Faunal Analysis of Walnut Canyon, Arizona

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ABSTRACT

A small sample of faunal remains (n = 701) was analyzed from various proveniences from Walnut Canyon National Monument, northern Arizona. The sample represents the Sinagua occupation of the region; most of the remains are from cliff dwellings occupied during the Elden Phase, from A.D. 1150 to 1220. In general the sample is too small to warrant broad conclusions, but some points can be made. The predominant game animal by specimen count and biomass is deer or artiodactyl (probably deer) from nearly all contexts, followed by leporids including jackrabbit or cottontail. This dominance of artiodactyl in the assemblage is unusual as compared to large contemporary sites in the region and may represent hunting preference, recovery bias, or both. Other wild taxa are found in small numbers, including commensal species such as pocket gopher and mice, and avian faunas like red-tailed hawk, Canada goose, mourning doves, and ravens. Sample sizes are insufficient to warrant conclusions about body part representation or age at death profiles, though most deer in the assemblage are from older subadult or adult animals, with the exception of a few fetal or neonate remains. A large number of worked bones are included in the assemblage. Bone tools are manufactured primarily from the long bones of artiodactyls, particularly deer.

INTRODUCTION

Walnut Canyon National Monument (National Park Service) is located in northern Arizona, about ten miles southeast of modern Flagstaff. The monument preserves dozens of archaeological sites, most of which are associated with the Sinagua, a group that occupied the upper and middle Verde River Valley and volcanic fields of the San Francisco Mountains in north-central Arizona from A.D. 700 to 1450 (Downum 1992). Sinagua lifeways were variable, with a mixed foraging-farming economy and architecture that ranged from semi- and subterranean pithouses to pueblos and cliff dwellings. The main ceramic type associated with the Sinagua is Alameda Brown Ware, which is undecorated, though they traded widely for painted pottery (Gilman 1976; Downum 1992).

The Sinagua is divided into several different cultural periods, and the ones relevant to this study are the Padre Phase, which spans from A.D. 1070 to 1150 and the Elden Phase, from A.D. 1150 to 1220 (Downum 1992). The Padre Phase began after the eruption of Sunset Crater, and marks a growing populations and the spread of Hohokam-like ballcourts at Sinagua sites. Other items, including higher frequencies of exotic ceramics and jewelry indicate an increase in trade with outside groups. Dry farming, which supported population growth, was practiced with the use of seasonally occupied field houses (Downum 1992). The Elden phase marks the appearance of Flagstaff and Walnut black-on-white ceramics. During this time, population densities continued to grow and pueblo size became larger. Structures that some have argued are defensive (e.g., cliff dwellings) are built during this period (Downum 1992). Walnut Canyon contains some of the most well-known examples of this architecture. In subsequent Sinagua cultural phases, populations shrunk and settlements became more dispersed, though it is unclear exactly why this happened.

The duration of the occupation of Walnut Canyon is much shorter than the larger Sinagua region; the marginal local environment seems to have been one of the first areas to be depopulated (Gilman 1976). The most well-known sites in Walnut Canyon are the cliff dwellings, which are associated with the Elden Phase, though some free-standing Elden Phase pueblos have also been recorded along the rim of the canyon (Gilman 1976). From the early to mid- 20th century, multiple archaeological surveys, excavations, and ruin stabilization projects were undertaken in Walnut Canyon. The results of these projects are discussed below, followed by an analysis of faunal remains from the area. Reports or field notes are available for some, though not all, of the areas from which the faunal sample is derived. Most of the sites discussed in this study are Elden Phase cliff dwellings, though at least two are not.

The Anniversary Site includes three site numbers, none of which are cliff dwellings. NA 103 is a two-room Elden Phase pueblo, and NA 476 and 478 are both late Padre Phase pithouses (Ritchie 1970). No faunal remains from NA 476 are included in the Walnut Canyon assemblage so it is not discussed further. These sites were initially recorded by H.S. Colton in the 1920s, and were subsequently excavated by Norman Ritchie, with the National Forest Service, and Roger Kelly, from Northern Arizona University, who directed a field school at the sites (Kelly 1968; Ritchie 1970). During excavations, most fill and all floor fill were screened through 1/15" mesh (Ritchie 1970) so it is expected that recovery of small items should be quite good.

As mentioned above, NA 478 is a single room pithouse that, based on diagnostic ceramics, dates to the late Padre Phase. (Ritchie 1970). The structure has a prepared clay floor, hearths and sandstone slabs brought to the site from over ten kilometers away. Diagnostic ceramics mostly include Sunset Red and Winona Brown Wares, both classified as Alameda Brown Wares (Ritchie 1970). Lithic debris, stone tools, azurite, and worked and unworked bones were also recovered from the site. An adjacent trash area was excavated and twelve associated burials were found (Kelly 1968; Ritchie 1970). Artifacts associated with the burials include worked bone, shell necklaces, and turquoise beads (Ritchie 1970).

NA 103 postdates NA 478, and it is unclear if the structures are related. The locality is a two-room Elden Phase pueblo north of the canyon rim, with prepared floors, hearths and sandstone slabs similar to those found at NA 478 (Ritchie 1970). A range of Alameda Brown Ware ceramics were recovered, including Sunset Red, Winona Brown, Angell Brown, Youngs Brown, and Elden Corrugated Ware. Other ceramics, classified as "trade ware" were also recovered in small numbers (Ritchie 1970). Lithic debitage was recovered, in addition to clay human and animal figurines, petrified wood, and azurite. Both NA 103 and NA 478 include groundstone artifacts such as manos and metates, stone points mostly made from obsidian and chert, stone tools, olivella shell, worked turquoise beads, and worked conus shell (Ritchie 1970).

Mitigation efforts at NA 311A-F, 312A and B, 313, and 313A and B, Elden Phase cliff dwellings, are described by Ezel (1940). The sites were initially excavated by park employees and members of the Civilian Conservation Corps in the 1930s, and ruin stabilization was subsequently undertaken by park employees in 1940 (Ezel 1940). Though different site numbers and letters were assigned to the locality, it seems that all of the designations represent different rooms on a larger cliff dwelling (indicated by letters), possibly built into adjacent rock shelters (with different site numbers). For example, Ezel (1940) notes that rooms 311A and B are adjacent to one another, but 312A is also adjacent to 311B. Because the site is a cliff dwelling, it is thought to date to the Elden Phase.

Most of the rooms have similar structures, with prepared earth floors and firepits, though 311F and 313B are described as terraces or patios (Ezel 1940). A range of artifacts were recovered from the site, including ceramics, arrow shaft smoothers, arrow heads, scrapers, axes, polishing stones, hammerstones, manos and metates, textiles such as basketry, mats, cotton cloth, cotton and yucca cordage, worked and unworked animal bone, turquoise earbobs, and olivella shell ornaments (Ezel 1940). Two diagnostic ceramics, a Sunset Red bowl and a fragment of Elden Corrugated ware recovered from NA 312B date to AD 1065-1200 and AD 1085-1200, respectively (Colton and Hargrave 1937; Colton 1958). Ezel (1940) indicates that some of the smaller artifacts, such as the beads, were recovered by screening, though he does not mention the size of the mesh or elaborate in any way on recovery methods during the project. Looting was noted at certain proveniences, specifically NA 311B (Ezel 1940). NA 311G was not mentioned as part of the site, but a single faunal specimen was identified from this context. Due to the nature of the numbering system at the site, it is assumed that it is from a nearby or related area.

Gilman (1976) synthesizes many unpublished reports about ruin stabilization and early excavations in Walnut Canyon. The stabilization of sites NA 320, NA 322, NA 323 and NA 324 was undertaken in 1958. No information is available concerning artifact assemblages or architecture, but the sites are cliff dwellings so it is assumed that they date to the Elden Phase.

A series of sites, including NA 737, NA 739 and NA 742 were excavated and stabilized repeatedly from the 1930s through 1950s (Gilman 1976). NA 737 and NA 739 are adjacent cliff dwellings, with five and nine rooms, respectively. NA 739 was first excavated in 1932 by Hargrave and Colton, and later by the Museum of Northern Arizona under Lyndon Hargrave (Gilman 1976). The architecture of two of the rooms at NA 739 is described as “typical” of site from Walnut Canyon: 17 by 10 feet, with a “T-shaped doorway” (unlike those found at Mesa Verde), a bench along the back of the room, and a fire pit. The rooms have multiple levels. A range of organic and inorganic artifacts were recovered from the NA 737 and 739, including various styles of ceramics, bone, stone tools, shell, groundstone, textiles, spindle whorls, botanicals, turquoise, copper, and other semi-precious minerals (Gilman 1976). The distribution of these artifacts across the rooms and dwellings is not mentioned. Based on the architecture and diagnostic ceramics, the sites date to the Elden Phase. All that is mentioned about NA 742 is that it is a two room cliff dwelling (Gilman 1976).

No provenience information is available for the other sites (NA 479 and NA 729) and catalogue numbers discussed below. However, all materials presented here were excavated from Walnut Canyon so at the very least they are thought to be Sinagua.

METHODS

The zooarchaeological analysis presented here represents the remains of multiple survey and excavation projects conducted from the 1940s through 1960s in Walnut Canyon, northern Arizona. Based on the species represented and associated artifacts and structures, the majority of the remains are thought to come from the Padre and Elden Phases, which lasted 150 years from A.D. 1070 to 1220. In all, 701 specimens were identified from the Walnut Canyon assemblage, from an unknown number of sites. This sample is exceptionally small, and is presented by site when provenience information permits. In many cases, site number was not known, so these samples are discussed by catalogue number (Cat #). Some catalogue numbers contain comparatively large samples, though most contain only one or two specimens. The catalogue numbers with small samples (less than 10 specimens) are presented together as “Miscellaneous Catalogue Numbers” in the following section. A list of the samples reported here is attached as Appendix A and is arranged by catalogue number within each site. The Walnut Canyon assemblage also includes a large number of worked bone artifacts from various proveniences.

These are described by site or Cat # in the results section, and then presented together in the discussion section.

Vertebrate remains were identified using standard zooarchaeological methods. All identifications of the materials reported here were made by Britt M. Starkovich using the comparative skeletal collections housed at the Stanley J. Olsen Laboratory of Zooarchaeology, Arizona State Museum, University of Arizona. A number of primary data classes are recorded. Specimens are identified according to species or body class, elements represented, the portion recovered, and symmetry. The Number of Identified Specimens (NISP) is determined. Broken specimens that cross-mend are counted as a single specimen. The only exception to these procedures are remains that are not identifiable beyond the "unidentified vertebrate" category. Specimens in this category are not counted due to their fragmented condition. All specimens are weighed to provide additional information about the relative abundance of the taxa identified. Indicators for sex, age at death, and modifications are noted where observed. The Minimum Number of Elements (MNE) is estimated based on unique markers on individual elements. Minimum Number of Individuals (MNI) is derived from paired elements and age at death.

While MNI is a standard zooarchaeological quantification unit, the measure has several well-known biases. For example, MNI tends to emphasize small-bodied taxa over larger ones. This is demonstrated in a hypothetical sample consisting of ten cottontails and one deer. Although an MNI of ten cottontails indicates an emphasis on the exploitation of cottontail, one deer supplies more meat. Further, some elements are more readily identifiable than others. The taxa represented by these elements may therefore be incorrectly perceived as more significant to the diet than animals with less distinctive elements. Conversely, some taxa represented by large numbers of specimens may present few paired elements and hence the number of individuals for these species may be underestimated. Fundamental to using MNI is the assumption that the entire individual was utilized at the site. From ethnographic evidence it is well known that this is not always true (Perkins 1968). This is particularly the case for large animals that are butchered in the field, animals used for special purposes, and where food exchange is an important economic activity (Thomas 1971; White 1953).

In addition to these primary biases, MNI is also subject to a secondary bias introduced by the way samples are aggregated during analysis. The aggregation of archaeological samples into analytical units (Grayson 1973) allows for a conservative estimate of MNI, while the "maximum distinction" method, applied when analysis discerns discrete sample units, results in a much larger MNI. In estimating MNI for the Walnut Canyon assemblages, all faunal remains associated by site and time period are grouped together.

Several strategies are employed to address the biases imposed by MNI. NISP and MNE are presented and used for certain calculations. Biomass estimates also attempt to compensate for some of the problems encountered with MNI. Biomass refers to the quantity of tissue (meat and other soft tissues) that a specific taxon might have supplied. Predictions of biomass are based on the allometric principle that the proportions of body mass, skeletal mass, and skeletal dimensions change with increasing body size. This scale effect results from a need to compensate for a weakness in the basic structural material, in this case the bones and teeth. The relationship between body weight and skeletal weight is described by the allometric equation (Simpson 1960):

$$Y = aX^b$$

In this equation, **X** is specimen weight, **Y** is biomass, **b** is the constant of allometry (the slope of the line), and **a** is the Y-intercept for a log-log plot using the method of least squares regression and the best-fit line (Casteel 1978; Reitz 1983; Reitz 1987; Wing 1979). Many biological phenomena show allometry described by this formula (Gould 1966, 1971) so that a given quantity of skeletal material or a specific skeletal dimension represents a predictable amount of tissue or body length due to the effects of allometric growth. Values for **a** and **b** are derived from calculations based on data at the Florida Museum of Natural History, University of Florida, and the University of Georgia Museum of Natural History. The allometric formulae used here for estimating biomass are presented in Table 1.

The species identified from the Walnut Canyon assemblages are summarized in faunal categories based on vertebrate class (Tables 3 and 10). This summary contrasts the percentage of various groups of taxa in the collection. These categories include: birds of prey, turkey, other birds, deer, leporids (jackrabbits and cottontails), carnivores, commensal taxa, and other wild mammals. Because of the small sample size for the assemblages and the biases inherent in MNI, NISP and biomass is presented in the summary. In order to make comparisons of MNI and biomass estimates possible, the summary tables include biomass estimates only for those taxa for which NISP is estimated.

Commensal taxa are those that are found in close association with humans and their constructed environments, though they are typically not consumed by people. They may include certain avian species, dogs, horses, and some rodents. Rodents are the main possible commensal taxa in the Walnut Canyon assemblages. In general, the smallest-bodied rodents, including pocket gophers (*Thomomys* sp.) and white-footed mice (*Peromyscus* sp.) are classified as commensals, while larger-bodied squirrels, Gunnison's prairie dog (*Cynomys gunnisoni*), and woodrats (*Neotoma* sp.) are not. In an analysis of coprolites from Archaic sites from the southwestern United States, Reinhard et al. (2007) find that though occasionally *Peromyscus* was consumed by people, larger-bodied *Neotoma* is much more common. Therefore, it is possible that pocket gophers and mice were occasionally eaten at Walnut Canyon, but in any case, their dietary contribution was negligible with the small samples of these taxa in the assemblages (see below). The remains of commensal taxa lack taphonomic damage caused by humans, such as evidence of burning and butchery.

The avian group is divided into birds of prey, turkeys, and other birds. This is because some of the archaeological contexts are kivas, where certain birds of prey are often found as part of ritual behaviors and were not eaten. Turkeys may represent domesticated species so they are distinguished from other birds.

The presence or absence of elements in an archaeological assemblage provides data on animal use such as butchery practices and transportation costs. Artiodactyl elements, in particular, may be instructive of differential transport, though smaller species may also be field-dressed or partial butchered elsewhere. The most common taxa in the Walnut Canyon are summarized into categories by body segments in Tables 4 and 11. This includes deer (*Odocoileus* sp.), jackrabbit (*Lepus californicus*), cottontail (*Sylvilagus* sp) and turkey (*Meleagris gallopavo*). The Head category includes only skull fragments, including antlers and teeth. The atlas and axis, along with other vertebrae and ribs, are placed into the Axial category. It is likely that the Head and Axial categories are underrepresented because of recovery and identification difficulties. Vertebrae and ribs of medium artiodactyls cannot always be identified as deer, pronghorn and bighorn sheep unless distinctive morphological features support such identifications. Usually they do not, and all specimens from these elements are classified as medium artiodactyl. The Forequarter segment includes the scapula, humerus, radius and ulna. Carpal and metacarpal specimens are presented in the Forefoot category. They Hindfoot category includes tarsal and metatarsal specimens. The Hindquarter category includes the innominate, sacrum, femur and tibia. Metapodiae and podiae which could not be assigned to one of the other categories, as well as sesamoids and phalanges, are assigned to the Foot category.

The archaeological deer element data are also compared to a standard deer using a ratio diagram (Simpson 1941; Reitz 1991). Described by Simpson (1960), the formula is as follows:

$$d = \log_e X - \log_e Y \quad \text{or} \quad d = \log_e(X/Y)$$

where **d** is the logged ratio, **X** is the percentage of each element category in the archaeological collections, and **Y** is the same percentage of this category in the standard deer. It does not matter to which base the measurements are converted, though one should be consistent in order to ensure that the results are comparable. As Simpson (1941:23) describes this approach:

> The basic purpose of the diagram is to represent each of a number of analogous observations by a single entry and to plot them in such a way that the horizontal distance between any two of them will represent the ratio of either one of those two to the other.

The standard deer is based on the number of elements present in an unmodified deer skeleton. In order to compare the archaeological data with the standard deer, the percentages of each element category for the standard deer are converted into logarithms, subtracted from the logged value of the same element category for the archaeological percentages, and plotted against the standard deer represented by the vertical line in the accompanying figure. MNE is the archaeological value used in this ratio diagram, which are directly comparable to the whole elements for the standard deer.

Relative ages of identified artiodactyls are estimated based on observations of the degree of epiphyseal fusion for diagnostic elements and tooth eruption data (Severinghaus 1949; Silver 1969). When animals are young their elements are not fully formed; the area of growth along the shaft and the end of the element, the epiphysis, is not fused. When growth is complete the shaft and epiphyses fuse. While environmental factors influence the actual age at which fusion is complete (Watson 1979), elements fuse at a known, predictable rate (Gilbert 1973; Purdue 1983; Schmid 1972).

During analysis, specimens are recorded as either fused or unfused and placed into one of three categories based on the age in which fusion generally occurs (early, middle or late). Unfused elements in the early-fusing category are interpreted as evidence for juveniles, unfused elements in the middle-fusing and late-fusing categories are usually interpreted as evidence for subadults, though sometimes characteristics of the specimens may suggest a juvenile. Fused specimens in the late-fusing group provide evidence for adults. Fused specimens in the early- and middle-fusing group are indeterminate. Clearly fusion is more informative for unfused elements that fuse early in the maturation sequence and for fused elements that complete fusion late in the maturation process than it is for other elements. An early-fusing element that is fused could be from an animal that died immediately after fusion was completed or many years later. The ambiguity inherent in age grouping is somewhat reduced by recording each element under the oldest category possible.

Modifications can indicate butchering methods as well as site formation processes. Modifications are classified as burning (blackened or calcined), cut or hack marks, snaps, marks or impacts, fractures, rodent gnawing or carnivore gnawing. While the NISP for specimens identified as UID Vertebrate are not included in the species list, burned UID Vertebrate specimens are included in the modification tables. Burned specimens may result from exposure to fire when a cut of meat is roasted. Burns may also occur if specimens are burned intentionally or unintentionally after discard. Cuts are small incisions across the surface of specimens. These marks were probably made by stone tools as meat was removed before or after cooking. Cuts may also be left on specimens if attempts are made to disarticulate the carcass at joints. Some marks that appear to be made by human tools may actually be abrasions inflicted after the specimens were discarded, but distinguishing this source of small cuts requires access to higher-powered magnification than is currently available (Shipman 1983). Hack marks are evidence that some larger instrument, such as a cleaver, was used. Presumably, a cleaver, hatchet, or axe would have been employed as the carcass was being dismembered rather than after the meat was cooked. Osseous tools are common in the assemblage. Worked specimens are those that show evidence of human tool or ornament manufacture, including completed tools, preforms, and debitage. Specimens determined to be worked are grooved and snapped, flaked, or polished.

Gnawing by rodents and carnivores indicates that specimens were not immediately buried after disposal. While burial does not ensure an absence of gnawing, exposure of specimens for any length of time might result in gnawing. Rodents include such animals as squirrels, mice and rats. Carnivores include species such as dogs and raccoons. Gnawing by carnivores and rodents may result in the loss of an unknown quantity of discarded material. Kent (1981) demonstrates that some bone gnawed by carnivores do not necessarily have any visible signs of gnawing, though some specimens were probably removed from their original context.

Calcined bones are the result of two possible processes. Burning at extreme temperatures can cause bones to become calcined, which may be indicated by blue-gray discoloration. However, *calcification* can also occur by the leaching of calcite from shell deposits, resulting in hardened bone virtually indistinguishable from calcined bone. Burning is the most likely cause of calcined bone in the assemblage because no shell was apparent.

Specimen count, MNE, MNI, biomass, and other derived measures are subject to several common biases (Casteel 1979; Grayson 1979, 1981; Wing 1979). In general, samples of at least 200 individuals or 1400 specimens are needed for reliable interpretations. Smaller samples will frequently generate a short species list with undue emphasis on one species in relation to others. It is not possible to determine the nature or the extent of the bias, or correct for it, until the sample is made larger through additional work.

Specimen count, MNE, MNI, and biomass also reflect identifiability. As discussed above, elements of some animals are simply more reliably identified than others and the taxa represented by these elements may appear more significant in terms of specimen count than they were in the diet. If these animals are identified largely by unpaired elements such as scales and cranial fragments, the estimated MNI for these taxa will be low. At the same time, animals with many highly diagnostic but unpaired elements will yield a high specimen weight and biomass estimate. Hence high specimen count, low MNI, and high biomass for some animals are artifacts of analysis. Recognizing this source of bias is particularly critical to interpretations of subsistence strategies in the Walnut Canyon faunal assemblages.

One method which addresses this bias by comparing variety and degree of specialization is to measure the diversity and equitability of the species identified from a site (Hardesty 1975; Reitz 1999). Diversity measures the number of species used. Equitability measures the degree of dependence on individual resources and the effective variety of species used at the site based on the even, or uneven, use of individuals species. These indices allow a discussion of food habits in terms of the variety of animals used at the site (richness or diversity) and the equitability (evenness) with which species were utilized.

Multiple diversity indices are available to zooarchaeologists, here the Shannon-Weaver Index is used. The formulae for the index is:

$$H' = -\Sigma p_i \log_e p_i$$

where $\mathbf{p_i}$ is the number of **i**th species, divided by the sample size (Pielou 1966; Shannon 1949). $\mathbf{P_i}$ is actually the evenness component of the assemblage since the Shannon-Weaver Index measures both how many species were used and how much each was utilized.

Equitability is calculated using the formula:

$$E = H'/\text{Log } S$$

where **H'** is the Diversity Index and **Log S** is the natural log of the number of observed species (Pielou 1966; Sheldon 1969).

Interpreting diversity and equitability indices is sometimes difficult. Diversity increases as both the number of species and the equitability of species abundance increases. A diversity index of 4.99 is the highest possible value. A sample with many species identified and in which the number of individuals slowly declines from most abundant to least abundant will be high in diversity. Diversity can be increased by adding a new taxon to the list, but if another individual of an already present taxon is added, diversity is decreased. A low diversity value can be obtained either by having a few species or by having a low equitability, where one species is considerably more abundant than others. A low equitability value indicates that one species was more heavily used than other species in the sample. A high equitability index, approaching 1.0, indicates an even distribution of species in the sample following a normal pattern where there are a few abundant species, a moderate number of common ones, and many rare ones.

Diversity and equitability were calculated for both MNI and biomass. In the case of MNI, estimates of individuals were taken directly from the species lists. Biomass represents a different situation because biomass was estimated for more taxonomic levels than MNI. It was considered important to calculate biomass diversity and equitability using the same taxonomic units used to calculate these values for MNI. For this reason, only those biomass estimates for taxa for which MNI was estimated are included in the biomass diversity and equitability calculations. For example, in calculating biomass diversity and equitability, biomass for *Lepus californicus* was used rather than biomass for Leporidae. This ensures that when comparing biomass and MNI diversity results, exactly the same observations were used in both cases.

Typically, the most common species in prehistoric faunal assemblages from the southwestern United States are leporids (e.g., jackrabbits and cottontails) and artiodactyls (e.g., deer, pronghorn, and bighorn sheep). The leporid and artiodactyl indices were developed in order to evaluate the proportion of these different prey groups and to compare them between archaeological sites (Bayham and Hatch 1985a, b; Szuter and Bayham 1989). Different proportions of jackrabbits and cottontails can be related to environmental factors, as jackrabbits favor more open vegetation and cottontails prefer bushy vegetation. Conversely, different proportions of leporid species can indicate social and cultural factors, as the clearing of areas for agriculture facilitates "garden hunting" of jackrabbits, or if jackrabbits are procured through communal hunting (Quirt-Booth and Cruz-Uribe 1997). Similarly, a higher proportion of leporids as compared to artiodactyls may indicate that small game was attracted to disturbed agricultural areas. The leporid index is as follows:

Leporid index = NISP cottontails/(NISP cottontails + NISP jackrabbits)

A leporid index of less than 0.50 indicates that jackrabbits are more common in an assemblage, while values greater than 0.50 indicate a dominance of cottontails. The artiodactyl index is similar:

Artiodactyl index = NISP artiodactyls/(NISP artiodactyls + NISP leporids)

An index value of greater than 0.50 indicates that artiodactyls are more important in the assemblage and a value less than 0.50 indicates an importance of leporids. Note that in the leporid index, genus or species-specific identifications are necessary, while in the artiodactyl index group-specific identifications are all that are required. This is because unidentified leporids may have either been jackrabbits or cottontails, which affects the leporid index, but not the artiodactyl index. Both NISP and biomass are used to calculate the leporid and artiodactyl indices to see if there are substantial differences between the importance of each group by count or amount of meat provided. These values are then comparable with other sites from northern Arizona.

RESULTS

NA 478

Only two specimens were analyzed from NA 478, a Padre Phase pithouse. One is a worked artiodactyl long bone fragment (Tables 2 and 8). The other is a fully fused deer metacarpal from an individual older than 26 months at death (Table 5).

NA 103

NA 103 is a small Elden Phase pueblo reported by Kelly (1968) and Ritchie (1970). It lies north of the canyon rim and is the only Elden Phase site in this study that is not a cliff dwelling. The faunal sample analyzed in this study is small, with only 85 specimens representing 14 individuals (Table 2). The majority of the remains were identified as artiodactyl, and deer (*Odocoileus* sp.) is the most common identifiable taxon. Birds are well-represented in the assemblage by NISP, mostly turkey (*Meleagris gallopavo*) but small amounts of red-tailed hawk (*Buteo jamaicensis*), raven (*Corvus corax*), mourning dove (*Zenaidura macroura*), owl (*Bubo* sp.), and Canada goose (*Branta canadensis*) are also present. Deer, black bear (*Ursus americanus*), and turkey are the most common species by biomass. Leporids are also present in the assemblage in small numbers. By prey group, deer are again the most common, followed by turkey and other birds; leporids have a lower representation at this site than at some of the others (Table 3).

Body parts represented in the assemblage by MNE are fairly variable, though the samples are quite small (Table 4; Figure 1). Turkey wings and legs are more common than other body segments, and all body units are represented for deer.

Fusion data are only available for two elements, both from deer (Table 5). They consist of an early and middle fusing element, both of which are fully fused. This indicates an animal of indeterminate age, though the individual was older than 26 months at death. Two fetal or neonate deer elements were recorded, a metatarsal and a radius (Table 6).

Human modifications are fairly common at NA 103, with a range of burning, cuts, snaps, impacts and fractures apparent, particularly on artiodactyl specimens but also on jackrabbit (Table 7). Rodent and carnivore gnawing is also present on the remains, including on some avian specimens as well as artiodactyls and leporids.

A total of thirteen worked specimens were recorded from NA 103, most of which could only be identified as artiodactyl long bone fragments (Table 8). Artiodactyl metapodials, a rib, and a deer antler were also worked.

NA 311, 312 and 313

Ezell (1940) discusses NA 311, 312 and 313, and indicate that they are all subunits of the same Elden Phase cliff dwelling. Some of the subunits were not specifically mentioned in the original report, but they are included here together because they are thought to be related based on the way the other parts of the site were named and organized.

The grouping of the samples from NA 311, 312 and 313 are somewhat difficult to interpret because they are occasionally grouped by room while, at other times, room blocks are combined. To be as accurate as possible, the faunal results are presented according to the most precise site information available. Sixty-three specimens representing an MNI of eight were identified from the combined provenience of NA 311A, B, C (Table 2). Deer are the most common taxa by NISP and biomass, followed by artiodactyls, Gunnison's prairie dog, and jackrabbit. Trace amounts of pronghorn, an unknown canid, cottontail and a bird belonging to the family Columbidae, which includes pigeons and doves, are also present. Considered by group, deer continue to be the most common, and leporids and other wild mammals are almost equally represented (Table 3). Three specimens were identified from NA 311A, fragments of deer, artiodactyl and jackrabbit. The sample specific to NA 311B is one of the largest in the assemblages, yielding an NISP count of 96 accounting for nine different individuals. The bulk of the sample by NISP and biomass are deer and artiodactyl, though other species including pronghorn, unknown canid, Gunnison's prairie dog, porcupine, jackrabbit, cottontail, and turkey are also represented. Only one specimen was recorded from NA 311G, a fragment of marmot (*Marmota* sp.).

Five specimens were identified from NA 312, all of which are artiodactyl (Table 2). NA 312A yielded an NISP of 26 from at least two individuals. Most of the remains were identified by NISP as artiodactyl, followed by deer and one jackrabbit, though deer comprised the majority of the sample by biomass. Twenty specimens were identified from NA 312B, which has an MNI of five. Species identified from the provenience include cottontails, jackrabbit, gray fox (*Urocyon cinereoargenteus*) and deer, as well as two artiodactyl specimens and five fragments from either pronghorn or bighorn sheep (*Ovis canadensis*). The different taxa are represented fairly evenly by NISP, MNI and biomass. By group, leporids are the most common followed by other wild mammals, carnivores, and deer (Table 3). A sample with mixed provenience from both NA 313A and B contains four specimens that account for two different individuals, a jackrabbit and deer. Only one specimen was identified from NA 313B, a burned fragment of deer hindfoot (Tables 4 and 7).

The deer foot region is the most common body part in the NA 311A, B, C mixed provenience by MNE, though this region contains a large number of the bones in a complete skeleton. The other body parts are fairly evenly represented for deer in the sample (Table 4, Figure 2). Only the forequarter and hindquarter regions are represented for jackrabbit, and cottontail elements from the axial and hindquarter segments were recorded. At NA 311A, one element from the deer head region was noted, as well as a jackrabbit forequarter element. NA 311B has a comparatively robust sample, with 31 elements identified for deer. Most elements are from the hindfoot, followed by the forequarter and hindquarter regions (Figure 3). Elements from the forequarter region were also recorded for cottontails, turkeys (wings), and jackrabbit; a hindquarter element was also noted for the latter.

There is a fairly even representation of deer body regions from NA 312A, though the sample is very small (Table 4). Deer head and axial regions are represented by one element each in the NA 312B sample. Forequarter elements are present for jackrabbits and cottontails, in addition to the head and hindquarter regions for the latter.

Several deer elements from the combined NA 311A, B and C proveniences yielded bone fusion data (Table 5). Two unfused phalanges can be assigned to a juvenile animal. An unfused vertebral centrum may be from a subadult or younger animal. An unfused distal tibia, proximal calcaneus and two distal metapodium indicate a subadult, at least younger than 29 months of age at death. Four fetal or neonate deer elements were also recorded (Table 6). Deer fusion data are also available for NA 311B. A series of early fusing elements that are fully fused are somewhat ambiguous for assigning age at death. An unfused distal tibia, distal metapodial, proximal ulna, and femora, however, are indicative of at least one subadult individual in the assemblage. A fetal or neonate innominate is also present in the assemblage.

Only two deer elements from NA 312A provide bone fusion data (Table 5). One, an unfused distal tibia is ambiguous, but comes from an individual older than 20 months at death. An unfused distal femur is from an animal that was a subadult at death, but it is unclear if the femur and tibia are from the same individual.

The only human modifications noted on the NA 311 A, B, and C combined sample are fresh bone fractures, which were apparent on artiodactyl, deer, and jackrabbit specimens (Table 7). Both rodent and carnivore gnawing were recorded in the assemblage. In the NA 311B sample, one artiodactyl specimen is burned, and cut marks are apparent on three specimens.

Fresh bone fractures are common on artiodactyl and deer remains, and are also observed on jackrabbit and turkey specimens. Rodent and/or carnivore damage was recorded on six specimens.

At NA 312, burning is apparent on two artiodactyl specimens and snap fractures were noted on two artiodactyl and one deer element (Table 7). Rodent gnawing was noted on two specimens. Burning is common on artiodactyl remains from NA 312A, and is also apparent on one deer specimen. Cuts and fresh bone fractures were recorded from one specimen each. Rodent gnawing was noted on three artiodactyl specimens. The only human damage recorded on the NA 312B assemblage is fresh bone fractures on both cottontail and pronghorn specimens. Rodent gnawing was also noted.

Several worked specimens were recorded in the NA 311, NA 312 and NA 313 series (Table 8). Two worked pieces are from NA 311A, an artiodactyl long bone fragment and a deer antler. A single artiodactyl long bone is the only worked specimen from NA 311B.

Five worked pieces were identified from NA 312, three of which were long bone fragments, and two were ulnas (Table 8). All of the worked bone at NA 312 could only be identified as artiodactyl. NA 312A yielded two worked specimens, a deer metatarsal and an artiodactyl metapodial. The combined sample of NA 313A and 313B contained three worked artiodactyl pieces, two of which were identified as long bone fragments, the third was made on a metapodial.

NA 320B

Two specimens were analyzed from NA 320B, an Elden Phase cliff dwelling, both of which are fragments of artiodactyl (Table 2).

NA 322

NA 322D, 322E and 322I are different rooms of the same Elden Phase cliff dwelling. Eighteen specimens from four individuals were identified at NA 322D. Most of the specimens were artiodactyl. Deer is the most common identified species by NISP and MNI, followed by pronghorn and jackrabbit (Table 2). Pronghorn is the most well-represented species by biomass. One specimen was identified from NA 322E, a fragment of bobcat (*Lynx rufus*) that has both carnivore and rodent gnawing (Tables 7). NA 322I has an NISP of 11, representing three different species and four individuals. Deer is the most common taxa by NISP and biomass, followed by artiodactyl. One specimen each was identified to large mammal, jackrabbit, and a member of the genus *Anas*, which includes dabbling ducks and teals.

Only one body segment for jackrabbit is represented in the NA 322D assemblage: the head. Deer MNE is dominated by the hindquarter, but the sample size is small (Table 4). At NA 322I, all identified elements are from either the forequarter or hindquarter region. One jackrabbit specimen was identified from the forequarter.

Fusion data are available for six deer elements from NA 322D (Table 5). At least one individual was an adult at death, based on a fused proximal tibia. Two unfused distal tibiae are from an individual that was a sub-adult or juvenile, younger than 23 months, at death. Fusion data are also available for six deer elements from NA 322I. Two are fully-fused early fusing elements which are less helpful for age designations. An unfused distal tibia is from either a sub-adult or juvenile individual that was younger than 23 months at death. Fully fused proximal and distal femora account for at least one adult individual older than 32 months.

Burning is apparent on two artiodactyl fragments from NA 322D and four specimens are fractured (Table 7). Animal modifications are uncommon; rodent gnawing was only observed on one pronghorn specimen. Two deer specimens from NA 322I are fractured and one has evidence of rodent gnawing.

Three worked bone pieces were recorded from NA 322I (Table 8). One could only be identified as an artiodactyl long bone fragment, the other two are worked deer ulnas.

NA 323K

Four specimens were identified from the Elden Phase cliff dwelling NA 323K, one artiodactyl and three fragments of deer, representing an MNI of two (Table 2). Deer body segments from 323K include one element from the head, one from the forefoot, and one from the hindquarter region (Table 4).

Bone fusion data are available for two of the deer elements from NA 323K (Table 5). An unfused distal metapodial is from a subadult animal younger than 29 months at death, and a fully fused proximal femur is from an adult individual older than 32 months at death.

Two deer specimens from NA 323K display fresh bone fractures (Table 7). Carnivore damage was noted on two specimens in the sample.

NA 324

Sixteen specimens were identified from NA 324, an Elden Phase cliff dwelling, all fragments of a burned pronghorn cranium from one individual (Tables 2 and 7).

NA 737

NA 737, an Elden Phase cliff dwelling, yielded twelve specimens, most of which were identified as artiodactyl, though two were identified as deer, accounting for an MNI of one (Table 2). Deer elements include one from the head and another from the forequarter region (Table 4). Age data is available for one of the deer elements, a fully fused proximal ulna from an adult individual, older than 26 months at death (Table 5). One artiodactyl fragment in the assemblage is burned (Table 7).

All of the specimens identified from NA 737 were worked (Table 8). Worked deer bone includes a fragment of antler and an ulna. Half of the worked artiodactyl elements can only be identified as long bone fragments, though metapodials, a radius and a tibia were also worked.

NA 739

The largest sample from the Walnut Canyon faunal assemblage is from NA 739, a series of rooms from an Elden Phase cliff dwelling. The site contains 218 specimens, for an MNI of 13 (Table 2). Most of the specimens were identified as artiodactyl, followed by jackrabbit, which accounts for two individuals, and deer, representing at least three individuals. These three groups are the largest by NISP as well as biomass, though turkey is more well-represented by biomass than jackrabbit. Other taxa included in the assemblage are cottontails, common raven, porcupine (*Erethizon dorsatum*), white-footed mice (*Peromyscus* sp.), squirrels, woodrats (*Neotoma* sp.) and Great horned owl (*Bubo virginianus*). By group, leporids dominate the assemblage by NISP, though deer and turkey are more important by biomass (Table 3). Commensal taxa and other wild mammals are more common groups in this sample than in many of the other proveniences from Walnut Canyon.

Most body regions are represented for deer in the NA 739 sample, though no axial elements were identified (Table 4, Figure 4). Vertebra and ribs are often difficult to identify to species, so it is likely that these elements were identified only as artiodactyl, if they were present. All regions are represented for jackrabbit, though axial and hindquarter elements are the most common. Cottontails are likewise represented by a diverse set of elements, though head and forefoot elements are absent. Turkey is represented by axial, forequarter (wing) and hindquarter (leg) elements.

Fusion data are available for several deer elements (Table 5). An unfused first phalanx indicates the presence of an individual younger than 20 months at death. Some fused early- and middle- fusing elements are less helpful in determining age. An unfused distal tibia and three unfused distal metapodials may have belonged to subadults younger than 29 months, or they could have been from the same young animal that yielded the unfused phalanx. The same can be said for an unfused distal ulna and proximal femur; they may have been from a subadult or younger individual.

Human modifications are fairly common in the NA 379 sample, particularly burning, which is present on 29 specimens, including artiodactyl, deer, cottontail, jackrabbit, and squirrel specimens (Table 7). Only one cut mark was noted, on an artiodactyl element, and three fragments have snap fractures. Fresh bone breaks were recorded on three specimens. Animal damage is uncommon considering the sample size from this locality, with only two rodent-gnawed specimens in the sample. Two worked artiodactyl long bone specimens were recorded (Table 8).

A worked artiodactyl metapodial was recorded from NA 739B. NA 739D contains four faunal specimens, three identified as artiodactyl and one from a jackrabbit. Three worked pieces were identified from the locality, including two worked artiodactyl fragments and one jackrabbit radius. NA 739G yielded two specimens, one from an artiodactyl, the other a worked jackrabbit radius.

NA 742

One specimen was identified from the Elden Phase cliff dwelling NA 742, a single worked piece of artiodactyl long bone (Tables 1 and 8).

NA 479

NA 479 contains an NISP count of 41, from at least five different individuals (Table 2). Cottontail is the most common species by NISP, but artiodactyl and deer have higher biomass values. Red-tailed hawk is also represented in the assemblage, as well as jackrabbit and black bear. By group, leporids have the highest NISP values, followed by birds of prey, deer and carnivores, though biomass values are higher for deer (Table 3).

Deer body parts recorded at NA 479 include elements from the foot, hindfoot, and hindquarter (Table 4). Forequarter and hindquarter elements were identified for jackrabbit and cottontail, in addition to cottontail head elements that were also recorded. One fused deer phalanx was recorded at NA 479, which is from an individual that was older than 17 months at death (Table 5).

Human modifications at NA 479 include burning on artiodactyl, deer and cottontail elements, as well as a snap fracture on an artiodactyl specimen (Table 7). Fresh fractures are also apparent on two elements. The only animal damage is from a gnawed cottontail specimen.

NA 729

One specimen was identified from NA 729, a fragment of a common crow (*Corvus brachyrynchos*) (Table 2).

Unknown Provenience

Many of the faunal specimens reported here from the Walnut Canyon assemblage lack site provenience information. These are presented here by catalogue number (Cat #). One of the Cat #s contains a comparatively large sample so it is discussed separately; the others have samples of one or two bones and are therefore described as a unit.

Catalogue Number 1743

The sample from Cat # 1743 includes 26 specimens from at least six individuals (Table 9). Most of the remains were identified as artiodactyl, followed by deer and ground squirrel (*Spermophilus* sp.), as well as woodrats, jackrabbit and cottontail. By group, deer and other wild mammals are the most well-represented categories from this Cat #, though the sample is small (Table 10).

The deer body parts represented in the Cat # 1743 sample include foot and hindfoot elements (Table 11). Cottontail and jackrabbit hindquarter elements were identified, in addition to a jackrabbit forequarter element. Fusion data are available for one element from Cat # 1743, an unfused proximal first phalanx, indicating the presence of a juvenile animal younger than 20 months at death (Table 12). No human modifications were recorded for the specimens from Cat # 1742. Rodent gnawing was, however, noted on three elements (Table 13).

Miscellaneous Catalogue Numbers

Cat #s 4 and 135 both yielded one specimen each of worked artiodactyl long bone (Table 9 and 14). A worked deer metapodial was identified in Cat # 469. This specimen was fully fused, indicating it was from an adult individual older than 26 months at death. A nearly complete hind foot of a jackrabbit was recorded in Cat # 911. Four specimens were identified in Cat # 912, including a burned fragment of squirrel, two deer specimens, and a burned artiodactyl fragment. Cat # 1002 includes two deer specimens, both of which are fully fused metapodials, indicating an individual older than 26 months at death (Table 12). Two worked deer specimens were identified in Cat # 1640. One of the worked pieces was made from a tibia, the other from a metapodial with a fused distal end, indicating the animal was older than 26 months at death. A single specimen was identified in Cat # 1642, a worked artiodactyl rib. Three worked artiodactyl fragments were included in Cat # 1660. Two of the fragments could not be identified beyond the long bone category, the third was manufactured from a metapodial fragment. A worked jackrabbit radius was recorded for Cat # 1661. Four specimens were identified from Cat # 1746, two of which were only identifiable as large mammal, the other two were identified as elk (*Cervus canadensis*) and cattle (unknown large bovid), respectively. The cattle specimen may have been from bison or domesticated cattle, in which case it would represent the only domesticated animal in the assemblage. A cut mark was noted on the cattle specimen. One fragment of artiodactyl was recorded in Cat # 2327.

DISCUSSION

Some generalized statements can be made about the Walnut Canyon fauna included in this sample. The sample is very likely biased, primarily because it is so small, but also for other reasons outlined below. Provenience information is unknown for much of the sample, and even in cases where site numbers are known, it is unclear if the remains are the result of surface collection, testing or excavation. Some of the materials were recovered during stabilization projects, where archaeological materials were not systematically recovered. At some of the larger sites (NA 103 and NA 478) the excavations employed 1/15" screens, and some smaller specimens were clearly recovered using these methods. From many of the other proveniences, however, it is not known whether or not screening was used. It is also unclear how all of the proveniences relate to one another, so this is not an optimal situation for trying to understand a comprehensive dietary picture from the area. A final bias in this assemblage is reflected in the recovery of a large number of worked bone tools. This pattern likely reflects a combination of recovery, curation, and sample selection decisions made over 60 years ago, when bone tools were recovered and curated preferentially over unmodified bone. As a result, and by necessity, the final sections of this report discuss subsistence behavior in general terms.

Sites or Cat #s with comparatively large samples (MNI > 1, NISP > 5) are discussed here individually, and the worked bone assemblage is addressed separately. Few conclusions can be drawn about proveniences with small samples, other than to note that with only one exception (Cat # 1746), none of the identified faunas contain domesticated taxa that were introduced by the Spanish. Even in the case of Cat # 1746, it is uncertain if the large bovid remain is from bison or domestic cattle. Therefore, based on the faunal evidence, in addition to supporting archaeological data, it is clear that the Walnut Canyon assemblages included in this study are from prehistoric contexts, specifically those associated with Sinagua.

Another point that must be made for the Walnut Canyon faunas is the complete lack of vertebrates aside from mammals and birds. No fish were identified; this may represent a combination of factors, including the local availability of aquatic habitats (or lack thereof), available technology, cultural preference, or a recovery bias against fish remains, which tend to be quite small and fragile. Amphibians and reptiles are also absent from the assemblage. The reasons for this may be similar to the lack of fish: they were not found in the local environment, they were not considered to be a food source, or they were not recovered during excavation.

NA 103

NA 103 is a two-room Elden phase pueblo. Though Ritchie (1970) noted a difference in the ceramic composition of the two rooms, no provenience information was available to indicate from which room the faunal remains were recovered. The sample from NA 103 has a fairly small NISP count, though the range of species represented is quite wide (Table 2).

Diversity and equitability values vary depending on whether biomass or MNI is used for the calculations. The diversity of the sample from NA 103 based on MNI is moderate (H' = 2.44) (Table 15). However, diversity based on biomass is low (H' = 1.29). MNI-based equitability is high (V' = 0.98), but is moderate based on biomass (V' = 0.52). This indicates that certain individuals were not greatly preferred over others, but that individuals from certain species contribute more meat to the diet. This makes sense in a situation where one taxon (e.g. deer) is much larger in size and has more meat, even though other species (e.g. turkey) are also present in the assemblage in comparatively high numbers.

Wild birds are common at NA 103 by MNI but not by biomass or NISP count. There are several avian taxa in the assemblage that probably did not have an economic value in terms of their use as food, such as red-tailed hawk, owl and raven. Their presence in the assemblage may relate to the use of their feathers or wings for decoration, prestige or ritual purposes, or as intrusive taxa that roosted on the overhanging rock shelter. Another species found in the assemblage, Canada goose, is a migratory species that does not live in the Walnut Canyon area year-round. Turkey, which comprises the bulk of the avian faunas may have been from domestic or wild birds.

The only carnivore element in the assemblage is a fragment of black bear, a species that is still be found in northern Arizona. The only commensal species in the assemblage is a single pocket gopher element. NA 103 was screened, so it is expected that small remains were recovered when encountered.

Deer clearly provided the bulk of the meat diet at NA 103, though only one individual is represented in the assemblage. Fusion data indicates the animal was older than 26 months, so it was fully-grown and provided the maximum amount of meat. The majority of the carcass was probably brought to the site, or at least no body part was preferentially left behind at the kill. Little can be said about the butchery techniques employed at the site. It is likely that cuts are associated with dismemberment and defleshing, and fresh bone fractures occurred when long bone diaphyses were broken to extract bone marrow.

NA 311, 312 and 313

The NA 311, 312 and 313 series is a cliff dwelling with a set of adjacent rooms and associated external terraces or patios (Ezel 1940). The excavation report does not indicate if the rooms were used for different purposes or by different families. The proveniences discussed here include NA 311A, B, C; NA 311B; NA 312A and NA 312B. The first two have larger samples than many of the others discussed in this section, and all have comparatively large MNI values as compared to their NISP counts (Table 2).

Diversity and equitability values are quite variable depending on whether MNI or biomass is used in the calculations (Table 15). The diversity the samples from NA 311A, B, C is moderate based on MNI (H' = 1.91) and lower based on biomass (H' = 1.24). Similarly, equitability values are high based on MNI (V' = 0.98) and moderate using biomass (V' = 0.64). This indicates little preference for individual species, though some large-bodied taxa contributed more to the diet at the site. The difference between diversity and equitability values based on MNI and biomass are in even more contrast to one another at NA 311B: MNI-based diversity is moderate (H' = 2.04) and biomass-based diversity is very low (H' = 0.31), similarly MNI-based equitability is very high (V' = 0.98) and biomass-based equitability is very low (V' = 0.15). This is because a wide range of species are represented at the locality in fairly even numbers, though deer comprises by far the bulk of the sample by biomass. The case at NA 312A is similar: MNI diversity is low (H' = 0.69) whereas biomass diversity is extremely low (H' = 0.05) and equitability based on MNI is high (V' = 1.00), while based on biomass it is very low (V' = 0.07). This reflects the similar MNI values for jackrabbits and deer at the site, while deer contributed much more significantly to the diet by biomass. The situation at NA 312B is much less extreme, with both MNI and biomass-based diversity values being quite low (H' = 1.61 and H' = 1.39, respectively) and MNI and biomass-based equitability values being high (V' = 1.00, and V' = 0.87). This reflects small samples evenly represented across species in the sample.

Wild birds are not particularly common, but are present, in the NA 311, 312, 313 series. An unknown pigeon or dove, as well as a few fragments of turkey, were recovered from the locality. These likely both reflect taxa that were eaten, and are probably not intrusive to the assemblage. It is unknown if the turkey represents a domestic or wild bird.

Carnivores are rare in the assemblage, with only one fragment from a fox and an unknown canid in the entire series. Commensal species are rare but present, and are represented by a few fragments of prairie dog. It is unclear if the sediments from the site were screened, so it is possible that small fragments were missed in the assemblage. Leporids are fairly common at the site, but they do not seem to have contributed greatly to the overall diet.

Artiodactyls provided the majority of the meat at the site. Deer is the dominant species, but pronghorn also contributed a great deal more meat than at the other localities in Walnut Canyon. Deer body parts from all regions are present in the assemblage, indicating that the animals were transported whole to the site; however, the samples are small so this conclusion must be regarded with caution. Bone fusion data indicates that deer in the assemblage are older subadults. Fetal or neonate remains were also recovered from several proveniences in this locality, indicating either a young fawn or pregnant mother was hunted. From the available comparative materials and size of the remains, it is not clear if the animal was born at the time of its death. These remains do indicate that at some point in the site's history, it was occupied in the late spring when deer are known to give birth (Nowak 1999). Specific butchery techniques cannot be understood from the available data, though it is clear that many of the remains at the site were defleshed and the bones were broken when fresh, likely for the extraction of marrow.

NA 322

NA 322 is an Elden Phase cliff dwelling. Sample size based on NISP count is small for NA 322D and 322I, although MNI counts are comparatively high (Table 2). This indicates that several unique species were present in the assemblage, though it also means that diversity and equitability values must be regarded with caution.

Diversity values from NA 322D are quite low, regardless of whether MNI (H' = 1.04) or biomass (H' = 0.82) is used to calculate diversity (Table 15). Equitability values based on MNI are very high (V' = 0.95), as are those based on biomass (V' = 0.75). These indices are likely driven by the small sample that includes multiple unique prey types. At NA 322I, diversity and equitability values are very different, depending on if MNI or biomass is used (Table 15). Diversity is low for both MNI (H' = 1.00) and biomass (H' = 0.11). Equitability is very high based on MNI (V' = 0.91) and extremely low based on biomass (V' =0.10). This disparity primarily reflects the small sample from the locality, but also illustrates the fact that MNI values for all three taxa are the same, while deer biomass is much larger than the other two taxa in the sample.

A fragment of the genus *Anas* was noted at NA 322I, which is the only avian remain, and one jackrabbit fragment was identified from each of the two proveniences. At both NA 322D and 322I, artiodactyls, both identifiable (e.g. deer and pronghorn) and not, completely dominate the small sample. At least two deer are represented in the assemblage, one of which was younger at 23 months at death, the other was an adult. On the basis of only two individuals, no conclusions can be drawn about any kind of hunting strategy targeting different age groups. There is a similar situation at NA 322I, where a deer younger than 23 months at death is represented, as is an individual older than 26 months.

The samples from both localities are too small to understand body part transport decisions for large animals. Likewise, few conclusions can be drawn about butchery patterns, though many fresh fragments on long artiodactyl long bones were likely the result of marrow extraction.

NA 739

The largest sample (NISP = 218), and consequently one of the largest MNI counts from the Walnut Canyon assemblage is from NA 739, a multi-room Elden Phase cliff dwelling. Diversity and equitability values are variable depending on if MNI or biomass is used for the calculations. Diversity based on MNI is moderate (H' = 2.10), but lower based on biomass (H' = 1.18). Equitability is high based on MNI (V' = 0.95) and low based on biomass (V' = 0.56). This indicates that certain individuals were not hunted more than others, but some (e.g. deer) provided more meat to the diet.

Birds are present in NA 739, but they are hardly common. Turkey is the most well-represented, though it is not clear if it was domestic or wild. Fragment of great-horned owl and raven were also identified. Owl was probably not hunted for meat; they may have been used for their feathers, or represent an intrusive species because they are known to roost in rock shelters and abandoned human dwellings.

Leporids represent the largest proportion of the remains by NISP value, which is different than in the other samples mentioned in this study. Commensal species, including white-footed mice, are also found in small numbers in the assemblage. These bones were not modified by humans so there is little reason to believe they were consumed by people.

Deer elements from almost all body regions are represented, suggesting that deer may have been transported to the site complete, though the sample is too small for this to be conclusive. No specific butchery patterns are apparent, though based on burning, cuts, and breaks it is clear that humans dismembered and cooked the remains. Though fusion data is available for several elements, all that can be said with certainty is that a deer younger than 20 months at death was brought to the site.

NA 479

It is unknown what kind of site is represented by NA 479. As with the other proveniences, NISP counts are low, though MNI values are fairly high and represent a wide range of species (Table 2). Diversity values are fairly low for NA 479, both based on MNI (H' = 1.61) and biomass (H' = 1.33) (Table 15). Equitability is high using both methods of calculating it: MNI (V' = 1.00) and biomass (V' = 0.83). This reflects the small number of species in the assemblage, and that none was favored in the diet, either by number of individuals or the amount of meat contributed.

Red-tailed hawk is well-represented in the NA 479 assemblage. This taxon is not typically considered as a food source, but it is possible that they were used for their feathers. Small game, specifically leporids, comprise nearly half of the assemblage by NISP count, but not by biomass. This is a case where higher incidences of small game do not necessarily reflect their importance in the diet by meat mass, as a single large mammal such as a deer provides much more meat. A single fragment of black bear was recorded, which represents the only carnivore in the assemblage.

Few conclusions can be drawn from the body part analysis about transport patterns of deer. Fusion information only indicates that an animal older than 17 months at death was procured, which is a nearly full grown or fully-grown individual. Human modifications likewise say little about butchery practices. There is definite evidence of human butchery, including burning and fresh breaks indicative of marrow processing, but little else can be said beyond these generalities.

Catalogue Number 1743

It is unknown what time period or site Cat # 1743 is from. The sample is small by NISP count, but represents a fairly high MNI value, of several different taxa (Table 9). Diversity values based on MNI (H' = 1.56) and biomass (H' = 0.74) are quite low due to the even representation of MNI across the number of species in the assemblage (Table 16). Equitability values are high based on MNI (V' = 0.97) and moderate based on biomass (V' = 0.46). This is because, though MNI and number of species are similar, deer contributed more to the overall biomass.

The assemblage is composed by fairly even amounts of deer, leporids, squirrels, and woodrats. Birds were not present in the sample, nor were carnivores. The assemblage is too small to draw conclusions about body part representation and transport decisions. Age at death could be assigned to one individual, a deer younger than 20 months at death. Depending on exactly how old this animal was a death would determine the amount of meat it contributed to the diet; if it was very young it provided little meat, but if it was older it may have provided a reasonable amount of high-quality meat. No evidence of butchery was observed on the remains.

Worked Bone

The worked bone component of the assemblage comes from various proveniences (Tables 8 and 14). This analysis focused on identifying worked pieces to species and element, no technological analysis was conducted (see individual artifact tags or the master database for presumed functions for tools). Most of the tools could only be identified as artiodactyl, and identifiable taxa include deer and jackrabbit (Table 18). Due to the small number of medium artiodactyls identified as pronghorn, it is likely that most of the worked bone is from deer.

Elements chosen for working were predominately robust long bones with thick, straight diaphyses, including metapodials and tibia, though several worked ulna were also recorded. Worked bone was not only manufactured into tools, some jackrabbit radii and at least one deer antler was formed into a bead or bead preform.

Leporid and Artiodactyl Indices

In calculating the leporid and artiodactyl indices, samples from Walnut Canyon were combined by cultural period and habitation type into Elden Phase rim pueblos and Elden Phase cliff dwellings (Table 17). This was done to determine if subsistence practices at the two site types were different. Not enough data were available for the Padre Phase pueblos discussed above. Sample size was only large enough from the cliff dwellings to calculate the leporid index (L.I.), which is dominated by jackrabbit both by NISP (L.I. = 0.382) and biomass (L.I. = 0.215). This may indicate that during the Elden Phase, Walnut Canyon was a more favorable natural environment for jackrabbits than cottontails, or that jackrabbits were attracted to agricultural fields. It seems unlikely that large-scale jackrabbit drives were undertaken because MNI values for jackrabbits are quite low at all sites in the sample.

The artiodactyl index (A.I.) from the Elden Phase rim pueblo indicates a dominance of artiodactyls by NISP (A.I. = 0.945) and biomass (A.I = 0.980). The artiodactyl index from the Elden Phase cliff dwellings likewise favors artiodactyls by both NISP (A.I. = 0.732) and biomass (A.I. = 0.949). These values indicate that artiodactyls were a much more significant part of human diets at both localities during the Elden Phase at Walnut Canyon, and there are no major differences between prey preference based on site type.

The leporid and artiodactyl indices differ quite markedly from contemporary Sinagua sites in northern Arizona (calculated on NISP counts). Jackrabbits are favored at Padre Phase sites, as well as the Elden Phase site of Wupatki (L.I. = 0.190), and though they are not dominant at Big Hawk Valley (L.I. = 0.598), their proportions are still much higher than sites on the Colorado Plateau and Mogollon Rim, where cottontails typically dominate zooarchaeological assemblages (Quirt-Booth and Cruz-Uribe 1997; Szuter and Gillespie 1994). Quirt-Booth and Cruz-Uribe (1998) relate this to both the generally more open environment of the Sinagua region, and use it as evidence for "garden-hunting" of jackrabbits in open agricultural fields. The leporid index value from Walnut Canyon lies between those from Wupatki and Big Hawk Valley, which may indicate that the sites had similar environments. "Garden hunting" may not have been employed at Walnut Canyon, however, because aside from a high leporid index as compared to Wupatki and Padre Phase sites (but not Big Hawk Valley), the artiodactyl index is very high. Quirt-Booth and Cruz-Uribe (1997) suggest that a combination of low leporid and low artiodactyl indices is indicative of garden hunting.

The artiodactyl index for Walnut Canyon is extremely high at both the rim pueblos and cliff dwellings, as compared to Wupatki (A.I. = 0.081) and Big Hawk Valley (A.I. = 0.096). This difference is quite striking and indicates a much greater importance of artiodactyls in Walnut Canyon that in contemporary Sinagua sites. This is surprising, as artiodactyls tend to be highly valued resources available in rich ecosystems, and Walnut Canyon is thought to have been an environmentally marginal area in the already difficult Sinagua region (Gilman 1976). There are several explanations for this disparity. One, is that Walnut Canyon was actually less environmentally hostile than previously thought. This seems unlikely with the short amount of time the area was occupied, and its early depopulation compared to other Sinagua sites. Two, is that the occupants of Walnut Canyon traveled great distances to procure artiodactyls or traded with neighboring groups for deer meat. This is a possibility, as it is known that interactions between adjacent groups intensified in the Padre and Elden Phases. Unfortunately, this hypothesis is not testable because body part data are too sparse to indicate if there was a pattern of specific elements showing up repeatedly in the assemblage. The third option is that there was a recovery bias during the projects included in this study, where sediments were not necessarily screened, toward the recovery of the largest fragments of bone, which tend to be from artiodactyls. This hypothesis is also possible, though it is difficult to test because recovery information from the assemblage is not available in most cases. It should be noted, however, that at NA 103, the Elden Phase rim pueblo that was excavated and screened, the artiodactyl index is very high. Whether this is a product of site location, or a small sample is not known.

CONCLUSIONS

Though the sample is small and most likely not fully representative of the faunal remains from Walnut Canyon during the Padre (A.D. 1070-1150) and Elden Phases, (A.D. 1150-1220), some patterns are apparent from the entire assemblage. First, artiodactyl, specifically deer and in some rare cases pronghorn, provided the bulk of the meat to the diet of the inhabitants of Walnut Canyon. Most of the animals exploited were adults or older subadults, with the exception of one or two fetal or neonate individuals that may have entered the site as very young fawns or as a result of hunting pregnant females. Not enough evidence exists to determine whether certain artiodactyl portions were preferentially transported to the site. Butchery patterns are consistent with defleshing with stone tools, and burning reflects cooking or post-depositional proximity to hearths.

Leporids, particularly jackrabbit but also cottontail, were the second most important food resource in the Walnut Canyon assemblages. In some of the samples, they actually outnumber deer by NISP and MNI counts, though they likely did not provide more meat.

Many other taxa are included in the assemblages in low numbers, specifically birds, carnivores and commensal species. Some of the birds, such as turkey, are known for their economic value and were likely eaten. Others, including red-tailed hawk and great horned owl, may have been used for their feathers, or conversely, may be intrusive into the assemblages since they are known to roost in rock shelters, into which structures are built at Walnut Canyon.

Carnivores are fairly rare in the assemblage, though those that are present range in size from fox to black bear. They may have been used for food (though not commonly, based on their low frequencies), for fur, or killed if they were threatening the people occupying the site.

The main candidate for a domesticated species at Walnut Canyon is turkey. It is unclear, however, if the turkey specimens in the assemblage are from domesticated birds. The small samples is inadequate for further analysis that would permit a determination of domestication. The canid remains were unidentifiable and cannot, therefore, indicate whether or not dogs were present at the site, although they probably were.

Commensal species, particularly very small rodents, are rare but present in the assemblages. There is little to indicate that they were eaten by humans occupying Walnut Canyon; the remains lack evidence of burning or butchery, and the bags that contain them typically include large portions of the skeleton, indicating that they were deposited and buried in whole form.

The large amount of worked bone from Walnut Canyon indicates its importance as a raw material. As noted above, a technological analysis of the bone is not presented here, but as identified on the tags and in the database, a range of different tools and osseous artifacts are present: borers, gravers, points, needles, beads and flutes. These items were typically manufactured on sturdy ungulate long bone shafts (particularly metapodials and tibia), ulnas, antler, and jackrabbit radii. This indicates consistency in the specific mechanical properties sought by manufacturers of bone objects.

Major questions concerning the Sinagua in general, and Walnut Canyon in particular, are whether cliff dwellings built during the Elden Phase are actually defensive structures, and what caused the eventual depopulation of the area (Downum 1992; Gilman 1976). In addressing these questions, the faunal data actually contradict other lines of archaeological evidence. In a socially stressed, environmentally marginal habitat, it is expected that humans would procure the easiest to attain local resources, which in northern Arizona should primarily include leporids. However, this does not seem to be what the inhabitants of Walnut Canyon did. Comparisons of the leporid and artiodactyl indices to other Sinagua sites indicate that large game played a much more important role in the diets of groups occupying Walnut Canyon. Along these lines, there is little evidence for a "garden hunting" strategy that results in the dominance of southwestern archaeofaunas by jackrabbits.

In this case, the most conservative conclusion is the assumption that the Walnut Canyon assemblage is heavily biased toward the largest, most easily recognized faunal specimens: artiodactyls. On the other hand, if the Walnut Canyon sample presented here is even partially representative of the meat diet during the Elden Phase, very different subsistence strategies were employed by the inhabitants of the area. Perhaps the Sinagua of Walnut Canyon focused more heavily on hunting and gathering, and less on agriculture, which would explain the apparent lack of "garden hunting." A heavy reliance on wild resources is less sustainable for a large semi- or fully sedentary population and results in the rapid abandonment of a region, which may partially explain the short occupation span of the sites. The investigation of an undisturbed, or less disturbed, cliff dwelling in Walnut Canyon with modern excavation and recovery techniques is the only way to determine how representative the assemblages included in this study really are, the extent to which inhabitants of Walnut Canyon relied on large game resources, and whether or not subsistence practices impacted the abandonment of the area after the Elden Phase.

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