Fremont Hunting and Resource Intensification in the Eastern Great Basin

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Empirical tests of resource-intensification models argue for diminishing foraging efficiency among hunter-gatherers in California over the past 2000 years (Basgall, 1987, Research in Economic Anthropology 9, 21–52; Broughton, 1994a, Journal of Archaeological Science 21, 501–514; 1994b, Journal of Anthropological Archaeology 13, 371–401). The evidence for this long-term trajectory consists of decreases in the abundance of large, high-ranked prey in archaeofaunal assemblages. This paper presents faunal data from Fremont structural sites in the eastern Great Basin and Northern Colorado Plateau as an additional empirical test of resource intensification patterns and compares them to trends in California and the American Southwest. The measure of resource efficiency used is the artiodactyl index (following Broughton, 1994a, b), a tool derived from prey choice models of optimal foraging. Faunal data from Fremont structural sites argue that (1) foraging efficiency declined during the Fremont period, and (2) this decline was due to population growth.

Keywords: RESOURCE INTENSIFICATION, EASTERN GREAT BASIN, AMERICAN SOUTHWEST, FREMONT, POPULATION GROWTH, LATE HOLOCENE.

Introduction

Broughton (1994a, b) and Broughton & Grayson (1993) have put intriguing arguments for decreasing foraging efficiency in hunter-gatherer subsistence economies during the Late Holocene in western North America. Using faunal data collected from sites in California and the western Great Basin, they maintain that hunter-gatherers shifted emphasis from large, high-ranked game to smaller, lower-ranked animals. The pattern of faunal exploitation has been noted by others for the western Basin (Elston, 1986; Bettinger, 1991). This process has been described as resource intensification, defined by Boserup (1965, cited in Broughton 1994b: 372) as “a process by which the total productivity per areal unit of land is increased at the expense of overall decreases in foraging efficiency. In other words, more energy is harvested from a given patch of land, but individuals must expend more energy, per unit time, in the process”. The evidence for intensification ranges from the increasing use of smaller fish and fewer large mammals (Broughton 1994a, 1995) in California to a shift toward a greater use of marmots relative to mountain sheep at high altitude sites in the White Mountains (Bettinger, 1991; Grayson, 1991; Broughton & Grayson, 1993; see also Bettinger & Baumhoff, 1982; Madsen, 1986 for additional efficiency arguments to explain change in the Great Basin).

Broughton’s (1994a, b, 1995) research on hunter-gatherers in California attributes the drop in larger animals to resource depression due to central place foraging and human population growth. Resource depression describes the process of game depletion in the vicinity of villages (central places) as a consequence of local ecology modification due to gardening or as a result of hunting. Ethnographical studies have documented how hunters reduce the populations of large game animals near villages, forcing a choice between taking lower-ranked prey close at hand or moving farther afield in pursuit of larger animals (Hames & Vickers, 1982). Transport and travel costs increase with distance and play an important role in prey selection decisions (see Szuter & Bayham, 1989: 88; Metcalfe & Barlow, 1992 for discussion of transport costs). Prey choice decisions should be reflected in faunal assemblages in the relative abundance of large and small animals (see Broughton, 1995).

In the American Southwest a contrasting pattern in faunal exploitation has been described by Bayham (1982), Speth & Scott (1989), and Szuter & Bayham (1989) for essentially the same period. They maintain that archaeofaunas here contain increasing rather than decreasing numbers of large game relative to small game through time. Speth & Scott (1989) cite empirical support of the trend from Anasazi contexts in New Mexico and Hohokam sites in southern Arizona. Szuter & Bayham (1989) report a steady expansion of artiodactyls in the Ventana Cave assemblages from 3000 BC to AD 1000, although they note that faunal data from Hohokam sites in the valleys and uplands
are highly variable and need further investigation (see James, 1994; Szuter & Gillespie, 1994, for more on trends in Hohokam sites). Speth & Scott reject climate, technology, and absolute population growth as potential explanations for this trend. Rather, they suggest that the pattern is a by-product of the “socioeconomic responses which accompany the aggregation of populations into more residentially stable and more horticulturally based communities” (Speth & Scott, 1989: 78). After reviewing the faunal evidence from south-central Arizona, Szuter & Bayham (1989) arrive at a similar conclusion: the increase in artiodactyls through time suggests changes in strategies as a consequence of increased sedentism and farming commitments. The shift in the faunal assemblages at Ventana Cave, for example, is described as evidence of a change in the way the cave was used, from a short-term base camp for mobile foragers to a short-term hunting camp used logistically by specialized groups from nearby sedentary villages.

Like Broughton, Southwest researchers cite resource depression as a primary factor in determining the pattern they describe. In both the California and Southwest cases, the underlying cause was the same: central place foraging by predators (human hunters) depleted large game in the vicinity of villages requiring some adjustment in foraging decisions by the hunters. However, the circumstances in these two cases are quite different. The California case describes hunter-gatherers exploiting land and marine mammals as well as fresh-water and salt-water fishes. The Southwest examples, on the other hand, all involve farmers with investments in land modification and both residential and ritual architecture. This latter fact is especially critical as such investments influence decision-making regarding hunting strategies and residential mobility. Perhaps as a consequence, the response of Southwestern farmers to resource depression is more variable than that seen in California (see Discussion for more on this issue).

The intent of this paper is to test the spatial extent and form of resource intensification in western North America using archaeofaunas gathered from Fremont occupations in the eastern Great Basin and Northern Colorado Plateau. The Fremont, often included as part of the greater Southwest (Cordell, 1984), would appear to be a particularly interesting test case as farming was an important aspect of the subsistence economy over much of the area, although hunting, fishing, and gathering contributed significantly to the diet (Madsen, 1989). The Fremont culture/strategy spread north of the Colorado and Virgin River drainages after about AD 400 and persisted for nearly a millennium. Ceramics reminiscent of Southwestern traditions, pithouse villages, adobe and masonry granaries, and a distinctive art style expressed in rock art and figurines are the material hallmarks of the Fremont period (see Marwitt, 1986). Scholars appear to agree that human populations expanded during this period of farming, although temporal variation occurred (Talbot & Wilde, 1989; Janetski, 1994; Simms, 1994); however, few empirically driven discussions of Fremont demography exist (see Talbot, 1995, for an exception).

Given that Fremont farmers were committed to a central place strategy and given increasing populations in the Fremont area, the resource-intensification model predicts that numbers of high-ranked prey available to villagers will be depressed through time. The archaeological consequences of the pattern are reductions in the quantities of bone from larger, higher-ranked animals during the Fremont period. This expectation is explored following a discussion of prey choice and resource-intensification models.

**Prey Choice Models and Resource Intensification**

Measures of selective efficiency developed from prey choice models have been useful in assessing long-term patterns in resource use for the Southwest and areas of California cited earlier in this paper (Bayham, 1982; Szuter & Bayham, 1989; Broughton, 1994a, b). Prey choice models base predictions of prey selection on ranking in terms of return for effort. The underlying premises and theoretical bases for optimal foraging models have been presented often and well, and a repeat of those arguments in full seems unnecessary (Bayham, 1979; Stephens & Krebs, 1986; Simms, 1987; Broughton, 1994b, and references therein). Briefly, the “energetic value” of prey is based on the number or quantity of calories and/or nutrition obtained from the organism captured (Broughton, 1994b: 375). Prey ranking is based on the energetic value less pursuit, handling, and processing costs. The models predict that the highest ranking prey will be taken whenever they are encountered. The capture of lower-ranking prey, therefore, depends directly on the abundance or encounter rate of higher-ranking animals. As the populations of higher-ranked prey drop, lower-ranked animals will be added to the diet. As Broughton (1994b: 373) notes, the relative frequency of high- and low-ranked prey can be an index of foraging efficiency. The more high-ranked prey in the diet, the more efficient the forager. Other values (hide, fur, bones for tools, prestige) are also recognized as important and can and should be combined with economic values in determining ranking, however (see Jochim, 1976; Kent, 1989; Hawkes, 1990).

Scholars investigating resource intensification through prey choice models have argued that prey ranking (profitability) closely follows prey size (Bayham, 1979; Simms, 1987; Szuter & Bayham, 1989; Broughton, 1994a, b). This statement is born out by studies of the Ache of eastern Paraguay (Hawkes, Hill & O’Connell, 1982), Cree hunters in Canada (Winterhalder, 1981), and various Amazon farmers (Gross, 1975; Hames & Vickers, 1982; various in Kent,
Alvard (1995: 794) concluded, based on observations of the Piro, that “body size alone was found to predict much of the Piro optimal diet”. Studies of African hunters (Hadza, Kung San), however, have shown that this prediction does not apply to very large animals such as cape buffalo and elephants (Lee, 1979; O’Connell, Hawkes & Blurton-Jones, 1992) simply because they are viewed as too dangerous. For the Great Basin of North America, however, where no food animals were so large as to pose a threat, the assumption seems valid given the various currencies mentioned above: nutritional values, utilitarian values, and prestige. More calories, fat, protein, etc. (nutritional values), hide and bone for tools (utilitarian values), and prestige (social values) will be obtained from larger animals. The most important consideration in prey ranking appears to be body size (Broughton, 1994: 376; however, see discussion of mass capture under Technological Innovation below).

The appeal of the above statement is that body size is inherent in bone size—the larger the bone the larger the animal. In addition, bones are abundant in archaeological collections and provide direct access to data on prey size, and access to level of foraging efficiency for the site’s occupants. As stated by Broughton (1994: 376): “Other things being equal (e.g. the seasonality of site occupation, taphonomic histories, transport distance), archaeological faunas dominated by large mammals should represent a higher level of mammalian predation efficiency compared to faunas dominated by smaller sized mammals”.

Predation efficiency, therefore, should be measurable by a ratio of large-to-small animals in the faunal assemblages. Bayham (1982; cited in Szuter & Bayham, 1989) and others (Szuter & Bayham, 1989; Broughton, 1994a, b) have developed a series of efficiency indices that rely on such ratios. Szuter & Bayham’s (1989) research in the Southwest used the artiodactyl index calculated as the artiodactyls/∑artiodactyls+lagomorphs. Broughton’s (see especially 1994a) research generated several indices that demonstrated shifts in the use of mammals compared to fish and the use of anadromous and fresh-water fishes over time. In all cases, the ratio is calculated to range from 0 to 1, with higher values suggesting greater dependence on large animals and higher foraging efficiency.

The artiodactyl index was chosen to analyse Fremont faunal data since small artiodactyls (deer, mountain sheep, antelope) and lagomorphs (both hares and cottontails) are commonly recovered from Fremont sites. Taphonomic concerns are relaxed in the face of overwhelming ethnographical evidence for the importance of rabbits and hares in the diet of Great Basin hunter–gatherers (Steward, 1938; Stewart, 1942; Fowler, 1989) and Southwest horticulturalists (various in Ortiz, 1979; however, see concerns in Schmitt & Lupo, 1995). Lagomorphs recovered from open structural sites are assumed to represent prey collected by Fremont hunters.

**Fremont Faunal Data**

Fremont faunal assemblages are highly variable depending on local environmental conditions (Madsen, 1980). In the north along the Great Salt Lake and Utah Lake margins, fish, waterfowl, muskrats, and occasionally bison are well represented. South of the Wasatch Front, lagomorphs (rabbits and hares) and small artiodactyls (deer, mountain sheep, antelope) dominate most assemblages. Several fundamental difficulties were encountered with the Fremont faunal data. First, the recovery techniques employed in the past vary from no screening to screening with one-quarter-in. sieves to one-eighth-in. sieves. In some cases screen sizes are not reported. Moreover, small bones would logically be recovered with smaller mesh screens, presumably making the collections incompatible for comparative purposes. A similar problem was present in the collections analysed by Broughton (1994a, b). However, he found that differing recovery methods were not influencing the temporal trends in large-to-small bone ratios. It is assumed here that differences in recovery techniques would not have a significant impact on the results of the analysis in part because numerous small animal bones are reported in the assemblages suggesting bones of all sizes were collected. In the Bear River sites, for example, no mention is made of screening, yet hundreds of bird and small mammal bones were recovered attesting to rather careful attention to collecting these remains during excavation. On the other hand, comparing quantities of fish bones collected from sites where fill was screened with one-eighth-in. mesh and sites that were not screened would clearly be inappropriate.

Second, the sites discussed herein are found in diverse environments; consequently, changes in site archaeofaunas could be a simple reflection of ecological differences. The ideal test would be a single well-stratified residential site or a series of temporally unique occupations in a small region wherein environmental factors could be held relatively constant. Although residential sites with multiple occupations are reported for the Fremont area, few report faunal assemblages by structure and supply dating estimates for each structure. As a consequence, data sets being compared are usually site-wide collections from sites in various locations across the eastern Great Basin and Colorado Plateau. In an effort to control somewhat for this problem, I analysed assemblages from all Fremont sites and then only those from the eastern Basin where environments are more similar.

Two additional concerns are functional differences and dating. Table 1 lists the sites used in the analysis along with physiographical province, elevation, and age estimate. To resolve the issue of anticipated differences in faunal assemblage due to functional variability, the analysis only included sites that reported the presence of residential structures (pit or surface houses). Age estimates are based on a combination of
radiocarbon dates and temporally diagnostic artefacts. Janetski \textit{et al.} (1995) have recently re-examined all Fremont dates, calibrating those that had not been adjusted, and have provided an “index date” for each site or occupation level. In some cases index dates are mean dates; in other cases they are best guesses given all the temporal evidence including Fremont ceramic types, architectural styles, and Anasazi trade wares. This approach follows Broughton’s (1994: 506) use of mean dates. The final consideration was the availability of quantified faunal data. Although analysis and reporting style varied from site to site, the restriction of the analysis to artiodactyls and lagomorphs allowed almost all data sets to be used, since nearly all reported assemblages included rabbits, deer, antelope, and mountain sheep.

Table 2 presents NISP values for Fremont sites from both the eastern Great Basin and the Northern Colorado Plateau. This analysis follows that of Szuter & Bayham (1989) and Broughton (1994b) who included bone identified only as artiodactyl in their analysis. The artiodactyl indices calculated here also include specimens identified as artiodactyl or large mammal, since that category is essentially a synonym for small artiodactyls in Fremont assemblages. On the other hand, the exclusion of small mammal bone, a good portion of which is probably leporid, clearly underrepresents rabbits and hares. Nonetheless, many
of the unidentifiable small mammal bones are from taxa other than leporids and may or may not have been food items. This taphonomic dilemma led Broughton (1994a) to exclude other small mammals (pocket gophers, ground squirrels) from his analysis, despite the fact that they were clearly important in the past (Janetski, 1979; see Lyman, 1992; and Schmitt & Lupo, 1995 for similar decisions). To counter this tendency to underrepresent rabbits and hares, all bones identified as Leporidae were included in the analysis. Leporid and lagomorph are used synonymously in this discussion.

To display temporal patterns in Fremont prey selection, the artiodactyl index was calculated for 20 residential Fremont sites with quantified faunal assemblages (Figure 1) (Tables 1 & 2). Figure 2 plots the artiodactyl index for these sites (or temporally separable assemblages) against time. A visual inspection of Figure 2 suggests a tendency for the artiodactyl index to decrease through time. This impression is borne out with Pearson’s correlation coefficient ($r = -0.536, P = 0.015, df = 18$ (all tests are two-tailed)), which demonstrates that there is a rather strong, inverse relationship between the artiodactyl
index and time for all Fremont sites. In other words, the use of deer, mountain sheep, and antelope relative to lagomorphs decreases in the later Fremont period.

As stated, the above calculations use data from all Fremont residential sites with faunal information available. Recognizing that environmental differences between the eastern Basin and the Colorado Plateau could make comparisons inappropriate, coefficients were recalculated for only eastern Basin Fremont structural sites. This recalculation considerably strengthened the relationship between the artiodactyl index and time ($r = 0.695, P = 0.003, df = 14$) (Figure 3). These analyses tend to support the conclusions of Broughton (1994b), who has noted that the relationship between time and the artiodactyl index is strengthened as the size of the region being considered is reduced.

Certainly an additional concern with this analysis is whether the values might be varying according to sample size. To examine this possibility, I calculated Pearson’s correlation coefficient comparing $\sum$NISP for artiodactyls and lagomorphs with the artiodactyl index. The resulting $r$-value ($r = 0.0234, P = 0.921$) is evidence that the index does not vary with the size of the assemblage.

Discussion

The empirical data presented suggest interesting trends in Fremont hunting success and strategies. Assuming that the pattern is real, what could account for the declining numbers of artiodactyls at Fremont residential sites? Speth & Scott (1989) and Broughton (1994a, b) consider climatic shifts, technological change, and resource depression. These are explored below along with butchering, transport, and taphonomic issues.

Climate

Climatic change such as increasing aridity could have a deleterious effect on large game populations. A detailed climatic reconstruction for the Holocene in the eastern Basin comes from archaeological data recovered at Hogup Cave (Aikens, 1970). Harper & Alder (1970) and Durrant (1970) view the variation in floral and faunal assemblages from Hogup Cave as a function of climatic change and track shifts in the occurrence of both plants and animals from 8000 years ago to the present. The most useful data are from rodent and bird remains. Harper & Alder (1970: 234) note that birds and rodents preferring more mesic environments gradually decrease in numbers during this period, while those preferring more xeric conditions increase. During the Fremont period (strata 12–14, c. AD 500–1200), however, evidence suggests that climates tend toward more mesic conditions. Waterfowl, for example, show a modest increase. Grayson (1993: 222) also characterizes the late Holocene as a time of increased moisture and somewhat cooler conditions relative to the middle Holocene (see also Currey & James, 1982; Lindsay, 1986; Murchison, 1989; Lyman, 1992).

More detailed climatic scenarios compiled by Lindsay (1986) and Newman (1995) document more mesic and somewhat warmer conditions at about the time of Christ and again between AD 600 and 1200. Newman’s (1995) reconstruction of the climates in central Utah during the Fremont era argues for only minor changes throughout the period. These reconstructions are consistent with the more general schemes noted above. The question is, how warmer and wetter conditions affect artiodactyl populations? Durrant (1952: 458) points to the importance of water for plant growth and access to winter range for the support of deer herds, both of which would have been more available during a warmer, more mesic climatic interval. These conclusions could reasonably be extended to antelope and mountain sheep as well: wetter, warmer climates should favour artiodactyls (see Szuter & Bayham, 1989: 87 for similar conclusions). These
data suggest that the climate between 2000 and 800 years ago was favourable for artiodactyls, and the decrease in artiodactyls at residential sites cannot be explained by environmental factors.

Technological innovation

Madsen (1986) has suggested that the adoption of the more efficient bow and arrow could have contributed to the decline of large game animals, especially deer and mountain sheep, since they were taken primarily by encounter hunting. Madsen (1986: 37) places the timing of the bow and arrow at about 500 BC, which is most probably too early. Several (Holmer, 1986; Geib & Bungart, 1989; Janetski, 1993) have reviewed the evidence for the arrival of bow and arrow technology in Utah north of the Anasazi and conclude its use was widespread no earlier than AD 200. The adoption of bow and arrow weaponry in Utah at about 1800 BP, however, seems about right for the issue under discussion. Traditional literature on the Fremont places the onset of that period at about 1600 years ago (Marwitt, 1986); therefore, since all dates for the Fremont assemblages presented here post-date the onset of bows and arrows, diminishing numbers of artiodactyls could be attributed to that technological innovation.

Speth & Scott (1989) and Broughton (1994b), however, discount the impact of the bow and arrow. Broughton (1994b: 393) notes that the decline in artiodactyl numbers begins well in advance of the introduction of the bow, which occurred by AD 500 in California. Speth & Scott (1989: 73) put forward a similar argument for the Southwest. Unfortunately, few faunal assemblages are known from early Fremont structural sites. Exceptions are the very recently reported Steinaker Gap and Confluence sites in the Uintah Basin and east of the Wasatch Front on Muddy Creek respectively. Both sites were aceramic with shallow houses and bell-shaped pits and dating to the first few centuries after Christ (Talbot & Richens, 1994; Greubel, 1996). The faunal assemblages in both cases were depauperate; consequently, no statements can be made about change across this technological shift. It is now clear, however, that (as with the Southwest and California) shifts in subsistence strategies in the Fremont area began several centuries earlier than the date offered by Marwitt and prior to the arrival of the bow and arrow and other farming accoutrements such as pottery and deep pithouses. Corn and the use of bell-shaped storage pits, for example, were in place in central Utah by 150 BC (Wilde & Newman, 1989). This suggests that intensification was under way in advance of the arrival of the bow and arrow.

Technological innovations could also include the development of mass capture techniques, such as drives, which, potentially, could have made small mammal procurement more productive than encounter hunting of artiodactyls. However, Speth & Scott (1989: 75, see also references therein) argue convincingly that communal hunting techniques are less efficient than encounter hunting and are practiced only when resources are depressed. They note that among farmer-hunters in the Amazon (admittedly a very different setting from the Great Basin) communal hunts are carried out primarily to obtain large quantities of meat for special occasions. This issue is complicated by the prey choice model, which assumes that prey are encountered and captured one at a time. Mass capture, therefore, could disrupt the logic of body size–equal prey rank*.

Communal hunting for both large and small game is well documented for the ethnographical period in the Great Basin (Steward, 1941; Stewart, 1942). The importance of drives for black-tailed jack rabbits (Lupus californicus), for example, is well known. Nets woven from vegetable fibres played a critical role in drives for rabbits as well as in the mass capture of birds and fish. The construction of nets appears to have considerable time depth given the quantities of netting fragments recovered from the lower strata in Hogup Cave (Aikens, 1970: 120). In fact, if numbers of net fragments represent commitment to communal hunts (such as rabbit drives), such hunts were more prevalent during the Archaic than the Fremont period, a conclusion borne out by the strong correlation between numbers of net fragments and lagomorph bones (Aikens, 1970: 189). Communal hunting at Hogup Cave, therefore, appears to have declined through time. In the absence of clear indications of how faunas were captured in the past (encounter hunting or drives), however, the issue remains problematic.

Resource depression

Local resource depletion due to over-hunting characterizes central place foraging strategies. Speth & Scott (1989) and Szuter & Bayham (1989) both point to the shift in hunting strategies in the Southwest as a consequence (at least in part) of resource depletion or depression in the immediate vicinity of villages. Ethnographical data from South America reinforce these conclusions (Gross, 1975; Hames & Vickers, 1982; and references therein). Hames & Vickers (1982), for example, consider the effect of settlement age on the hunting patterns of the horticultural Siona-Secoya, Yek’wana, and Yanamamo Indians of the Amazon Basin. They note the conventional wisdom that hunting is typically better around new villages and that game depletion is a significant factor in the relocation of villages. The choice of new sites is usually in previously uninhabited or “rested” areas (Hames & Vickers, 1982: 363). Game depletion is measured in

*An example to the contrary may be fish. Raymond & Sobel (1990) have suggested that small tui chub captured with gill nets by Indians in the western Great Basin may have been more cost-efficient than larger fish when the greater costs of gutting and drying are considered.
terms of the availability of higher-ranked or larger animals found in the vicinity of the village. As the region around the village (0–4 km radius) is exploited, hunters focus on smaller animals in the areas near the village and move farther afield to capture larger game. Empirical support for this pattern of game depletion comes from Vickers (1989) whose longitudinal study of Siona-Secoya demonstrated an increase in smaller animals and a decrease in larger animals taken over time. Further, mean weight of game taken increases as a function of distance from the village (Hames & Vickers, 1982: 366). These findings suggest that hunters in distant zones (more than 9 km from a village) select larger animals over smaller prey. Day hunts averaged 20 km for Siona-Secoya following near zone depletion (Hames & Vickers, 1982: 364). Even longer trips, or “expedition hunting” (Vickers, 1989: 54), carry Siona-Secoya hunters up to 75 km from the main village, although the composition of the hunting party often changes to include a hunter and his family. Groups can be gone for up to 4 weeks on such hunts. It is not clear from Vickers’s (1989: 55) data what is brought back to the village as a consequence of these longer expeditions, however.

Broughton’s (1995) analysis of vertebrate faunas from the Emeryville Shellmound demonstrates the pattern of initial local resource depression and subsequent hunting of larger game at greater distances. Relative numbers of elk and deer as well as sturgeon (the largest fish present in the assemblage) decline in the earlier deposits; sturgeon and elk continue to decline, but deer increase in later levels. Importantly, this pattern can be further tested through body part representation, an expectation explored below.

Butchering and transport

Two additional questions are of interest here: (1) how are Fremont faunal assemblages structured by diachronic changes in butchering and transport; and, closely related, (2) density-dependent preservation? Broughton (1995) has cautioned that transport costs are an important additional consideration when central place foragers (such as the Fremont) are the focus of analysis (see also M et al. & Barlow, 1992). Increased logistical hunting would tend to leave bones at butchering sites, thereby accounting for the diachronic pattern seen at residences (i.e. decreasing numbers of bones from larger game). Hunters travelling farther afield in search of large game may have stripped meat and left heavy, low-utility bones behind. At least two predictions follow from this complementary pattern: (1) relative numbers of artiodactyl remains at logistical or kill/butchering sites should increase throughout the Fremont period; and (2) faunal assemblages from residential sites should contain increasing numbers of high utility (in terms of food value) artiodactyl elements through time as a result of field butchering prior to transport back to residential bases (Binford, 1981).

Testing these propositions is difficult. Chronological data from logistical sites, such as caves or rockshelters, are usually limited to a single date from the Fremont period; consequently, no trajectory of change in ratios over the Fremont period can be drawn. Additionally, few logistical sites in the Fremont area have been excavated and reported in detail. Only Hogup Cave (Aikens, 1970) has more than one date for the Fremont period. Significant quantities of Fremont ceramics first appear at Hogup in Stratum 12, dated to c. AD 540 and 780, and continue through to Stratum 14, dated to between AD 780 and 1360 (these are calibrated index dates from Janetski et al., 1995; based on Aikens’s (1970: 29) report). Interestingly, the artiodactyl index increases as expected for Strata 12–14 (Figure 4). Although the patterns at Hogup are intriguing and the data support the general patterns being discussed here, it is difficult to imagine Hogup Cave as a logistical outpost for a Fremont village given its remote location on the west side of the Great Salt Lake. The closest known Fremont structural site is in the Bear River marsh, which lies a minimum of 100 km to the east, depending on the route taken. The closest access would be to skirt the north end of the Great Salt Lake. It seems more reasonable to suggest that sites such as Hogup were used primarily by non-farmers who increased efforts at big game procurement in order to trade with horticulturalists for farm products (see Kelly, 1964 for description of such a pattern among Southern Paiute people). Finally, taphonomic issues cloud conclusions using faunal data from sites such as Hogup (for example see Hockett, 1994 for a discussion of the origins of Hogup Cave leporids).

The second expectation, that numbers of high-utility elements should increase at later residential sites if logistical hunting were the primary means of procuring artiodactyls, has two parts: (1) determining ratios of high- to low-utility elements; and (2) demonstrating a temporal shift in those ratios. Broughton’s analysis (1995) of the stratified Emeryville Shellmound fauna, for example, found that, after a period of decline,
high-utility elements increased in later strata, a pattern that Broughton suggests is evidence for greater use of distant hunting patches, field butchering, and subsequent transport of selected elements back to the shellmound residence. Similar patterns of change in high-utility elements have apparently also been documented in the Southwest at both Chacoan (Akins, 1982; cited in Speth & Scott, 1989: 73) and Hohokam sites (Bayham & Hatch, 1984; cited in Speth & Scott, 1989: 73).

Relative abundance of high- and low-utility body parts in Fremont faunal assemblages has been explored by several analysts. Sharp (1992), Rood & Butler (1993), and the author (Janetski, 1995) have recently described large faunal collections from Nawthis Village, Round Spring with deer bone density as presented by Lyman (1994: 246–247, table 7·6) (Table 3)*. In all cases there is a positive strong relationship between bone density and %MAU (\( r_{\text{Nawthis}}=0·4696, \text{P}=0·014; r_{\text{Five Finger}}=0·6325, \text{P}=0·001; r_{\text{Round Spring}}=0·5829, \text{P}=0·003 \)). These values argue strongly that preservation, bone processing (Bunn, 1993), or carnivore gnawing are primary factors in shaping the assemblages from these sites.

That reverse utility curves should describe the three Fremont faunal assemblages mentioned above is no surprise given the research by Lyman (1994) on this topic. He concludes that researchers should expect that archaeologically recovered assemblages of bones have been altered by density-mediated, post-depositional processes, particularly carnivore gnawing (Lyman, 1994: 246-247). My conclusions were based on a comparison of percentage minimal animal units (%MAU) for small artiodactyls from Nawthis Village, Five Finger Ridge, and Round Spring with deer bone density as presented by Lyman (1994: 246–247, table 7·6) (Table 3)*. In all cases there is a positive strong relationship between bone density and %MAU (\( r_{\text{Nawthis}}=0·4696, \text{P}=0·014; r_{\text{Five Finger}}=0·6325, \text{P}=0·001; r_{\text{Round Spring}}=0·5829, \text{P}=0·003 \)). These values argue strongly that preservation, bone processing (Bunn, 1993), or carnivore gnawing are primary factors in shaping the assemblages from these sites.

Relative abundance of high- and low-utility body parts in Fremont faunal assemblages has been explored by several analysts. Sharp (1992), Rood & Butler (1993), and the author (Janetski, 1995) have recently described large faunal collections from Nawthis Village, Round Spring, and Five Finger Ridge respectively and reported on the distribution of artiodactyl elements. In each case the pattern of body part distribution was more characteristic of that expected at a kill site than at a residential site; that is, among other things, the assemblages were dominated by low-rather than high-utility elements. This pattern seems unacceptable for what are clearly residential sites. Explanations offered range from the process of drying meat (Todd, 1993: 384–385), to the selection of bone for tools (Sharp, 1992: 152), and density-mediated attrition due to carnivore gnawing (Sharp, 1992; Janetski, 1995: 137). My conclusions were based on a comparison of percentage minimal animal units (%MAU) for small artiodactyls from Nawthis Village, Five Finger Ridge, and Round Spring with deer bone density as presented by Lyman (1994: 246–247, table 7·6) (Table 3)*. In all cases there is a positive strong relationship between bone density and %MAU (\( r_{\text{Nawthis}}=0·4696, \text{P}=0·014; r_{\text{Five Finger}}=0·6325, \text{P}=0·001; r_{\text{Round Spring}}=0·5829, \text{P}=0·003 \)). These values argue strongly that preservation, bone processing (Bunn, 1993), or carnivore gnawing are primary factors in shaping the assemblages from these sites.

Table 3. %MAU for small artiodactyls from three Fremont sites and bone density for deer and domestic sheep (from Lyman, 1994)

<table>
<thead>
<tr>
<th>Element</th>
<th>Five Finger Ridge</th>
<th>Nawthis Village</th>
<th>Round Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%MAU *</td>
<td>%MAU †</td>
<td>%MAU ‡</td>
</tr>
<tr>
<td>Sacrum</td>
<td>0</td>
<td>15·38</td>
<td>10·5</td>
</tr>
<tr>
<td>Thoracic vert</td>
<td>0</td>
<td>9·47</td>
<td>4·0</td>
</tr>
<tr>
<td>Cervical vert</td>
<td>0</td>
<td>13·85</td>
<td>8·4</td>
</tr>
<tr>
<td>Lumbar vert</td>
<td>0</td>
<td>5·69</td>
<td>5·3</td>
</tr>
<tr>
<td>Pfemur</td>
<td>0</td>
<td>42·31</td>
<td>21·1</td>
</tr>
<tr>
<td>Dluna</td>
<td>0</td>
<td>3·85</td>
<td>10·5</td>
</tr>
<tr>
<td>Atlas</td>
<td>0</td>
<td>7·69</td>
<td>0</td>
</tr>
<tr>
<td>Axis</td>
<td>0</td>
<td>76·92</td>
<td>21·1</td>
</tr>
<tr>
<td>Pelvis</td>
<td>0</td>
<td>61·54</td>
<td>28·5</td>
</tr>
<tr>
<td>Ribs</td>
<td>0·20</td>
<td>10·95</td>
<td>3·6</td>
</tr>
<tr>
<td>Phumerus</td>
<td>2·5</td>
<td>26·92</td>
<td>10·5</td>
</tr>
<tr>
<td>Dfemur</td>
<td>5</td>
<td>30·77</td>
<td>10·5</td>
</tr>
<tr>
<td>Pfemur</td>
<td>5</td>
<td>57·69</td>
<td>5·3</td>
</tr>
<tr>
<td>Pmetacarpal</td>
<td>10</td>
<td>84·62</td>
<td>42·1</td>
</tr>
<tr>
<td>Pmetatarsal</td>
<td>17·5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Dmetacarpal</td>
<td>22·5</td>
<td>23·08</td>
<td>21·1</td>
</tr>
<tr>
<td>Puina</td>
<td>25</td>
<td>19·23</td>
<td>10·5</td>
</tr>
<tr>
<td>Phalanges</td>
<td>27</td>
<td>85·4</td>
<td>58·9</td>
</tr>
<tr>
<td>Dradius</td>
<td>32·5</td>
<td>15·38</td>
<td>26·3</td>
</tr>
<tr>
<td>Pradus</td>
<td>47·5</td>
<td>26·92</td>
<td>52·6</td>
</tr>
<tr>
<td>Mandible</td>
<td>52·5</td>
<td>50</td>
<td>26·3</td>
</tr>
<tr>
<td>Dhumeres</td>
<td>57·5</td>
<td>23·08</td>
<td>42·1</td>
</tr>
<tr>
<td>Scapula</td>
<td>62·5</td>
<td>53·85</td>
<td>15·8</td>
</tr>
<tr>
<td>Dmetatarsal</td>
<td>82·5</td>
<td>65·38</td>
<td>10·5</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>87·5</td>
<td>42·31</td>
<td>15·8</td>
</tr>
<tr>
<td>Dfibia</td>
<td>100</td>
<td>80·77</td>
<td>47·4</td>
</tr>
<tr>
<td>Atracagulus</td>
<td>100</td>
<td>73·8</td>
<td>26·3</td>
</tr>
</tbody>
</table>

*Based on MNE of mountain sheep plus deer.
†Based on MNE of small artiodactyls.
‡Based on MNE of body size III bovids (predominantly bighorn sheep and deer).

*Lyman (1994: 246-247) scanned multiple sites on bones resulting in several values for proximal or distal ends, for example. Since few analyses provide MNEs for other than proximal and distal ends, I averaged Lyman’s numbers to obtain a single density value for that portion of the bone. For example, density values for the proximal tibia were obtained by averaging scan sites T11 (0·30) and T12 (0·32) for deer to obtain a value of 0·31 (see Table 3). The pelvis value was the most worrisome as there are seven scan sites; all seven were averaged to obtain the single value of 0·49.
The work of Rapson (1990), Marean & Spencer (1991), Marean et al. (1992), and others have provided additional ways of quantifying elements (calculating ratios of long bone shafts to long bone ends, for example) in order that patterns resulting from cultural behaviour can be differentiated from attrition due to carnivore activity. Marean et al. (1992: 117) conclude that this is best performed by combining evidences of hammer stone percussion and tooth marks as well as analysis of body parts that includes sorting of elements by shafts and ends. Todd’s (1993: 358–360) report of the Round Spring assemblage comes closest to covering all of the analytical bases suggested, although he does not differentiate between shaft ends and middle shafts. However, plotting the MNEs based on long bone ends only and MNEs calculated on both ends and shafts for the Round Spring long bones (following Lyman, 1994: 271–272) does not alter the pattern of reverse utility at Round Spring (Table 4, Figure 5). The slope of the best fit lines in Figure 5 is essentially the same for MNE for ends only and MNE for ends plus shafts: as utility increases, frequency decreases. Persistence of the reverse utility pattern is likely to be due to intense processing of bones by people, village dogs, and/or other scavengers; an explanation that may also apply to Nawthis Village, and Five Finger Ridge.

The second part of the expectation regarding the occurrence of high-utility elements (that element ratios should shift toward increasing numbers of high-utility parts through time) is hindered by the scarcity of useful data from early sites. The three sites mentioned above, Round Spring, Nawthis Village, and Five Finger Ridge, are all late sites (post-1000 AD) so tracking change through time is difficult. Further, the previous discussion questions whether transport behaviour can be derived from body part ratios, at least as currently calculated. Clearly, excavations of early Fremont sites and more sophisticated faunal analyses from all periods are areas that need attention in Fremont studies.

Summary

Long-term trends in Fremont artiodactyl use may be best explained as a function of resource depression due to increasing populations. Unfortunately, discussions of Fremont population levels are few and most are synchronic in nature (see Meighan, 1958; Gunnerson, 1969; for some examples). Sammons-Lohse (1981) considered village size, but again her discussion was essentially synchronic. Talbot (1995) offers one of the few discussions of Fremont demographical trends. Following an exhaustive review of dated sites, he argues that significant population growth and site aggregation began after AD 900 and continued into the AD 1200s. Talbot & Wilde (1989: 11), relying on radiocarbon dates, have shown that site density in the middle Sevier River Valley was high during the period between AD 1050 and 1200, suggesting a population increase. Settlement data from the Richfield area and Clear Creek Canyon, a tributary to the Sevier River, demonstrate that early occupations were primarily on floodplains as evidenced by early dates at Backhoe Village (Madsen & Lindsay, 1977), Lott’s Farm, and Icicle Bench (Talbot et al., 1994). Later villages tended to be aggregated and were located increasingly on ridges (Five Finger Ridge is an example), although use of the floodplains or valley sites continued. This pattern is evidence that people were using more of the landscape through time and that absolute numbers were increasing.

Under conditions of higher populations, the Fremont may have remained in one place for longer periods simply because there may have been fewer places to move. Or, if the village were moved, the new area may not have lain “fallow” or rested long enough.

Table 4. MNE for Round Spring long bones calculated by ends only and shafts plus ends compared to utility values (SFUI)

<table>
<thead>
<tr>
<th>Element</th>
<th>MNE based on ends (proximal, distal, shafts)</th>
<th>MNE based on ends+shafts</th>
<th>SFUI (Metcalfe &amp; Jones, 1988)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humerus</td>
<td>12 (2/12/6)</td>
<td>18</td>
<td>36.8</td>
</tr>
<tr>
<td>Radius</td>
<td>14 (14/7/2)</td>
<td>16</td>
<td>25.8</td>
</tr>
<tr>
<td>Metacarpal</td>
<td>9 (9/0/6)</td>
<td>15</td>
<td>5.2</td>
</tr>
<tr>
<td>Femur</td>
<td>5 (5/3/2)</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>Tibia</td>
<td>13 (1/13/3)</td>
<td>16</td>
<td>62.8</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>19 (19/2/2)</td>
<td>21</td>
<td>37</td>
</tr>
</tbody>
</table>

Figure 5. Scatterplot and linear fit for utility (SFUI) and MNE frequencies for Round Spring long bone ends only and ends plus shafts. □, ---, ends only; ▼, - - -, ends plus shafts.
for large game populations to rebound from years of hunting by the last group to occupy the area. Archaeological evidence of this could be reoccupation of preferred locations such as that documented for Median Village (Marwitt, 1970) and the Evans Mound (Berry, 1974; Dodd, 1982) in Parowan Valley where superimposed houses were common. It is noteworthy that superpositioning seems more common at structural sites found in valley locations than at ridgetop sites (see also Simms, 1986).

Somewhat puzzling is the contrast between Southwestern faunal assemblages, where artiodactyl elements apparently increase in village sites, and Fremont assemblages, where numbers of artiodactyls decrease. Why is that so? Recent, well-controlled faunal data may argue that the Southwestern pattern is not as widespread as Speth & Scott (1989) suggest. Szuter & Gillespie (1994), for example, point out that more rigorous screening techniques at Hohokam sites during the 1980s have produced evidence that smaller game, especially lagomorphs, were more important than previously thought. Also, James (1994) has summarized new data from the Roosevelt Dam area that are somewhat mixed but which appear to show an increase in lagomorph exploitation through time. No increase in large game is apparent at the several sites he discusses. More compelling are data from the Four Corners area where Munro (1994: 123–124) has documented the increasing importance of turkeys from Basketmaker to Pueblo III occupations. Likewise, Thompson (1990), who analysed faunal assemblages from early Pueblo II and late Pueblo III contexts at the Nancy Patterson site in south-eastern Utah, found that use of turkeys increased dramatically in Pueblo III times while artiodactyl use declined.

Speth & Scott (1989: 78) predict variable responses to localized protein depletion. Options may have included greater dependence on turkey, as described for the Four Corners region, increased use of fish, or, as was the case on the eastern Puebloan borders, exchange with Plains hunters for bison meat. However, these options were pursued only when significant investments in agricultural facilities (irrigation canals, check dams, etc.) close to villages precluded settlement relocation. In contrast to Southwest farmers, Fremont investments in land modification for agricultural purposes were few (see M etcalf & L arrabee, 1985; T albot & R ichens, 1994, for reviews). Likewise, residential architecture, although more elaborate than that seen for Great Basin or California aboriginal groups, was relatively modest and no ritual architecture (such as kivas) has been documented in the Fremont area. Consequently, the option to move was more attractive to the Fremont than to the Anasazi or Hohokam.

A Model of Fremont Subsistence

These brief discussions suggest several possibilities for modelling subsistence practices of Fremont farmers. I use the term “farmers” since the model is based on the assumption that those occupying structural sites were involved in farming. This does not assume that farming was the only strategy or that other strategies were not operating concurrently with the horticultural pattern (Madsen, 1982, 1989; Simms, 1986, 1990, 1994; Upham, 1994).

The analysis of faunal data from Fremont residential or structural sites suggests a pattern generally reminiscent of that seen in the Southwest. As corn and gardening were included in the subsistence economy about 2000 years ago, people made a greater commitment to a central place strategy followed by a slow decline in hunting success between AD 500 and 1300 (see Lupo & Schmitt, 1995 for some corroboration of this trend for the northern portion of the region and M etcalf, 1993 for a different view).

The Fremont who occupied village sites are best modelled as farmer–hunters who were concerned with both the productivity of their fields and the productivity of their hunting forays (see also Sharp, 1992). Abandonment of village locations to maintain maximum yields on both fronts may have occurred as often as very few years as a consequence of resource depression (see various examples of mobility of part-time agriculturalists in Kent, 1989). Declining yields of hunters who hunt big game, not only as an important way of provisioning their families (meat, buckskins for clothing, bone for tools, sinew for a multitude of purposes), but also as a source of prestige for the successful, may have spurred site abandonment (see Kent, 1989; Hawkes, 1990 for discussions of why meat is more valuable than plant foods).

Conclusions

The aim of this paper has been to test resource-intensification models developed in California and the American Southwest. The test case was the Fremont, a group who practiced a mixed economy north of the better-known Southwestern farmers. Relying on prey choice logic and the artiodactyl index, the analysis concluded that a gradual reduction in foraging efficiency occurred in the eastern Great Basin and Northern Colorado Plateau during the Late Holocene. Faunal assemblages from archaeological sites show a slow decline in the relative numbers of large game animals between AD 500 and 1300. This trend may have influenced the regular movement of villages and discouraged the construction of major agricultural facilities. The persistence of the pattern (artiodactyl hunting, regular residential moves) combined with population increase over several centuries resulted in a gradual reduction of small artiodactyl populations across the Fremont area.

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References


