, were not engaged in a primarily sedentary lifestyle in the marsh. This view implies that although the marsh contained a variety of economically-important foods and could probably support a population year-round, the Stillwater population was mobile. In fact, research at rockshelters in the Stillwater Mountains finds that when the Stillwater Marsh sites were occupied, foragers used the shelters as short-term camps, with evidence of bighorn sheep hunting (Kelly 2005). Comparison with other Great Basin settings suggests that mobility was commonplace throughout the region, at least as can be determined from these three settings.

Second, diet was diverse. Based just on the analysis of carbon and nitrogen stable isotope ratios, it is not possible to say conclusively whether or not foods were extracted from primarily marsh or nonmarsh settings. Rather, subsistence may have involved various combinations of both. In contrast to other regions of the Great Basin, there can be little doubt that pinyon contributed only marginally to the diets of hunter–gatherers at Stillwater Marsh. This may be because pinyon was not present in abundance during the time period when the Stillwater Marsh sites were occupied as the paleoecological research suggests (reviewed in Kelly 2005). In general, both C_3 and C_4 plants and their animal consumers were eaten, and there was little difference with respect to age, sex, or burial locality.

Finally, the health of these populations was likely relatively good in that physiological stress was present at moderate levels and of short duration or severity or both. The presence of relatively low levels of bone mass in adults suggests some nutritional deprivation, which may reflect seasonal or some other form of variable resource availability.

Study of the Stillwater and other Great Basin skeletal series presents an opportunity to address issues regarding hunter–gatherer adaptation using archaeological data. Winterhalder (1993) remarks that the lack of consensus among anthropologists regarding labor in hunter-gatherers results from the lack of an encompassing framework for work analysis. In a broader sense, our discussion points to recent developments in bioarchaeological analysis that can clarify work behaviors in human societies.

The study of human remains takes us closer to an understanding of human ecology in the Great Basin and consequently toward understanding variation in the hunting and gathering lifestyle. It is not important to say whether the Hobbesian or the original affluent society model better portrays foraging societies in the Great Basin in particular or among hunter–gatherers in general, but rather that there is variability among hunter–gatherers in terms of workload, diet, and health status. Some hunter-gatherer populations also will incorporate agriculture where it is seen as advantageous, at least for a time (e.g., Coltrain and Stafford 1999). The exercise becomes much more valuable when attention is focused on the sources of this variation, rather than on a debate over which model better characterizes *all* hunter-gatherers.

ACKNOWLEDGMENTS

Many individuals deserve special thanks for their role in the study of the Stillwater human remains. Thanks are extended to the staff of the Stillwater Wildlife Management Area (U.S. Department of the Interior, Fish and Wildlife Service), and especially to Anan Raymond, for his help and advice throughout the fieldwork and the following analysis. The fieldwork and research could not have been completed without the trust and understanding of the Fallon

Paiute-Shoshone Tribe and former Tribal Chairman Richard Hicks. The Stillwater data collection and analysis were facilitated by various people. Christine Larsen provided invaluable assistance in data recording. Thanks are extended to Thomas Barcia at the Veterans Administration Hospital, Reno, Nevada, for approval and arrangements for our use of the computed tomography scanner for long bone structural analysis. John Blitz, Al Hengge, Urszula Iwaniec, Matthew Murray, Renee Robinson, Mark Schurr, and Isabel Treichel prepared samples for stable isotope analysis. Modern plants for stable isotope analysis in the Carson Desert were collected by Elizabeth Budy and Anan Raymond. Investigation of the human remains in the Nevada State Museum was made easier due to the work of Michelle Haldeman, Sheilagh Brooks, Amy Dansie, and Don Tuohy in identifying skeletons and in cataloging and arranging skeletal remains prior to our study of them. Katherine Russell's participation in the project as field director, osteologist, and consultant extraordinaire is greatly appreciated. Amelia Hubbard provided editorial assistance in the preparation of this chapter. The fieldwork and laboratory analysis were funded by the National Science Foundation (BNS-8704094). Additional funding came from Northern Illinois University, the University of Louisville, and the University of Wisconsin Alumni Research Foundation.

REFERENCES

Bettinger, R. L., 1989, *The Archaeology of Pinyon House, Two Eagles, and Crater Middens: Three Residential Sites in Owens Valley, Eastern California, Anthropological Papers* 67, American Museum of Natural History, New York.

Blakey, M. L., and Armelagos, G. J., 1985, Deciduous Enamel Defects in Prehistoric Americans from Dickson Mounds, Prenatal and Postnatal Stress, *American Journal of Physical Anthropology* 66:371–380.

Braidwood, R. J., 1967, *Prehistoric Men*, 7th ed., Scott, Foresman, Glenview, Illinois.

Bridges, P. S., 1989, Changes in Activities with the Shift to Agriculture in the Southeastern United States, *Current Anthropology* 30:385–394.

Bridges, P. S., 1992, Prehistoric Arthritis in the Americas, *Annual Review of Anthropology* 21:67–91.

Bridges, P. S., Blitz, J. H., and Solano, M. C., 2000, Changes in Long Bone Diaphyseal Strength with Horticultural Intensification in West-Central Illinois, *American Journal of Physical Anthropology* 112:217–238.

Bright, J. R., and Loveland, C. J., 1999, A Biological Perspective on Prehistoric Human Adaptation in the Great Salt Lake Wetlands, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 103–116.

Brock, S. L., and Ruff, C. B., 1988, Diachronic Patterns of Change in Structural Properties of the Femur in the Prehistoric American Southwest, *American Journal of Physical Anthropology* 75:113–127.

Brooks, S., and Brooks, R. H., 1990, Who Were the Stillwater Marsh People? *Halcyon: A Journal of the Humanities* 12:63–74.

Brooks, S. T., Haldeman, M. B., and Brooks, R. H., 1988, *Osteological Analyses of the Stillwater Skeletal Series, Cultural Resource Series* 2, U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Buikstra, J. E., 1988, *The Mound-Builders of Eastern North America: A Regional Perspective*, Elfde Kroon-Voordracht, Amsterdam.

Charles, D. K., and Buikstra, J. E., 1983, Archaic Mortuary Sites in the Central Mississippi Drainage: Distribution, Structure, and Behavioral Implications, in: *Archaic Hunters and Gatherers in the American Midwest* (J. L. Phillips and J. A. Brown, eds.), Academic Press, New York, pp. 117–145.

Charles, D. K., Buikstra, J. E., and Konigsberg, L. W., 1986, Behavioral Implications of Terminal Archaic and Early Woodland Mortuary Practices in the Lower Illinois Valley, in: *Early Woodland Archeology* (K. B. Farnsworth and T. E. Emerson, eds.), *Kampsville Seminars in Archeology* 2, Center for American Archeology, Kampsville, Illinois, pp. 458–474.

Cohen, M. N., and Armelagos, G. J., 1984, *Paleopathology at the Origins of Agriculture*, Academic Press, Orlando, Florida.

Coltrain, J. B., and Leavitt, S. W., 2002, Climate and Diet in Fremont Prehistory: Economic Variability and Abandonment of Maize Agriculture in the Great Salt Lake Basin, *American Antiquity* 67:453–485.

Coltrain, J. B., and Stafford, T. W., Jr., 1999, Stable Carbon Isotopes and Great Salt Lake Wetlands Diet: Towards an Understanding of the Great Basin Formative, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 55–83.

Cybulski, J. S., 1992, *A Greenville Burial Ground: Human Remains and Mortuary Elements in British Columbia Coast Prehistory, Archaeological Survey of Canada Mercury Series Paper* 146, Canadian Museum of Civilization, Ottawa.

DeNiro, M. J., and Schoeninger, M. J., 1983, Stable Carbon and Nitrogen Isotope Ratios of Bone Collagen: Variations Within Individuals, Between Sexes, and Within Populations Raised on Monotonous Diets, *Journal of Archaeological Science* 10:199–203.

Domett, K. M., 2001, *Health in Late Prehistoric Thailand, British Archaeological Reports International Series* (Oxford) S946, Archaeopress, Oxford, England.

Fowler, C. S., 1990, *Tule Technology: Northern Paiute Uses of Marsh Resources in Western Nevada, Smithsonian Folklore Studies* 6, Smithsonian Institution Press, Washington, DC.

Fowler, C. S., 1992, *In the Shadow of Fox Peak: An Ethnography of the Cattail-Eater Northern Paiute People of Stillwater Marsh, Cultural Resource Series* 5, U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Garn, S. M., 1966, Malnutrition and Skeletal Development in the Pre-School Child, in: *Pre-School Child Malnutrition*, National Academy of Science, Washington, DC, pp. 43–62.

Garn, S. M., Rohrmann, C. G., Behar, M., Viteri, F., and Guzman, M. A., 1964, Compact Bone Deficiency in Protein-Calorie Malnutrition, *Science* 145:1444–1445.

Goodman, A. H., and Armelagos, G. J., 1985, The Chronological Distribution of Enamel Hypoplasia in Human Permanent Incisor and Canine Teeth, *Archives of Oral Biology* 30:503–507.

Goodman, A. H., and Rose, J. C., 1990, Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Associated Histological Structures, *Yearbook of Physical Anthropology* 33:59–110.

Goodman, A. H., and Rose, J. C., 1991, Dental Enamel Hypoplasias as Indicators of Nutritional Status, in: *Advances in Dental Anthropology* (M. A. Kelley and C. S. Larsen, eds.), Wiley-Liss, New York, pp. 279–292.

Goodman, A. H., Martinez, C., and Chavez, A., 1991, Nutritional Supplementation and the Development of Linear Enamel Hypoplasias in Children from Tezonteopan, Mexico, *American Journal of Clinical Nutrition* 53:773–781.

Grayson, D. K., 1993, *The Desert's Past: A Natural Prehistory of the Great Basin*, Smithsonian Institution Press, Washington, DC.

Guatelli-Steinberg, D., Larsen, C. S., and Hutchinson, D. L., 2004, Prevalence and the Duration of Linear Enamel Hypoplasia: A Comprehensive Study of Neadertals and Inuit Foragers, *Journal of Human Evolution* 47:65–84.

Guita, J. L., 1984, *Oral Pathology*, 2nd ed., Williams and Wilkins, Baltimore, Maryland.

Heizer, R. F., and Krieger, A. D., 1956, *The Archaeology of Humboldt Cave, Churchill County, Nevada, Publications in American Archaeology and Ethnology* 47(1), University of California, Berkeley.

Heizer, R. F., and Napton, L. K., 1970, *Archaeology and the Prehistoric Great Basin Lacustrine Subsistence Regime as Seen from Lovelock Cave, Nevada, Contributions of the University of California Archaeological Research Facility* 10, Berkeley.

Hemphill, B. E., 1992, *An Osteological Analysis of the Human Remains from Malheur Lake, Oregon* (3 volumes), *U.S. Department of the Interior, Fish and Wildlife Service, Cultural Resource Series* 6, Washington, DC.

Hemphill, B. E., 1999, Wear and Tear: Osteoarthritis as an Indicator of Mobility among Great Basin Hunter-Gatherers, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 241–289.

Hemphill, B. E., 2005, At What Cost a Full Belly? An Investigation of the Seductive Allure of Sedentary Horticulture in the Great Basin, *American Journal of Physical Anthropology*, Supplement 40:113.

Hemphill, B. E., and Larsen, C. S. (eds.), 1999, *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation*, University of Utah Press, Salt Lake City.

Hill, K., and Hurtado, A. M., 1989, Hunter-Gatherers of the New World, *American Scientist* 77:436–443.

Hodges, D. C., 1989, *Agricultural Intensification and Prehistoric Health in the Valley of Oaxaca, Mexico, Museum of Anthropology Memoirs* 22, University of Michigan, Ann Arbor.

Holt, B. M., 2003, Mobility in Upper Paleolithic and Mesolithic Europe: Evidence from the Lower Limb, *American Journal of Physical Anthropology* 122:200–215.

Hough, A. J., Jr., 2001, Pathology of Osteoarthritis, in: *Osteoarthritis: Diagnosis and Medical/Surgical Management*, 3rd ed. (R. W. Moskowitz, D. S. Howell, R. D. Altman, J. A. Buckwalter and V. M. Goldberg, eds.), W. B. Saunders Company, Philadelphia, pp. 69–100.

Hutchinson, D. L., 2002, *Foraging, Farming, and Coastal Biocultural Adaptation in Late Prehistoric North Carolina*, University Press of Florida, Gainesville.

Hutchinson, D. L., and Larsen, C. S., 1988, Determination of Stress Episode Duration from Linear Enamel Hypoplasias: A Case Study from St. Catherines Island, Georgia, *Human Biology* 60:93–110.

Hutchinson, D. L., and Larsen, C. S., 1990, Stress and Lifeway Change: The Evidence from Enamel Hypoplasia, in: *The Archaeology of Mission Santa Catalina de Guale: 2. Biocultural Interpretations of a Population in Transition* (C. S. Larsen, ed.), *Anthropological Papers* 68, American Museum of Natural History, New York, pp. 50–65.

Hutchinson, D. L., and Larsen, C. S., 1995, Physiological Stress in the Prehistoric Stillwater Marsh: Evidence of Enamel Defects, in: *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin* (C. S. Larsen and R. L. Kelly, eds.), *Anthropological Papers* 77, American Museum of Natural History, New York, pp. 81–95.

Hutchinson, D. L., and Larsen, C. S., 2001, Enamel Hypoplasia and Stress in La Florida, in: *Bioarchaeology of Spanish Florida: The Impact of Colonialism* (C. S. Larsen, ed.), University Press of Florida, Gainesville, pp. 181–206.

Janetski, J. C., and Madsen, D. B. (eds.), 1990, *Wetland Adaptations in the Great Basin: Papers from the Twenty-First Great Basin Anthropological Conference, Museum of Peoples and Cultures Occasional Paper* 1, Brigham Young University, Provo, Utah.

Jennings, J. D., 1957, *Danger Cave, University of Utah Anthropological Papers* 27, Salt Lake City, Utah.

Jenning, J. D., 1978, *Prehistory of Utah and Eastern Great Basin, University of Utah Anthropological Papers* 98, Salt Lake City, Utah.

Katzenberg, M. A., 2000, Stable Isotope Analysis: A Tool for Studying Past Diet, Demography, and Life History, in: *Biological Anthropology of the Human Skeleton* (M. A. Katzenberg and S. R. Saunders, eds.), Wiley-Liss, New York, pp. 305–327.

Katzenberg, M. A., and Saunders, S. R. (eds.), 2000, *Biological Anthropology of the Human Skeleton*, Wiley-Liss, New York.

Kelly, R. L., 1992, Mobility/Sedentism: Concepts, Archaeological Measures, and Effects, *Annual Review of Anthropology* 21:43–66.

Kelly, R. L., 1995a, *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*, Smithsonian Institution Press, Washington, DC.

Kelly, R. L., 1995b, Hunter-Gatherer Lifeways in the Carson Desert: A Context for Bioarchaeology, in: *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin* (C. S. Larsen and R. L. Kelly, eds.), *Anthropological Papers* 77, American Museum of Natural History, New York, pp. 12–32.

Kelly, R. L., 1997, The Late Holocene Prehistory of the Great Basin, *Journal of World Prehistory* 11:1–49.

Kelly, R. L., 2001, *Prehistory of the Carson Desert and Stillwater Mountains: Environment, Mobility, and Subsistence in a Great Basin Wetland, University of Utah Anthropological Papers* 123, Salt Lake City, Utah.

Kelly, R. L., 2005, Mustang Shelter: Test Excavation of a Rockshelter in the Stillwater Mountains, Western Nevada, manuscript on file, Department of Anthropology, University of Wyoming, Laramie.

Kent, S., 1992, Studying Variability in the Archaeological Record: An Ethnoarchaeological Model for Distinguishing Mobility Patterns, *American Antiquity* 57:635–660.

Kreshover, S. J., 1960, Metabolic Disturbances in Tooth Formation, *Annals of the New York Academy of Sciences* 85:161–167.

Kreshover, S., and Clough, O. W., 1953a, Prenatal Influences on Tooth Development. I. Alloxan Diabetes in Rats, *Journal of Dental Research* 32:246–261.

Kreshover, S., and Clough, O. W., 1953b, Prenatal Influences on Tooth Development. II. Artificially Induced Fever in Rats, *Journal of Dental Research* 32:565–572.

Kuhlbusch, T. A., Lobert, J. M., Crutzen, P. J., and Warneck, P., 1991, Molecular Nitrogen Emissions from Denitrification during Biomass Burning, *Nature* 351:135–137.

Lambert, P. M. (ed.), 2000, *Bioarchaeologial Studies of Life in the Age of Agriculture: A View from the Southeast*, University of Alabama Press, Tuscaloosa.

Lanyon, L. E., and Rubin, C. T., 1985, Functional Adaptation in Skeletal Structures, in: *Functional Vertebrate Morphology* (M. Hildebrand, D. M. Bramble, K. F. Liem and D. B. Wake, eds.), Belknap Press and Harvard University Press, Cambridge, Massachusetts, pp. 1–25.

Larsen, C. S., 1997, *Bioarchaeology: Interpreting Behavior from the Human Skeleton*, Cambridge University Press, Cambridge.

Larsen, C. S. (ed.), 2001, *Bioarchaeology of La Florida: The Impact of Colonization*, University Press of Florida, Gainesville.

Larsen, C. S., 2006, Great Basin: Skeletal Biology, in: *Handbook of North American Indians: Environment, Origins, and Population*, Volume 3 (W. C. Sturtevant, general ed.), (D. H. Ubelaker, ed.), Smithsonian Institution Press, Washington, DC, pp. 581–589.

Larsen, C. S., and Hutchinson, D. L., 1992, Dental Evidence for Physiological Disruption: Biocultural Interpretations from the Eastern Spanish Borderlands, in: *Recent Contributions to the Study of Enamel Developmental Defects* (A. H. Goodman and L. L. Capasso, eds.), *Journal of Paleopathology Monographic Publications* 2, Associazione Anthropologica Abruzzese, Chieti, Italy, pp. 151–169.

Larsen, C. S., and Kelly, R. L. (eds.), 1995, *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin, Anthropological Papers 77*, American Museum of Natural History, New York.

Larsen, C. S., and Milner, G. R. (eds.), 1994, *In the Wake of Contact: Biological Responses to Conquest*, Wiley-Liss, New York.

Larsen, C. S., Ruff, C. B., and Kelly, R. L., 1995, Structural Analysis of the Stillwater Postcranial Human Remains: Behavioral Implications of Articular Joint Pathology and Long Bone Diaphyseal Morphology, in: *Bioarchaeology in the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin* (C. S. Larsen and R. L. Kelly, eds.), *Anthropological Papers* 77, American Museum of Natural History, New York, pp. 107–133.

Ledger, M., Holtzhausen, L.-M., Constant, D., and Morris, A. G., 2000, Biomechanical Beam Analysis of Long Bones from a Late 18th Century Slave Cemetery in Cape Town, South Africa, *American Journal of Physical Anthropology* 112:207–216.

Lee, R. B., 1979, *Kalahari Hunter-Gatherers*, Harvard University Press, Cambridge, Massachusetts.

Lee, R. B., and DeVore, I. (eds.), 1968, *Man the Hunter*, Aldine, Chicago, Illinois.

Lowie, R. F., 1924, *Notes on Shoshonean Ethnography, Anthropological Papers* 20(3), American Museum of Natural History, New York.

Mack, M. E., and Coppa, A., 1992, Frequency and Chronological Distribution of Enamel Hypoplasias from the Ra's al-Hamra-5 (RH5) Skeletal Collection (Oman), in: *Recent Contributions to the Study of Enamel Development Defects* (A. H. Goodman and L. L. Capasso, eds.), *Journal of Paleopathology Monographic Publications* 2, Associazione Anthropologica Abruzzese, Chieti, Italy, pp. 131–141.

Mandryk, C. A. S., 1993, Hunter-Gatherer Social Costs and the Nonviability of Submarginal Environments, *Journal of Anthropological Research* 49:39–71.

Martin, D. L., Akins, N. J., Goodman, A. H., Toll, H. W., and Swedlund, A. C., 2001, *Harmony and Discord: Bioarchaeology, Archaeology Notes* 242, Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Merbs, C. F., 1983, *Patterns of Activity-Induced Pathology in a Canadian Inuit Population, Archaeological Survey of Canada Mercury Series Paper* 119, Canadian Museum of Civilization, Ottawa.

Nelson, G. C., 1999, Physiologic Stress and Environmental Fluctuation in the Northern Great Basin, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 219–240.

Oetting, A. C., 1999, An Examination of Wetland Adaptive Strategies in Harney Basin: Comparing Ethnographic Paradigms and the Archaeological Record, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 203–218.

Papathanasiou, A., 2001, *A Bioarchaeological Analysis of Neolithic Alepotrypa Cave, Greece, British Archaeological Reports International Series* (Oxford) S961, Archaeopress, Oxford, England.

Peterson, J., 2002, *Sexual Revolutions: Gender and Labor at the Dawn of Agriculture*, Altamira Press, Walnut Creek, California.

Pietrusewsky, M., and Douglas, M. T., 2001, *Ban Chiang, A Prehistoric Village Site in Northeast Thailand I: The Human Skeletal Remains*, University of Pennsylvania Press, Philadelphia.

Pindborg, J. J., 1982, Aetiology of Developmental Defects Not Related to Fluorosis, *International Dental Journal* 32:123–134.

Radin, E. L., Paul, I. L., and Rose, R. M., 1972, Role of Mechanical Factors in Pathogenesis of Primary Osteoarthritis, *Lancet* 1:519–522.

Rafferty, J. E., 1985, The Archaeological Record on Sedentariness: Recognition, Development and Implications, in: *Advances in Archaeological Method and Theory*, Volume 8 (M. B. Schiffer, ed.), Academic Press, Orlando, Florida, pp. 113–156.

Raven, C., 1990, *Prehistoric Human Geography in the Carson Desert. Part II. Archaeological Field Tests of Model Predictions, Cultural Resource Series* 4, U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Raven, C., and Elston, R. G. (eds.), 1989, *Prehistoric Human Geography in the Carson Desert. Part I. A Predictive Model of Land-Use in the Stillwater Wildlife Management Area, Cultural Resource Series* 3, U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Raymond, A. W., and Parks, V. M., 1990, Archaeological Sites Exposed by Recent Flooding of Stillwater Marsh, Carson Desert, Churchill County, Nevada, in: *Wetland Adaptations in the Great Basin* (J. C. Janetski and D. B. Madsen, eds.), *Museum of Peoples and Cultures Occasional Paper* 1, Brigham Young University, Provo, Utah, pp. 33–61.

Reinhard, K. J., 1990, Archaeoparasitology in North America, *American Journal of Physical Anthropology* 82:145–163.

Robbins, D. M., Rosenberg, K. R., and Ruff, C. B., 1989, Activity Patterns in Late Middle Woodland, Delaware, *American Journal of Physical Anthropology* 78:290–291.

Rose, J. C., Burnett, B. A., Nassaney, M. S., and Blaeuer, M. W., 1984, Paleopathology and the Origins of Maize Agriculture in the Lower Mississippi Valley and Caddoan Culture Areas, in: *Paleopathology at the Origins of Agriculture* (M. N. Cohen and G. J. Armelagos, eds.), Academic Press, Orlando, Florida, pp. 393–424.

Ruff, C. B., 1987, Sexual Dimorphism in the Human Lower Limb Bone Structure: Relationship to Subsistence Strategy and Sexual Division of Labor, *Journal of Human Evolution* 16:391–416.

Ruff, C. B., 1991, *Aging and Osteoporosis in Native Americans from Pecos Pueblo, New Mexico*, Garland, New York.

Ruff, C. B., 1994, Biomechanical Analysis of Northern and Southern Plains Femora: Behavioral Implications, in: *Skeletal Biology in the Great Plains: A Multidisciplinary View* (D. W. Owsley and R. L. Jantz, eds.), Smithsonian Institution Press, Washington, DC, pp. 235–245.

Ruff, C. B., 1999, Skeletal Structure and Behavioral Patterns of Prehistoric Great Basin Populations, in: *Understanding Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 290–320.

Ruff, C. B., 2000, Biomechanical Analyses of Archaeological Human Skeletons, in: *Biological Anthropology of the Human Skeleton* (M. A. Katzenberg and S. R. Saunders, eds.), Wiley-Liss, New York, pp. 71–102.

Ruff, C. B., and Larsen, C. S., 2001, Reconstructing Behavior in Spanish Florida: The Biomechanical Evidence, in: *Bioarchaeology of Spanish Florida: The Impact of Colonialism* (C. S. Larsen, ed.), University Press of Florida, Gainesville, pp. 113–145.

Ruff, C. B., Trinkaus, E., Walker, A., and Larsen, C. S., 1993, Postcranial Robusticity in *Homo*. I. Temporal Trends and Mechanical Interpretation, *American Journal of Physical Anthropology* 91:21–53.

Sahlins, M., 1972, *Stone Age Economics*, Aldine, Chicago, Illinois.

Sarnat, B. G., and Schour, I., 1941, Enamel Hypoplasia (Chronologic Enamel Aplasia) in Relation to Systemic Disease: A Chronologic, Morphologic and Etiologic Classification, *Journal of the American Dental Association* 28:1989–2000.

Sarnat, B. G., and Schour, I., 1942, Enamel Hypoplasia (Chronologic Enamel Aplasia) in Relation to Systemic Disease: A Chronologic, Morphologic and Etiologic Classification, *Journal of the American Dental Association* 29:67–77.

Schoeninger, M. J., 1995, Dietary Reconstruction in the Prehistoric Carson Desert: Stable Carbon and Nitrogen Isotopic Analysis, in: *Bioarchaeology in the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin* (C. S. Larsen and R. L. Kelly, eds.), *Anthropological Papers* 77, American Museum of Natural History, New York, pp. 96–106.

Schoeninger, M. J., 1999, Prehistoric Subsistence Strategies in the Stillwater Marsh Region of the Carson Desert, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 151–166.

Schoeninger, M. J., and Moore, K., 1992, Bone Stable Isotope Studies in Archaeology, *Journal of World Prehistory* 6:247–296.

Schoeninger, M. J., DeNiro, M. J., and Tauber, H., 1983, Stable Nitrogen Isotope Ratios of Bone Collagen Reflect Marine and Terrestrial Components of Prehistoric Human Diet, *Science* 220:1381–1383.

Schwarcz, H. P., and Schoeninger, M. J., 1991, Stable Isotope Analyses in Human Nutritional Ecology, *Yearbook of Physical Anthropology* 34:283–321.

Sharma, L., 2001, Epidemiology of Osteoarthritis, in: *Osteoarthritis: Diagnosis and Medical/Surgical Management*, 3rd ed. (R. W. Moskowitz, D. S. Howell, R. D. Altman, J. A. Buckwalter and V. M. Goldberg, eds.), W. B. Saunders Company, Philadelphia, pp. 3–27.

Simms, S. R., 1999, Farmers, Foragers, and Adaptive Diversity, in: *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation* (B. E. Hemphill and C. S. Larsen, eds.), University of Utah Press, Salt Lake City, pp. 21–54.

Simpson, J. H., 1876, *Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon-Route from Camp Floyd to Genoa, in Carson Valley, in 1859*, U.S. Government Printing Office, Washington, DC.

Skinner, M. F., and Hung, J. T. W., 1989, Social and Biological Correlates of Localized Enamel Hypoplasia of the Human Deciduous Canine Tooth, *American Journal of Physical Anthropology* 79:159–175.

Steckel, R. H., and Rose, J. C. (eds.), 2002, *The Backbone of History: Health and Nutrition in the Western Hemisphere*, Cambridge University Press, Cambridge, England.

Steinbock, R. T., 1976, *Paleopathological Diagnosis and Interpretation: Bone Diseases in Ancient Human Populations*, Charles C. Thomas, Springfield, Illinois.

Steward, J. H., 1938, *Basin-Plateau Aboriginal Sociopolitical Groups, Bulletin* 120, Bureau of American Ethnology, Washington, DC.

Stock, J. T., and Pfeiffer, S. K., 2001, Linking Structural Variability in Long Bone Diaphyses to Habitual Behaviors: Foragers from the Southern African Later Stone Age and the Andaman Islands, *American Journal of Physical Anthropology* 115:337–348.

Stock, J. T., and Pfeiffer, S. K., 2004, Long Bone Robusticity and Subsistence Behaviour among Later Stone Age Foragers of the Forest and Fynbos Biomes of South Africa, *Journal of Archaeological Science* 31:999–1013.

Suckling, G., 1989, Developmental Defects of Enamel-Historical and Present-Day Perspectives of Their Pathogenesis, *Advances in Dental Research* 3:87–94.

Suckling, G., Elliot, D. C., and Thurley, D. C., 1986, The Macroscopic Appearance and Associated Histological Changes in the Enamel Organ of Hypoplastic Lesions of Sheep Incisor Teeth Resulting from Induced Parasitism, *Archives of Oral Biology* 31:427–439.

Suckling, G., and Thurley, D. C., 1984, Developmental Defects of Enamel: Factors Influencing Their Macroscopic Appearance, in: *Tooth Enamel IV* (R. W. Fearnhead and S. Suga, eds.), Elsevier, Amsterdam, pp. 357–362.

Ten Cate, A. R., 1994, *Oral Histology: Development, Structure, and Function*, 4th ed., C. V. Mosby, St. Louis, Missouri.

Thomas, D. H. 1985, *The Archaeology of Hidden Cave, Nevada, Anthropological Papers* 61(1), American Museum of Natural History, New York.

Thomas, D. H. (ed.), 1988, *The Archaeology of Monitor Valley: 3. Survey and Additional Excavations, Anthropological Papers* 66(2), American Museum of Natural History, New York.

Tieszen, L. L., 1991, Natural Variations in the Carbon Isotope Values of Plants: Implications for Archaeology, Ecology, and Paleoecology, *Journal of Archaeological Science* 18:227–248.

Tuohy, D. R., Dansie, A. J., and Haldeman, M. B., 1987, *Final Report on Excavations in the Stillwater Marsch Archaeological District, Nevada, Archaeological Services Reports*, Nevada State Museum, Carson City.

Ubelaker, D. H., 1992, Enamel Hypoplasia in Ancient Ecuador, in: *Recent Contributions to the Study of Enamel Developmental Defects* (A. H. Goodman and L. L. Capasso, eds.), *Journal of Paleopathology Monographic Publications* 2, Associazione Antropologica Abruzzese, Chieti, Italy, pp. 207–217.

Ubelaker, D. H., 1994, The Biological Impact of European Contact in Ecuador, in: *In the Wake of Contact: Biological Responses to Conquest* (C. S. Larsen and G. R. Milner, eds.), Wiley-Liss, New York, pp. 147–160.

Vogel, J. C., Talma, A. S., Hall-Martin, A. J., and Viljoen, P. J., 1990, Carbon and Nitrogen Isotopes in Elephants, *South African Journal of Science* 86:147–150.

Wheat, M. M., 1967, *Survival Arts of the Primitive Paiutes*, University of Nevada Press, Reno.

Whittington, S. L., and Reed, D. M. (eds.), 1997, *Bone of the Maya: Studies of Ancient Skeletons*, Smithsonian Institution Press, Washington, DC.

Williamson, R. F., and Pfeiffer, S. (eds.), 2003, *Bones of the Ancestors: The Archaeology and Osteobiography of the Moatfield Ossuary, Canadian Museum of Civilization Mercury Series* 163, Gatineau, Quebec.

Wing, E. S., and Brown, A. B., 1979, *Paleonutrition: Method and Theory in Prehistoric Foodways*, Academic Press, New York.

Winterhalder, B., 1993, Work, Resources and Population in Foraging Societies, *Man* 28:321–340.

Witkop, C., 1970, Heritable Disorders, in: *Thoma's Oral Pathology*, Volume 2 (R. Gorlin and H. Goldman, eds.), C. V. Mosby, St. Louis, Missouri, pp. 635–637.

Zeannah, D. W., 1996, *Predicting Settlement Patterns and Mobility Strategies: An Optimal Foraging Analysis of Hunter-Gatherer Use of Mountain, Desert, and Wetland Habitats in the Carson Desert*, Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City.

Zeannah, D. W., 2004, Sexual Division of Labor and Central Place Foraging: A Model for the Carson Desert of Western Nevada, *Journal of Archaeological Archaeology* 23:1–32.

Zeannah, D. W., Carter, J. A., Dugas, D. P., Elston, R. G., and Hammett, J. E., 1995, *An Optimal Foraging Model of Hunter-Gatherer Land Use in the Carson Desert*, Report to the U.S. Fish and Wildlife Service and U.S. Department of Navy, Portland, Oregon.