Far Western Puebloans occupied that portion of the American Southwest stretching westward from Kanab, Utah, across northern Arizona and southern Utah to the Muddy River drainage of southern Nevada (Watson 2008). Others (Altschul and Fairley 1989:101) extend this range as far east as the Colorado River (see Lyneis 1995 for a more restricted definition). The most thoroughly studied region is the lower Virgin River and its tributaries (Aikens 1966; Allison 1990; Dally and McFadden 1985, 1988; Lyneis 1995; Shutler 1961; Walling et al. 1986; Westfall et al. 1987). Research has shown that farming-based populations flourished here from the first century A.D. until about A.D. 1200 when, like Puebloan societies in the Four Corners and elsewhere, there was a dramatic contraction of populations, presumably to the aggregated pueblos of Arizona and New Mexico. These far west Puebloans, traditionally referred to as the Virgin Anasazi, are often ignored or treated briefly in the more general Ancestral Puebloan literature (e.g., Driver 2002; James 2006; Kohler et al. 2008) largely due to the limited amount of research on this area compared to the massive number of studies on the Four Corners area.

Previous research in the area demonstrates that our understanding of Far Western Puebloan subsistence practices is still in flux. The intention of this paper is to continue refining insights into Virgin Anasazi strategy variability with new data from the Uinkaret Plateau in northwestern Arizona, specifically from Antelope Cave, a dry, sheltered site with rich artifactual, faunal, and botanical material. We propose that Ancestral Puebloans in this region practiced a complex pattern of seasonal movement that included sites such as Antelope Cave that functioned logistically as a field station remote from village sites to the northeast as well as a locale for communal rabbit drives to procure fur and food.

There has been very little research on subsistence strategies in the region, and scholars have presented conflicting positions on this issue. Scenarios range from fully sedentary farmers relying heavily on domesticates to farmer/foragers favoring a mixed strategy. Aikens (1966), Dalley and McFadden (1985, 1988), and others, for example, have been proponents of the former view and describe the Virgin Anasazi of the upper Virgin River as wholly horticultural populations who relied little on hunting. In contrast, Allison (1990:112) has maintained that "Dalley and McFadden are wrong about the lack of hunting by the St. George Basin Anasazi"; he presented data from his work along the Santa Clara River to support that statement. In addition, Westfall et al. (1987:144) stated that the Virgin Anasazi "pursued a broad-based foraging strategy..."
that included hunting, with a tendency toward specializing on local resources late in the sequence.

Recently, Harry and Watson (2010) revisited issues of Virgin Anasazi subsistence using new data from Lost City, while Watson (2008) provided a more synthetic treatment of Virgin Anasazi subsistence. Harry and Watson (2010) studied faunal remains from House 20 at Main Ridge in the Lost City complex to examine the relative importance of farmed products in the diet as well as the role of local and non-local foodstuffs. Their conclusion is that diets were a mixture of both wild foods and domesticates. Landon (2010) provided a detailed review of macrobotanical data from the region and added additional data from Pueblo II sites near Hurricane, Utah. Her findings demonstrated variability in macrobotanical remains between indoor and outdoor hearths, and among different pithouses. She concluded that domesticates were of primary dietary importance, although wild and weedy plants were common in all cases. She found few differences between lowland and upland sites, however. Landon’s emphasis on wild seeds as a supplement to domesticates is supported by Nelson et al. (2005), who reported abundant wild seeds stored in a Pueblo II burial vessel at the Reusch Site north of St. George. Martin’s (1999) stable carbon isotope analysis of Basketmaker and Puebloan burials from the larger region also demonstrated that maize contributed the largest component of the diet, but wild resources still comprised 25 percent of the diet.

For the most part, past research in the region has focused on dietary emphasis without consideration of overall subsistence strategies. Exceptions include Watson’s (2008) regional approach, which, while conceding dietary primacy to maize, offers an ecological perspective on Virgin Anasazi faunal use. He suggested that the importance of large versus small game varied with physiographic setting. He examined faunal data from the Virgin River lowlands, the St George Basin, and upland or plateau regions to support his argument. Talbot and Richens (2009) brought a different and important perspective in their study of non-structural sites in the Sand Hollow region just south of the Virgin River and east of St George, Utah. They also recognized the importance of maize in the diet but concluded that Puebloan peoples occupying the structural sites along the river “ranged far for wild resources, and that the efforts were indeed serious and logistically complex” (Talbot and Richens 2009:273).

**UINKARET PLATEAU ENVIRONMENTS**

The northern Uinkaret Plateau is a gently rolling limestone formation bounded sharply by the Hurricane Cliffs to the west and by the Uinkaret Mountains to the south (Figure 1). The plateau blends imperceptibly into Antelope Valley to the southeast and transitions more abruptly into highlands such as Yellowstone Mesa to the east and Lost Springs and Little Creek Mountains to the north and east. Short Creek drains the Vermillion Cliffs and the Canaan Mountain region south of Zion National Park, cuts between the Lost Springs and Little Creek uplands, and joins with Cottonwood Creek and Clayhole Wash just above Rock Canyon. The latter, along with Cottonwood Canyon, cuts through the Hurricane Cliffs and drains into Hurricane Wash 350 m below. Clayhole Wash drains the Uinkaret Mountains to the south. The region is semi-arid with only a few scattered springs and intermittent drainages. Elevations range from approximately 1829 m (6000 ft) at the southern extent of the Plateau to 1280 m (4200 ft), where Short Creek drops into Rock Canyon.

Permanent water is limited to occasional springs, all of which are between 5 and 7 km distant from Antelope Cave. The vegetation in the vicinity of the cave is sparse and dominated by xeric species: big sage (Artemisia tridentata), snakeweed (Gutierrezia sp.), shadscale (Atriplex confertifolia), four-wing saltbush (Atriplex canescens), rabbitbrush (Chrysothamnus nauseosus), Mormon tea (Ephedra sp.), skunkbush (Rhus trilobata), and cactus (Opuntia spp.) in addition to perennial grasses (Stipa and Agropyron), annual grasses, and desert flowers.

**ANTELOPE CAVE DESCRIPTION**

Antelope Cave (NA 5507) is a large collapse and solution cavern in the upper levels of the Permain age Kaibab limestone formation near Clayhole Wash on the open rolling plain of the Uinkaret Plateau (see Figure 1). Currently, the Navajo-McCullough Transmission Line runs just north of the sink. The elevation of the cave is 1417 m (4650 ft).

The cave entrance is at the head of a small draw draining into Clayhole Wash and is partially obscured by large limestone boulders that have fallen in front of the cave. A small limestone rimrock immediately above and circling the opening of the cave is the only visual landmark of the cave entrance. The cave interior is hemispherical. The area immediately inside the entrance is dominated by several massive limestone blocks that had fallen from the ceiling relatively recently. The floor descends rapidly to the rear in a series of distinct terraces corresponding to roof spalling events. Along the west wall and to the rear of the cave, the floor is covered with dirt, and the ceiling is heavily blackened from smoke. At the extreme back/bottom of the cavern, there is a sink marked by concentric bands of limestone rock; the bands were formed by the slow, spiraling and sinking of the cave deposits into a solution cavern that is believed to exist
Figure 1. Locations of Antelope Cave and other archaeological sites discussed in the paper.
below (Maxfield 1983). The presence of such a cavern is supported by the testimony of the Atkin family (see Previous Research below), who stated that another smaller cavern underlies Antelope Cave. The cave interior is cool and pleasant, although the coolness becomes less agreeable after a period of inactivity.

After a rainstorm, water enters the cave at its south end. As a result, the lower midden in unit UCLA 59-1 was found to be damp up to 75 cm (30 in) from the surface. However, the rest of the cave’s cultural deposit has remained dry for 2000 years or perhaps longer.

Vandal pits pock the site surface where occasional faunal bone, vegetal fragments, and artifacts are visible. A long history of vandalism has compromised cave stratigraphy as a result of overlapping pit excavations and redundant burying of intact deposits with back dirt. Profile cleaning and test excavations are difficult due to poor visibility in the cave and the very dry deposits. Disturbance causes dust to float in the air, and that dust obscures vision and hinders breathing until a gentle current carried the dust up and out the cave entrance.

PREVIOUS RESEARCH AT ANTELOPE CAVE

Archaeological work in the Uinkaret Plateau portion of the Arizona Strip has been sparse since Judd's (1926) exploratory trips. Some attention in the region has been focused on the dry contents of Antelope Cave (see below), but more extensive excavations and surveys have been made north of the project area on Little Creek Mountain (Heid 1982; Thompson 1980) and to a lesser extent on Lost Creek Mountain (Barbara Walling-Frank, personal communication 2010). A massive excavation project was carried on in advance of State Highway 213 construction to the north and east of the site (Wade 1967). Allison (1988) led some survey and mapping work on Yellowstone Mesa to the east, while Westfall et al. (1987) surveyed the Kanab Plateau. Additionally, excavations near Hildale and Colorado City on Short Creek have revealed abundant Puebloan occupation spanning Basketmaker through Pueblo II (Nielsen 1998). Moffitt et al. (1978) surveyed the Navajo-McCullough Transmission Line, which crosses the northern end of the Uinkaret Plateau a mere 100 m north of Antelope Cave. For a more complete, although somewhat dated review of past work in the broader Arizona Strip, see Altschul and Fairley (1989).

William Atkin, of St. George, Utah, first explored Antelope Cave in the 1920s and later sent a modest collection of artifacts to the Smithsonian for identification. Although these items were not returned, Smithsonian personnel informed the Atkins family that the cave was used in Basketmaker times (Floyd Atkin, personal communication 2009). The reputation of the site as a rich source of prehistoric artifacts spread quickly after its discovery and attracted numerous collectors. The total scope of the material recovered will never be known, but certainly included hundreds of sandals (both Basketmaker and Pueblo styles), whole ceramic vessels, basketry, and many miscellaneous perishable items (Robert Euler, personal communication 1985; Johnson and Pendergast 1960). The looting continued at least into the 1980s, despite the efforts of the Bureau of Land Management (BLM) to seal the site. Floyd Atkins related in 2009 that there was evidence of recent collecting activity during a visit to the site in 2006.

Jack Rudy of the University of Utah conducted the first professional archaeological work in Antelope Cave with his visit in 1949; he reported heavy vandalism at the time (Jesse D. Jennings, personal communication 1986). Robert Euler excavated the cave in 1953 and 1954 while he was Curator of Anthropology at the Museum of Northern Arizona (MNA) (Figure 2). Euler excavated a series of test pits and mapped the cave with a small crew that included Milton Wetherill, then Associate Curator of Mammology at MNA, and Leland J. Abel, who also served as project photographer.

Archaeologists with the University of California, Los Angeles (UCLA) carried out the most extensive excavations. Clement Meighan in 1956 and Henry Nicholson in 1957 directed excavations of two test units (UCLA E and B) with students from UCLA summer field schools based in Cedar City, Utah. Robert Euler supervised the student excavation of UCLA Unit E in 1956 and Henry Nicholson oversaw the work at UCLA Unit B in 1957. In 1959, Vilate Hardy of La Verkin, Utah, convinced Clement Meighan to carry out more intensive investigations at the cave before vandals destroyed most of the site. As a result, UCLA sent David Pendergast, Keith Johnson, and Basil Katem to the cave in 1959 to salvage as much archaeological material as possible in a short amount of time. The crew of three spent 19 days in Antelope Cave and excavated five test pits (Figure 3). Because of the dim light and thick dust in the cave, the 1959 UCLA crew constructed a unique tram/pulley system to carry deposits up and out of the cave for processing (Figure 4). In 1960 Johnson and Pendergast along with Esther Pendergast returned to the cave to complete the excavation of unit UCLA 59-5 and to sample one of two possible living areas. UCLA geographer Richard Logan accompanied this group and gathered data for a report on the physical geography of the area. In 2009, Johnson revisited the cave to obtain a radiocarbon sample from one of the hearths located on a huge limestone slab near the cave entrance.
Figure 2. Photo of Antelope Cave interior in 1954, Robert Euler and Milton Wetherill in the rear of the cave, courtesy of the Museum of Northern Arizona, NA5507.14, Leland J. Abel, photographer.
Figure 3. Plan map of Antelope Cave showing locations of tests by the Museum of Northern Arizona, UCLA, and Brigham Young University.
The substantial collections recovered through this work are, at the time of this writing, with Keith Johnson at the Museum of Anthropology, California State University, Chico, on loan from the Fowler Museum of Cultural History at UCLA. Johnson and Pendergast (1960) produced a short summary of their excavations and a cursory catalog. More recently, analysis of coprolites from the UCLA collections has revealed the importance of human and dog parasites present in the cave (Fugassa et al. 2011; Johnson et al. 2008), as well as detailing the diet of the Virgin Anasazi who lived there (Reinhard et al. 2012; see below).

Hugh Culter conducted some botanical analysis of the Euler material during the Glen Canyon Project (Cutler 1966, 1968; Cutler and Meyer 1965), and Richard Hevly analyzed some of the corn from the cave in the late 1960s. Also, in 1970, Paul S. Martin was interested in the possibility that sloth dung might be present in Antelope Cave; however, no verification of sloth dung is known. The above analyses and inquiries are documented by letters on file at the Arizona Strip BLM archaeologist offices in St. George (Janetski and Hall 1983:10).

No professional work was done at the cave after UCLA’s efforts until Moffitt et al. (1978) of the Museum of Northern Arizona visited the site during the survey of the Navajo-McCullough transmission line. They made a small surface collection of ceramics and projectile points and perhaps other artifacts, although it is possible that they only photographed some items (Moffitt et al. 1978:166-167). In 1983, the Office of Public Archaeology at Brigham Young University, in cooperation with the Arizona Strip Bureau of Land Management, visited the site to assess whether intact deposits remained and assess the roof stability (Janetski and Hall 1983). Some surface collections were made and a small test pit placed in the midden in the sink area to recover datable materials. Janetski and Hall (1983) concluded that intact deposits remained at the site. BYU archaeologists returned in 1986 to determine when the site was first occupied and to recover systematic samples of stratified sediments for faunal and paleoenvironmental data (see Janetski and Wilde 1989 for a preliminary report and Janetski et al. 2012 for the final report). During the course of BYU/OPA’s research, the Arizona Strip BLM borrowed Euler’s Antelope Cave collections from the Museum of Northern Arizona. The materials were then transferred to OPA/BYU, where they remain as of this writing. Collections consist of unmodified faunal material, chipped stone, ceramics, and textiles, including sandals and abundant cordage (Janetski et al. 2012; Yoder 2008, 2009, 2010).
Table 1. Radiocarbon dates from Antelope Cave.

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Provenience</th>
<th>Material</th>
<th>Radiocarbon Age</th>
<th>2σ calibrated range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-3510</td>
<td>Stratum 3, BYU Test 5</td>
<td>corn cob</td>
<td>1190 ± 110 BP</td>
<td>AD 644-1032</td>
</tr>
<tr>
<td>A-3511</td>
<td>Stratum 2, BYU Test 5</td>
<td>cob/sandal fragment</td>
<td>1160 ± 100 BP</td>
<td>AD 660-1032</td>
</tr>
<tr>
<td>Beta 8394</td>
<td>Rear midden</td>
<td>atlatl fragment</td>
<td>1859 ± 60 BP</td>
<td>AD 26-331</td>
</tr>
<tr>
<td>Beta 24432</td>
<td>Stratum 2-A, BYU Test 2</td>
<td>unid wood charcoal</td>
<td>3290 ± 60 BP</td>
<td>1730-1438 BC</td>
</tr>
<tr>
<td>Beta 24434</td>
<td>Stratum 2-C, BYU Test 2</td>
<td>unid wood charcoal</td>
<td>3490 ± 60 BP</td>
<td>1964-1643 BC</td>
</tr>
<tr>
<td>Beta 24433</td>
<td>Stratum 2-A, BYU Test 2</td>
<td>unid wood charcoal</td>
<td>3590 ± 50 BP</td>
<td>2128-1773 BC</td>
</tr>
<tr>
<td>AA80803</td>
<td>MNA collections</td>
<td>yucca sandal</td>
<td>1241 ± 36 BP</td>
<td>AD 683-878</td>
</tr>
<tr>
<td>AA80801</td>
<td>MNA collections</td>
<td>yucca sandal</td>
<td>1237 ± 42 BP</td>
<td>AD 680-885</td>
</tr>
<tr>
<td>AA80802</td>
<td>MNA collections</td>
<td>yucca sandal</td>
<td>1228 ± 36 BP</td>
<td>AD 668-885</td>
</tr>
<tr>
<td>Beta 264019</td>
<td>UCLA Hearth 3</td>
<td>ash/charcoal</td>
<td>180 ± 40 BP</td>
<td>AD 1650-1950</td>
</tr>
<tr>
<td>Beta 257786</td>
<td>UCLA 59-2, 0-6&quot;</td>
<td>yucca quid</td>
<td>1230 ± 40 BP</td>
<td>AD 680-890</td>
</tr>
<tr>
<td>Beta 257787</td>
<td>UCLA 59-2, 24-30&quot;</td>
<td>yucca quid</td>
<td>1190 ± 40 BP</td>
<td>AD 710-750</td>
</tr>
<tr>
<td>Beta 257788</td>
<td>UCLA 59-5, 66-72&quot;</td>
<td>corn cob</td>
<td>1220 ± 40 BP</td>
<td>AD 680-890</td>
</tr>
</tbody>
</table>

ARCHAEOLOGY AT ANTELOPE CAVE

Dating and Stratigraphy

Thirteen radiocarbon ages obtained from a variety of material are now available from Antelope Cave (Table 1). The dates combined with ceramic typology demonstrate use of Antelope Cave in the Late Archaic, Basketmaker II, late Basketmaker III/early and later Pueblo I, and Pueblo II periods. The dates correspond well with late Archaic artifacts found in the lower sediments of the test units, and corroborate a late Archaic occupation similar in age to Rock Canyon Shelter (Janetski et al. 2012) and other sheltered sites on the Arizona Strip (John Herron, personal communication 2012). Johnson and Pendergast (1960) recovered at least 13 square-toed sandals as well, which demonstrates a substantial Basketmaker II occupation. The Archaic dates and atlatl points from Euler’s work and BYU’s tests are all evidence of pre-farming use of the site. The early Puebloan material culture overlies, and in some cases, overwhelms earlier Basketmaker and Archaic remains; consequently, the spatial extent of these earlier occupations is largely unknown. A test unit (BYU 86-2) placed at the lower edge of the large rock fall (see Figure 2) demonstrated that Late Archaic deposits most likely lie under the large monoliths at the front of the cave (Figure 5). Interestingly, there does not appear to be a Basketmaker presence in these deposits, as the ceramics from levels immediately above Stratum 2-C are all Puebloan. The BYU tests recovered no evidence of post-Anasazi occupations. Artifacts attributable to the Southern Paiute may exist in private collections, however. The Museum of Northern Arizona holds photos of private collections attributed to the cave that show a twined water jar (VH 20) that is likely affiliated with the Southern Paiute (photocopies provided by Rick Malcomson).

Cave stratigraphy varied widely depending on the area tested. The BYU 1986 test adjacent to the rock fall found the most intact sediments. They consisted of alternating layers of matted vegetation, rock spall, and fine grayish brown, ashy sediment (see Figure 5). The tests in the sink were apparently in a midden or dump area, with very little sediment observed in the deposits. Rather the fill consisted mostly of matted vegetation, grass, small twigs and other plant parts that were so abundant that cutting profiles and screening were difficult. A depression or pit in Stratum 2-F is the only possible feature found at Antelope Cave during BYU’s 1983 and 1986 work. However, the UCLA crew recognized two possible living areas in 1959 (see Figure 3). At that time, these two areas were relatively flat. Adjacent to each area were higher mounds of midden containing discarded materials such as corn cobs, faunal bones, and broken artifacts. The presence of these remains adjacent to the living areas suggests that occupants created a “toss zone” (Binford 1983), a conclusion that is supported by the discovery of two superimposed fire hearths in unit UCLA 60 in the northernmost living area. In 2009, Johnson recorded three hearths on top of the monolithic limestone slab.
Figure 5. Profile of BYU 86-Test 2.
near the cave entrance. The fire forming Hearth No. 3 was ignited sometime between 1650 cal A.D. and 1950 cal A.D. (Table 1), long after the Puebloans had abandoned the cave.

It is possible vandals have destroyed evidence of features; however, no slabs were observed on the surface that would suggest the presence of such features. Surely, given the smoke-blackened condition of the ceiling, many hearths existed, but those portions of the cave where fires were likely built are now largely destroyed by looting and previous excavations. Numerous soot-encrusted and blackened sherds and charred faunal remains also testify to cooking fires. A single, burned sandstone slab fragment recovered from BYU 86-3 may suggest slab-lined features were present at one time, and the several fire-blackened but reworked slabs from the 1954 collections may represent the remains of slab-lined cists.

**Antelope Cave Collection**

Dry caves are renowned for the preservation of all material remains left by their visitors, people and animals alike, and Antelope Cave is no exception. Textiles, primarily sandals and cordage (including net fragments), are abundant in these collections, as are faunal bone and botanical remains. Ceramics, chipped, and ground stone are also common, although stone tools are relatively sparse when compared to nearby Rock Canyon Shelter, another dry site located in the canyon of its namesake (Janetski et al. 2012). Given the subsistence focus of this paper, the emphasis is on the botanical and faunal remains.

**Botanical Remains.** Plant remains are very well represented in the Antelope Cave collections. Macrobotanical analysis of the material recovered by MNA, UCLA, and BYU has identified a minimum of 26 plant taxa representing a wide range of ecozones. Table 2 presents plant taxa recovered along with counts of seeds in some cases. The latter category contains specimens of unworked sticks or other plant parts presumably gathered for firewood. Domesticates are common, with corn (*Zea mays*) the most abundant taxon, and beans (*Phaseolus* sp.) and squash (*Cucurbita* sp.) also present.

The richness of this assemblage is due to the preservation of the dry deposits. Those dry deposits also complicate differentiating items deposited as a consequence of human activity and items brought in via other, non-anthropogenic agents. What is perhaps most striking, however, is that many of these taxa are not available immediately outside the cave and represent a range of environmental settings. Plant taxa include species from riparian (willow, reeds, and hackberry), pinyon-juniper woodlands (pinyon pine, juniper, chokecherry, service berry, and cliff rose), and mixed desert shrub (black brush, sagebrush, and mesquite) communities.

The importance of this array of plant macrofossils is that they represent the broad catchment of site occupants. In other words, cave visitors apparently had traveled through ecozones where they gathered these plants and brought them to the cave. In addition, these remains undoubtedly represent gathering activities that occurred while people were in residence, and the macrobotanical material gathered would have served as fuel as well as food. Domesticates and pinyon suggest summer and early fall occupation, while other remains (Indian rice grass, mallow, and other grasses) typically are ready for collecting by early summer, although the timing for the ripening of these and other grasses could extend into early fall depending on elevation (Kelly 1964:41; Cumming and Puseman 2009). Reinhard’s (2009) analysis of seeds from coprolites also suggests late summer to early fall site use. It is important to recognize, however, that conclusions regarding season of site use based solely on the presence of certain seeds must be done with caution given that such seeds could be stored and consumed at other times of the year. Inferences derived from pinyon must be treated with particular caution, because it could be stored for several years (Fowler 1986:65).

**Faunal Remains.** In general, the recovered faunal assemblage appears to be primarily the result of past cultural processes. The assemblage is characterized by a combination of an extremely low frequency of non-human modifications with a comparatively high frequency of cultural markers, such as burning, that suggest that humans were the primary agent of deposition (Fisher 2009). Furthermore, the assemblage appears to be largely unaltered by post-depositional impacts, as indicated by the lack of density-mediated destruction (Fisher 2009).

The archaeofauna from Antelope Cave is strongly dominated by jackrabbits (*Lepus californicus*), and to a much lesser degree, cottontail rabbits (*Sylvilagus* sp.) (Table 3). Larger taxa (pronghorn, deer, mountain sheep), some small mammals (other than leporids), and birds are also present but in very modest quantities. Some of the non-leporid taxa may represent non-dietary use of animal resources (e.g., fur-bearing species), or these remains may have resulted from non-cultural deposition (e.g., rodents). Large game likely was a minor contribution to the diet compared to the leporid resources. As with the botanical remains discussed above, the faunal remains include non-locally available taxa. In particular, the presence of waterfowl (Canada goose, *Branta canadensis* and unidentified Anatidae) provides further support that the occupants of Antelope Cave had a wide catchment that included riparian zones.
# Table 2. Macrobotanical remains recovered from Antelope Cave by MNA, UCLA, and BYU.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Common Name</th>
<th>MNA/BYU</th>
<th>UCLA</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Seeds</td>
<td>Stems/Wood</td>
<td>Seeds</td>
</tr>
<tr>
<td><strong>Domesticates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zea mays</td>
<td>maize/corn</td>
<td>765</td>
<td>3245</td>
<td>4010</td>
</tr>
<tr>
<td>kernels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cobs</td>
<td></td>
<td>533</td>
<td>6382</td>
<td>6915</td>
</tr>
<tr>
<td>cob fragments</td>
<td></td>
<td>199</td>
<td></td>
<td>199</td>
</tr>
<tr>
<td>husks</td>
<td></td>
<td></td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Cucurbitae</td>
<td>gourd family</td>
<td>24</td>
<td>78</td>
<td>102</td>
</tr>
<tr>
<td>seeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rind fragments</td>
<td></td>
<td>21</td>
<td>387</td>
<td>408</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>common bean</td>
<td>19</td>
<td>80</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Trees</strong></td>
<td></td>
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</tr>
<tr>
<td>Celtis reticulata</td>
<td>neatleaf hackberry</td>
<td>405</td>
<td>11</td>
<td>416</td>
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<tr>
<td>Juniperus sp. seeds</td>
<td>juniper</td>
<td>99</td>
<td>31</td>
<td>130</td>
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<tr>
<td>Pinus spp. nut hulls</td>
<td>two-leaf pinyon</td>
<td>101</td>
<td>1</td>
<td>102</td>
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<tr>
<td>Prunus sp.</td>
<td>chokecherry</td>
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<td>Rhus sp.</td>
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<td></td>
<td></td>
<td></td>
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<td><strong>Shrubs</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Amelanchier sp.</td>
<td>service berry</td>
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<td></td>
<td>2</td>
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<tr>
<td>Artemisia tridentata</td>
<td>big sagebrush</td>
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<td>189</td>
</tr>
<tr>
<td>Atriplex</td>
<td>salt bush</td>
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<tr>
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<td></td>
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</tr>
<tr>
<td>Cheno-­Am</td>
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<td>1271</td>
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<td>Echinocereus-type</td>
<td>claretcup cactus</td>
<td>3</td>
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<tr>
<td>Ephedra spp.</td>
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<td>76</td>
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<tr>
<td>Cactaceae</td>
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<td>Opuntia sp.</td>
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<tr>
<td>cf.Polygonon sp.</td>
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<td>7</td>
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<tr>
<td>Physalis-type</td>
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<td>Purshia mexicana</td>
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<td>78</td>
<td>189</td>
<td>238</td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cf. Astragalus</td>
<td>locoweed</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Atriplex humenelytra</td>
<td>desert holly</td>
<td>15</td>
<td></td>
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<tr>
<td>Ceratoides lanata</td>
<td>winterfat</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>cf. Corispermum</td>
<td>tickseed</td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td>Cruciferae</td>
<td>mustard family</td>
<td>3</td>
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</tr>
<tr>
<td>Liliaceae</td>
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<td>Portulaca sp.</td>
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<td></td>
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</tr>
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<td></td>
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<td></td>
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<tr>
<td><strong>Grasses</strong></td>
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<td></td>
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</tr>
<tr>
<td>Achnatherum hymenoides</td>
<td>Indian rice grass</td>
<td>15</td>
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<tr>
<td>Graminae</td>
<td>grass family</td>
<td>86</td>
<td></td>
<td>86</td>
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<tr>
<td>Panicum urvilleanum</td>
<td>panic grass</td>
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<td></td>
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</tr>
<tr>
<td>Phragmites sp.</td>
<td>arrow reed</td>
<td>171</td>
<td></td>
<td>171</td>
</tr>
<tr>
<td>cf. Sporobolus</td>
<td>dropseed</td>
<td>937</td>
<td></td>
<td>937</td>
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<tr>
<td>Poaceae</td>
<td>Unidentified grass</td>
<td>24</td>
<td>58</td>
<td>82</td>
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Table 3. Faunal skeletal remains recovered from Antelope Cave by MNA, UCLA, and BYU.

<table>
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<td>Small Artiodactyl</td>
<td>15</td>
<td>44</td>
<td>6</td>
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<tr>
<td>Antilocapra americana</td>
<td>1</td>
<td>1</td>
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<td>2</td>
</tr>
<tr>
<td>cf. Antilocapra americana</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ovis canadensis</td>
<td>13</td>
<td>13</td>
<td>3</td>
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<td>Odocoileus hemionus</td>
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<tr>
<td>Chiroptera</td>
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<td></td>
<td></td>
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<tr>
<td>Carnivora</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Felis rufus</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>cf. Urocyon cinereoargenteus</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>Leporidae</td>
<td>19</td>
<td>122</td>
<td>70</td>
<td>191</td>
<td>402</td>
</tr>
<tr>
<td>Lepus californicus</td>
<td>433</td>
<td>19881</td>
<td>795</td>
<td>2090</td>
<td>23199</td>
</tr>
<tr>
<td>Sylvilagus spp.</td>
<td>27</td>
<td>3420</td>
<td>150</td>
<td>744</td>
<td>4341</td>
</tr>
<tr>
<td>Rodentia</td>
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</tr>
<tr>
<td>Spermophilus spp.</td>
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<td>4</td>
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<td></td>
<td>4</td>
</tr>
<tr>
<td>Neotoma sp.</td>
<td>22</td>
<td>4</td>
<td>10</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Thomomys sp.</td>
<td>15</td>
<td>13</td>
<td>34</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Dipotomys sp.</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
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<tr>
<td>Anatidae</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Picidae</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Strigidae</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Corvus corax</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Testudinae</td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
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<tr>
<td>Squamata</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Iguanidae</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Aves, Unidentified</td>
<td>3</td>
<td>3</td>
<td>17</td>
<td>23</td>
<td></td>
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<tr>
<td>Mammalia, Unidentified</td>
<td>2</td>
<td>336</td>
<td>3297</td>
<td>3635</td>
<td></td>
</tr>
<tr>
<td>Unidentified</td>
<td>606</td>
<td>10</td>
<td></td>
<td>616</td>
<td></td>
</tr>
<tr>
<td>Total NISP</td>
<td>511</td>
<td>23542</td>
<td>1381</td>
<td>6397</td>
<td>31831</td>
</tr>
<tr>
<td>Total Bone</td>
<td>511</td>
<td>24148</td>
<td>1391</td>
<td>6397</td>
<td>32447</td>
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</table>
Based on the relatively high level of skeletal completeness, it appears that whole jackrabbits and cottontail rabbits were brought to the site for consumption and fur processing. Jackrabbits were systematically and intensively processed for cooking, an interpretation that is based on patterns of burning, fragmentation, relative skeletal abundances, and other data (Fisher 2009). This processing included butchering into smaller components, roasting of meaty segments, pulverization of the rib cage, fragmenting long bones for marrow access, and stewing the latter two products with wild and cultivated plant resources.

In addition to the culinary processing, evidence for fur processing is present at Antelope Cave. There are 2,425 scraps of rabbit fur or skin with attached fur from the 1959 excavations (Table 4). We believe that most of these fur fragments are discard from the manufacture of skin cordage or the production of rabbit skin blankets. The vast majority of specimens are of untwisted rawhide with fur attached, although 132 twisted cords of rawhide with fur attached and lengths ranging up to 37 cm are also present. Scraps vary greatly in size and shape; burned fur was noted on only one specimen. The fur scraps come from several parts of the rabbit pelt and show a variety of colors, including white, light tan, dark tan, red-brown, gray, black, and combinations of these colors. On some of the twisted strips, the fur has been evenly trimmed so the hair is a uniform length along the entire piece. More than half the specimens (n = 77) are single-ply; the rest are composed of 2-, 3-, 4-, and 5-ply cordage twisted together. None are braided. Of the 132 pieces of twisted fur, 115 are Z-twist; only 17 are S-twist. A few of the strips have been extended by the addition of one or more of the cords coiled together or tied together with fiber knots.

Further evidence for fur-processing at Antelope Cave come from the archaeofaunal skeletal remains. Whole, articulated, furred feet are common in the assemblage, which may represent discarded byproducts from the processing of the skins. Additionally, the lack of burning around the braincase compared to the facial portion of the skull suggests that the brain was removed before roasting; the brain may have been used to process the skins, although consumption is also reported ethnographically (Fowler 1989). Skeletal remains of bobcat (*Lynx rufus*) and fox (cf. *Urocyon cinereoargenteus*), and fur remains of ringtail (*Bassariscus astutus*) also hint at fur processing of other taxa. Cutmarks present on a bobcat maxillary specimen are likely the result of skinning the animal for its fur.

No significant change through time could be detected in relative abundance or utilization of particular species in the samples recovered by BYU and MNA. However, it was observed that the only small artiodactyls recovered by BYU came from the late Archaic levels in BYU 86–2, while leporids are abundant in both late Archaic and Puebloan levels. Based on the much larger sample from the UCLA excavations, Fisher (2009) reported a greater use of artiodactyls early, especially during the Basketmaker period as compared to the Puebloan period, although artiodactyls were never a significant part of the diet. When comparing leporids, Fisher (2009) found a significant increase in the use of *Lepus* over *Sylvilagus* through time. He speculated that this shift from *Sylvilagus* to *Lepus* may re-

### Table 4: Distribution of leporid fur/skin scrap from UCLA excavations.

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>59-1</th>
<th>59-3</th>
<th>59-4</th>
<th>59-2</th>
<th>59-5</th>
<th>NP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6</td>
<td>9</td>
<td></td>
<td></td>
<td>113</td>
<td>332</td>
<td>5</td>
<td>459</td>
</tr>
<tr>
<td>6-12</td>
<td>39</td>
<td>5</td>
<td>167</td>
<td>165</td>
<td>4</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>12-18</td>
<td>8</td>
<td>8</td>
<td>82</td>
<td>125</td>
<td></td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>1</td>
<td>22</td>
<td>13</td>
<td>106</td>
<td>276</td>
<td>418</td>
<td></td>
</tr>
<tr>
<td>24-30</td>
<td>13</td>
<td>6</td>
<td>6</td>
<td>41</td>
<td>379</td>
<td>445</td>
<td></td>
</tr>
<tr>
<td>30-36</td>
<td>7</td>
<td>17</td>
<td>39</td>
<td>273</td>
<td></td>
<td>336</td>
<td></td>
</tr>
<tr>
<td>36-42</td>
<td>3</td>
<td>11</td>
<td>33</td>
<td>3</td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>42-48</td>
<td>2</td>
<td></td>
<td>30</td>
<td>10</td>
<td></td>
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</tr>
<tr>
<td>48-54</td>
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<td>52</td>
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</tr>
<tr>
<td>54-60</td>
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<td></td>
<td>9</td>
<td></td>
<td></td>
<td>9</td>
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<td>60-66</td>
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<td>9</td>
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<td>66-72</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>53</td>
<td>55</td>
<td>62</td>
<td>650</td>
<td>1596</td>
<td>9</td>
<td>2425</td>
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</table>

Based on the relatively high level of skeletal completeness, it appears that whole jackrabbits and cottontail rabbits were brought to the site for consumption and fur processing. Jackrabbits were systematically and intensively processed for cooking, an interpretation that is based on patterns of burning, fragmentation, relative skeletal abundances, and other data (Fisher 2009). This processing included butchering into smaller components, roasting of meaty segments, pulverization of the rib cage, fragmenting long bones for marrow access, and stewing the latter two products with wild and cultivated plant resources.
fect the impact of local environmental changes (see below). It is worth noting that Driver’s (2002) broad synthesis of Anasazi faunal trends in the Four Corners region found that, contrary to expectations, Lepus use did not increase through time, despite a growing reliance on domesticated crops.

\section*{ANTELOPE CAVE SITE FUNCTION}

Antelope Cave appears to have functioned as temporary living quarters while individuals hunted, perhaps tended crops, and used fur from captured leporids to manufacture raw material for making rabbitskin robes. Here, we review evidence that the deposits at Antelope Cave represent local communal jackrabbit drive and horticultural activities (assumed by Janetski and Hall 1983).

The previous section demonstrated that the primary prey of hunters during all periods were leporids, mostly jackrabbits, which were harvested in large numbers. The assumption is that the high numbers of Lepus remains are evidence of communal drives to capture these otherwise elusive animals. Testing this assumption presents some difficulties and demands further discussion. Following that discussion, we confront the evidence for gardening locally and the composition of the groups who used the site. Both questions play into our understanding of how Antelope Cave functioned within the regional Puebloan strategy.

\section*{Evidence for Communal Jackrabbit Drives}

Communal jackrabbit drives are well documented in the Great Basin and Southwest ethnographic literature, although the number as well as age and gender of the participants vary somewhat between accounts. These analogs provide some basis for assuming that communal jackrabbit hunts on the Uinkaret Plateau consisted of small groups, perhaps mostly adult males and boys, who drove their prey into nets. Howard Egan’s (1917) descriptions for the Western Shoshone are especially useful. Once the area to be driven was identified, nets owned by families were stretched between posts, each family’s net joining with another’s until they formed a semi-circle with wings into which the drivers herded the rabbits. Each net was about 76 cm high and 140 m to 180 m long. Kelly (1964:50-51) has described a Kaibab Southern Paiute drive as consisting of 10 to 20 males, from one or more bands, who used three to five nets strung together. Puebloan people valued rabbits as a food source and as the focus of sport hunting. Men hunted rabbits for sport and as part of a ritual activity that involved throwing sticks to dispatch rabbits (various in Ortiz 1979, but see Kendrick 1979:357 and Bodine 1979:256 for specifics).

Several researchers (see Shaffer and Gardner 1995; Schmidt 1999; Schmitt and Lupo 2005 and references therein) have provided excellent summaries of ethnographic accounts and the behavioral characteristics of Lepus spp. that predisposed them to drives. These accounts support our position that individual capture of such massive numbers of jackrabbits (combined NISP of 23,199 for all excavations) is unlikely. Abundant jackrabbit remains often suggest that communal drives were used to capture these animals for both food and for their skins, which were commonly used to make warm robes or blankets (Yoder et al. 2005). Steward (1941:220), for example, noted that a “major purpose” of Western Shoshone communal rabbit hunts was “to provide skins for woven blankets.” Also Kelly (1964:68) described in detail how Kaibab Paiute made rabbitskin blankets used by both men and women for “wraps” or “bedding.” However, some caution must be exercised before attributing communal hunting to the Antelope Cave assemblage, because assemblages consisting of large quantities of jackrabbit remains may also represent an accumulation of individually captured animals (Grayson and Cannon 1999; Jones 2004; Lyman 2003).

Accumulation rates may be used to rectify this problem of equifinality. There is overlap between three radiocarbon dates spanning 1.85 m (6 ft) of deposits from two adjacent excavation units, UCLA AC 59-2 and AC 59-5 (Table 1). As presented in Figure 6, the Leporid Index

\[
\sum \text{Sylvilagus} / \sum \text{Leporids}
\]

decreases incrementally through time in these units (Spearman’s \(r_s = +.905, p = .002\); Level 42-48 removed as outlier). This decrease corresponds well with alluvial and palynological data that indicate that this period saw the development of an open landscape (Dean 1985 in Rose 1989), a shift that likely favored Lepus over Sylvilagus. Thus, this portion of the assemblage does not represent a single deposit, as suggested by the radiocarbon dates, but a series of deposits documenting local environmental change in resource abundances. These data do not, however, preclude the possibility of communal drives at Antelope Cave; it may simply be that Puebloan people increasingly focused on drives which would have resulted in the capture of more jackrabbits.

Communal hunting may also be identified using catastrophic mortality profiles (e.g., Jones 2006; Klein 1982; Lupo and Schmitt 2002), and may be utilized for Lepus based on the relative abundance of age classes in an assemblage. Data regarding birthing times for jackrabbits in northwestern Arizona are not available, but data from California and southern Arizona indicate that birthing peaks in late winter and spring, and ceases in September (Haskell and Reynolds 1947; Vorhies and Taylor 1933). As noted above, plant remains from Antelope Cave coprolites represent diets consumed in
late summer or early fall (Reinhard 2009), when birth-
ing declines and hares are in prime condition for
hunting (Fowler 1986:82).

Epiphyseal fusion of the proximal humerus is com-
plete around 11 to 15 months in jackrabbits (fusion
timing of other skeletal parts is unknown), and skele-
tally mature adults are almost never in frequencies
greater than 50 percent in populations from Sacra-
mento Valley, California (Lechleiner 1959; Tiemeier
and Plenert 1964). If the Antelope Cave faunal assem-
blage was a product of fall communal drives, the re-
sulting death assemblage should approximate this dis-
tribution of skeletal mature to immature individuals. In
contrast, only nine (1.9 percent, NISP = 475) unfused
proximal humeri (the skeletal part used by Lechleitner
(1959) for age classifications) are present in the Ante-
lope Cave assemblage. The very sparse evidence for
subadults in the assemblage argues against drives as a
primary method for obtaining *Lepus* remains. Howev-
er, this conclusion is based on the assumption that the
relative abundance of juvenile jackrabbits would be as
high as the frequencies observed by Lechleitner (1959)
in California, yet there are expected differences in de-
mographics and reproduction between geographic
regions. If birthing ceases much earlier in the vicinity
of Antelope Cave (as may be expected in a more mar-
ginal environment), fewer subadults would be present
in the fall. It is also noteworthy that the high level of
preservation may actually result in lower observation of incompletely fused humeri, because the frequent
presence of desiccated tissue limits the visibility of epi-
physeal lines.

Patterning in burning and element representation
has also been used as evidence for drives. For exam-
ple, Schmidt (1999:111) found that a high percentage
of the leporid bones from the Five Feature Site, a late
Formative site in southeast Arizona, was burned, and
there was a strong pattern in the elements present,
notably only distal tibiae and radii along with foot
bones. Schmitt et al. (2004: 93) on the other hand re-
ported leporid remains from Archaic levels in Camel’s
Back Cave in west central Utah. These authors docu-
mented that skull and limb bones were the most com-
mon elements recovered, a pattern suggesting not on-
ly butchering and transport of select body parts but
also mass capture (see also Shaffer and Gardner 1995
for additional archaeological examples of drive evi-
dence). As previously discussed, systematic processing
also occurred at Antelope Cave (Fisher 2009). Although
these reports describe contrasting patterns, the fact
that there is patterning suggests people processed
these animals in culturally prescribed ways. However,
such systematic processing does not necessarily
equate with the mode of capture unless it can be

Figure 6. Changes in the Leporid Index through time for adjacent excavation units AC 59-2 and AC 59-5 compared with radiocarbon dates and paleoenvironmental data. Paleoenvironmental data from Rose (1989).
demonstrated that such methods were not used for individually acquired hares.

The presence of a variety of hunting equipment commonly associated with communal hunting of jackrabbits at Antelope Cave provides the strongest support for the drive argument. One throwing stick and 57 net fragments were recovered from the 1959-60 excavations, and additional net fragments and a throwing stick were recovered during later work. Both of these artifact types were employed during drives ethnographically (Adovasio et al. 2009; Shaffer and Gardner 1995: Kennard 1979). Additionally, arrow points (n = 31), wooden nocks for arrows (n = 3), and cane arrow fragments (n = 12) may have been used to dispatch hares during drives (e.g., Fowler 1989) or for individual hunting of other game, including mountain sheep and cottontail rabbits.

Clearly, identifying the communal rabbit drives from archaeological data with a high level of confidence is difficult. However, it is our position that the bulk of the jackrabbit assemblage from Antelope Cave represents the products of communal rabbit drives. This conclusion is supported by the analysis of 20 human coprolites from Antelope Cave. That work reveals that rabbit meat was almost as prevalent (14 of 20 coprolites) in the Antelope Cave diet as all other plant foods combined. In addition, maize made up only 25 percent of the major foods eaten in the cave (5 of 20 coprolites), less than prickly pear alone (7 of 20 coprolites) (Reinhard et al. 2012, Supplement A:3, Table A1).

Understanding why past peoples would have focused foraging efforts on such relatively small game has been debated in recent literature. Grimstead (2010) modeled the travel and transport costs for black-tailed deer (Odocoileus hemionus), antelope jackrabbit (L. alleni), and desert cottontail (S. audubonii) obtained between 0-200 km from a central place. She concluded that large game remains a high-return prey item even with high travel distances. A 141 kg artiodactyl procured within 200 km would produce the equivalent return of 31 jackrabbits acquired within 1 km. This model assumes that the captured product was transported back to a central place and explains why large game continued to be hunted at the structural sites; the model does not account for logistical bases used to acquire smaller game. Grimstead (2010) found that the “point of no returns” for central-place foraging of jackrabbits is 23.6 km. When approaching this distance, it may be more profitable to move the central place from a residential base to a logistical base. This distance places Antelope Cave well within the foraging radius from known residential bases on Little Creek and Lost Spring Mountains that lie 20 and 10 km distant respectively.

Although this estimated distance can be used to determine when logistical bases might be established, it does not predict whether people will hunt on an individual basis or use communal drives at such locations. Ugan (2005) evaluated the return rates of mass harvested and individually acquired prey to demonstrate that the supposed high efficiency of mass collecting is generally overstated, since the processing costs for each individual package acquired from communal hunts are still relatively high and the returns per individual are low.

However, Ugan’s study focused on energy-based return rates while masking other, non-dietary uses for game. The evidence at Antelope Cave for fur processing indicates that this was likely an important product, as documented in various ethnographic accounts (e.g., Fowler 1989). Whether fur was the primary or secondary product is not known, but it clearly provided an additional resource that cannot be incorporated easily into diet-based foraging models. Rather the rabbit skins and fur may have acted as a currency other than calories and may have provided benefits beyond nutrition (e.g., see Bettinger 1991:114).

Additionally, hunting risk should be considered. The intrapatch encounter rate for jackrabbit drives is 0.6 to 4.9 kg/hr, which exceeds the maximum rates provided for commumally hunted deer (0.4 kg/hr) and bighorn sheep (0.7 kg/hr) (Simms 1987: Table 8). While the post-encounter energetic returns for jackrabbits may be comparatively lower than that of small artiodactyls, the high encounter rates suggest that hunters were not likely to return home empty-handed. Indeed, the fact that nets and other equipment were cached at Antelope Cave suggests that the occupants recognized the low risk involved in communal hunting of jackrabbits at this location. Furthermore, communal rabbit drives may have been embedded into other seasonal activities, such as crop harvesting (see below) and ceremonial events (e.g., Beaglehole 1936) that involved family groups. It is expected that risks associated with hunting would have been minimized during visits to the site to allow for these other activities to occur.

In conjunction with foraging models, stronger faunal data from structural sites may be used to test whether the importance of logistical bases for communal jackrabbit drives increased through time. For one, Harry and Watson’s (2010) contention that the high frequency of artiodactyls at structural sites is the result of regional compaction may be demonstrated by showing that artiodactyls increased in abundance through time. If hunting artiodactyls in surrounding patches increased, it is expected that transportation costs increased. Increases in transported cost can be identified with skeletal part representation and isotopic analyses (Fisher 2010, Fisher and Valentine 2013). It is also critical to demonstrate that such hunting insufficiently met the energetic requirements from animal resources.
Evidence for Farming at Antelope Cave

Several questions about Virgin Anasazi settlement and subsistence are posed by the presence of sites such as Antelope Cave, which appears to have functioned as temporary living quarters for Anasazi peoples while they hunted and presumably planted and tended crops (Janetski and Hall 1983). For example, excavators recovered thousands of maize cobs and shucks as well as abundant squash and bean remains (see Table 2). We believe that such non-food by-products would not have been transported to Antelope Cave from village locations given the minimal caloric benefit. Also, Hugh Cutler’s analysis (undated manuscript, Illinois State Museum) of corn cobs from MNA pit C revealed that 80 percent of the corn was eaten or shelled almost immediately after harvesting (see also Cutler and Mayer 1965). His conclusions are based on an observation that small fragments of a corn kernels’ skin (pericarp) remain attached to the pedicle and are visible on the cobs after fresh, moist corn is eaten or shelled.

Concomitantly, with the exception of a few hearths, constructed site facilities are essentially non-existent in Antelope Cave. Puebloan peoples commonly constructed dwellings inside caves and overhangs, as Judd’s (1926) work in Cottonwood Canyon near Kanab amply illustrated. The presumption is that if long term stays, as required by tending gardens, were intended, occupants would have invested in similar facilities. Below we attempt to resolve these somewhat contradictory lines of evidence.

The Antelope Cave data suggest that the Virgin Anasazi in the Uinkaret Plateau region were not practicing the traditional, sedentary strategy assumed for people in the Kayenta and Mesa Verde regions. Rather, Virgin Anasazi peoples may have developed a residentially mobile or transhumant strategy (see also Ambler et al. 1983; Fairley 1989:121). Transhumance suggests seasonal shifts in residence location, moves which are designed to meet subsistence and perhaps other life requirements. The traditional literature on the Pueblo I Virgin Anasazi settlement-subsistence strategies contains some speculation regarding seasonal mobility (see Altschul and Fairley 1989:120-121 for a review). Several researchers have advanced the notion of spring-summer occupations in lowland, riverine settings and fall-winter use of the uplands in the region (Aikens 1966; Heid 1982). Geib (1996:182) has offered a model of Puebloan seasonal movement between lowlands and highlands in the Glen Canyon region. Geib (1996) suggested that temperature gradients between the lowlands and highlands provided an opportunity for a mid-to late summer harvest in the lowland environments and a later fall harvest in highland areas. Schwartz et al. (1981) have posited a reverse pattern (i.e., summer highland occupation and winter lowland) for the Grand Canyon to the south during the slightly later A.D. 1050-1150 period. A paucity of survey data makes proposing a residentially mobile model for the Uinkaret Plateau difficult, an issue largely unchanged since Altschul and Fairley’s (1989) excellent overview (see also O’Hara 2010).

Posing an appropriate analog for a transhumant or seasonally mobile pattern is also difficult. The modern Pueblo groups, such as the Hopi and others, who are considered by most to be descendants of the Anasazi, do not practice a strategy of seasonal movement. Nor did any Pueblo groups reside in the study area during the Historic period. Since the time of European contact, the only recorded Native Americans who occupied the region were the Uinkaret Band of the Southern Paiute (Kelly 1964). The Uinkaret people were hunter-gatherers, but the Kaibab to the east were recent horticulturalist (Kelly 1964; Fowler 1982; Kelly and Fowler 1986). We recognize that, although there are some similarities in the Kaibab and prehistoric Anasazi pattern (e.g., both made ceramics, practiced farming), there were also significant differences. The Anasazi architectural style and ceramic traditions were both more elaborated than the Southern Paiute. In addition, based on investments in storage facilities, the importance of agriculture was greater for the Anasazi than for the Southern Paiute. As a consequence, the application of a Southern Paiute analog must be made with caution.

In this context, we suggest a model of greater settlement mobility combined with the Hopi practice of double or triple cropping (Whiting 1966) is useful in understanding the regional pattern and the role of Antelope Cave within it. The purpose of such a strategy is to insure against crop failure. The Hopi planted crops in a variety of locales, such as in flood plains, in the mouth of draws, and on mesas. The area around Antelope Cave, including Clayhole Wash, likely offered flood plain and akchin settings which would perhaps complement crop production in mesa top environments. The assumption is that the fields were maintained and harvested during short term visits to these locales. Testing these ideas would require survey around the site to determine the feasibility of local gardening as well as to document the presence or absence of either field houses or residences. Although there is no known evidence for it, the cave may have also served as temporary storage for crops destined for transport to villages.

The probability that cave users spent time in more traditional Pueblos in other locations is supported by two lines of evidence. First, the parasitological data from human coprolites provide important insights regarding seasonal mobility. The high incidence of pinworm (Enterobius vermiculais) eggs (5 of 22 samples)
from Antelope Cave is comparable to that found at Ancestral Puebloan village sites; the comparable infection rates suggests that the occupants of the site likely came from more crowded conditions elsewhere (Fugassa et al. 2011). Furthermore, a high incidence of whipworm (Trichuris vulpis) in canid coprolites suggests that dogs came to Antelope Cave from a location with high canid population densities (Fugassa et al. 2011). Interestingly, despite the coprolite evidence of dogs at Antelope Cave, the faunal remains show no evidence of carnivore ravaging (e.g., density mediated destruction or markers of chewing or digestion). If visits to the cave were limited to harvesting crops and conducting rabbit drives, dogs may have been well supplied with jackrabbit viscera to the extent that they did not ravage the scrap bone. Second, the abundance and diversity of plant remains from both riverine and upland sites indicate that users spent time in such zones and carried important resources with them to Antelope Cave. While the presence of domesticated crops, including non-dietary portions of maize (e.g., pollen, stems, shucks, cobs), is indicative of local cultivation, the lack of storage and other site investments hints at the possibility that the processed product (i.e., shelled corn may have been transported to more permanent, densely packed settlements. Kelly (1964:39), for example, reported that the St. George Paiute traded “a small sack of corn” to the Kaibab Paiute; the description suggests corn was transported as kernels. An archaeological example comes from Cowboy Cave, which yielded two skin bags containing shelled corn (Jennings 1980:29). Both cases support the conclusion 1) that maize was grown locally, as it is unlikely that shucks, stems, and cobs would have been transported any distance, and 2) that maize grown in the vicinity of the cave would have been carried to distant locales as shelled kernels.

The many sandals recovered by researchers from MNA and UCLA also provide useful insights regarding site function and perhaps group composition. The total number of sandals taken out of the cave will probably never be known. However, the MNA collections combined with those from UCLA and the few collected by BYU bring the total to over 200, by far the majority of which are the round-toed, Pueblo I style (see Yoder 2009, 2010). Based on length measurements, Yoder has argued that all of the round-toed (Pueblo I) sandals from the cave available for his analysis were adult-size. The UCLA collection contains a single sandal fragment considered child-size. These data suggest that adults were the primary users of the cave, although it is possible that most children went barefoot. The evidence for residential groups is hard to ignore, however. For example, adult-sized sandals could have been worn by women. The presence of women is amply supported by the enormous quantity of plant remains and rabbit skin robe material, both of which are material consequences of activities assumed to be carried out by women (see Kelly 1964; Schwartz 1983 for gender roles of Southern Paiute and Havasupai). It is doubtful that women would be in the cave without children; consequently, we conclude that family groups were often present in the cave.

**THE ROLE OF ANTELOPE CAVE IN THE VIRGIN ANASAZI SUBSISTENCE STRATEGY**

How do the Antelope Cave data play into our understanding of Virgin Anasazi subsistence strategies? The massive quantity of leporid remains in Antelope Cave dating to the early Puebloan period points to the importance of hunting by Virgin Anasazi on the Uinkaret Plateau during the early Pueblo period. But these findings seem to contrast with the faunal data from some Anasazi sites in the St. George area, where the absence of faunal remains led to the conclusion that Virgin River Puebloans were full time horticulturalists (Aikens 1966; Dalley and McFadden 1985, 1988; Martin 1999). Excavations by the University of Utah at sites such as the Frei Site (Pendergast 1960), Gunlock Flats (Day 1966), and Three Mile Ruin (Aikens 1965); by the BLM at Red Cliffs and Little Man sites (Dalley and McFadden 1985, 1988); and by Walling et al. (1986) at Quail Creek Reservoir sites, recovered little in the way of animal bone. This variability could be due to several factors taken either individually or in combination: 1) differential screen sizes or the lack of screening altogether, 2) variable sample sizes, 3) sampling bias (whether or not portions of middens were excavated), 4) poor preservation, 5) variations in Anasazi strategies in the region, 6) differences in site function, or 7) temporal differences.

There is little doubt that the presence or absence of screening has biased the faunal data available for analysis. The two sites that contained the highest numbers of bone (42Ws1342 and NA5507) were both screened, and portions or all of the deposits were processed with eighth-inch screens. However, other sites that were screened (e.g., 42Ws1287, 42Ws1288, and 42Ws326) yielded few bones (2, 276, and 275 respectively), despite the excavation of rather large samples. Conversely, at least one site that was not screened (42Ws395 [Walling et al. 1986: Table 31]) yielded a significant sample of faunal bone (n = 429).

The variability seen among these sites may simply be a matter of differential sampling, either in the location of excavations or in the choice of faunal elements collected. More specifically, the differences may be a result of excavating only living areas (houses) and ignoring middens or dump areas, or collecting only complete or “interesting” bones. Allison (1990:88-89), for
example, noted that the small number of bones from Anasazi Valley site 42Ws1287 is most likely due to the fact that midden was not sampled. In support of that conclusion, he observed that all but three of the bones from 42Ws1288 came from midden deposits. Pendergast (1960:134) made a similar comment about the importance of sampling refuse areas to recover food scrap in his description of the work at the Frei Site. All 110 of the deer bones from the site apparently came from midden in the fill of the structures excavated. A similar pattern may be present at 42Ws326, where 173 of the 275 bones recovered came from an area east of the primary concentration of house and cist features (Baker and Billat 1992:81). Although this area (Cist Complex 3) was not labeled a midden in the report, it may have functioned as a dump. In addition, over half of the remaining bone came from structural fill, which may also represent dumping activities. At 42Ws395, the larger yield of bone may simply be the result of a sampling bias, as it was one of the largest excavations on the project. Significant quantities of the bone from here were recovered from structural fill also. A similar case can be made for the recovery of a fairly rich assemblage of faunal material from House 20 at Main Ridge (Harry and Watson 2010). However, Dalley and McFadden (1985, 1988) excavated significant samples of midden areas and still recovered minimal bone, although they did not screen.

Although differential data recovery techniques, biased sampling, and variable sampling size may account for a significant portion of the variability in the St. George Anasazi sites, these seem to fall short of explaining the patterning present in the archaeological record for the larger region. We suggest that attempting to sort Virgin Puebloan subsistence into either-or categories, such as primarily farming or a mix of wild food gathering and farming, falls short of capturing the complexity of the strategy.

For some limited archaeological illustration of this possibility, we turn to data from the work of Moffitt et al. (1978) on the Navajo-McCullough Transmission Line southwest of St. George and into northern Arizona, and to the data from Antelope Cave. The research of Moffitt et al. (1978) included survey and excavation in the Beaver Dam Mountains north of the Virgin River in extreme southwestern Utah. The seven sites that they investigated contained multiple occupations from the Archaic period through the Late Prehistoric and Historic Southern Paiute periods. All deposits were screened. Of the seven sites, three (NA11,405, NA11,408, and NA11,634) contained evidence of Virgin Anasazi use. NA11,634, for example, contained two roasting pits, probably for processing mescal, that also yielded Anasazi ceramics. At NA11,405 they found a wickiup depression (Wickiup Depression 3) that contained only Anasazi diagnostics, and another, Wickiup Depression 4, which contained a mixed assemblage of Anasazi and Southern Paiute sherds (Moffitt et al. 1978:11-20). Bone was more abundant here than at any of the other Beaver Dam Mountain sites, although the bone is reported as a single lot rather than by provenience; as a result, no specific statements can be made about Anasazi hunting activities. Large mammal bone was by far the most abundant class of faunal remains recovered, however.

All of the sites mentioned above are away from the river and tend to represent more ephemeral use than sites with formal architecture. Antelope Cave was also well away from the riverine setting and contrasts markedly from excavated structural sites. As noted, no constructed features (walls, cists) were encountered during either UCLA’s or BYU’s visits nor did Euler (personal communication, various) mention any such features. The absence of structural features suggests the cave functioned as a logistical outpost for both fall jackrabbit drives and an alternative location for strategically placed garden plots. The cave lies at a distance from residential sites on Short Creek or Little Creek and Lost Spring Mountains, the proposed sources for Antelope Cave visitors. In addition, travelers on their way across the Uinkaret Plateau may have used the cave to cache items, especially sandals, for future use. However, most of the objects from the excavations reflect the domestic activities of family groups living in the cave. Besides sandals, these include thousands of pieces of cordage (fiber, feather, fur, hair), basketry, pottery, and seed grinding implements.

Sites in uplands documented by Moffitt et al. (1978) as well as those in lower lying areas but away from the Virgin River corridor (see Talbot and Richens 2009) were also distant outposts that were important dietary procurement locales for the Anasazi. Most scholars working in the region are in agreement that maize was the primary component of Virgin Anasazi diet (e.g., Martin 1999; Watson 2008; Landon 2010); however, non-riverine sites such as Antelope Cave and perhaps Heaton Cave (Judd 1926) and Rock Canyon Shelter (Janetski et al. 2013) are critical nodes in a far-flung subsistence strategy. Martin’s (1999) important study found that up to 75 percent of Virgin Anasazi diet consisted of plants with a $\delta^{13}C$ signature. The remaining 25 percent of the diet consisted of wild resources, including a wide array of plants and animals. The rich plant assemblages reported by Nelson et al. (2005) from the Reusch site as well as work by others (Allison 1990; Harry and Watson 2010; Landon 2010; Westfall et al. 1987 to name a few) make clear that gathering such resources was a continuous activity. Similarly, the many sites yielding faunal bone are evidence that animal protein was pursued aggressively and successfully.

Along the Virgin River, large game appears to have been most important. The high frequency of artiodac-
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Notes
1. Mr. Floyd Atkin related this early site history during a on-site visit with the BYU crews in 1986 and during a phone conversation in 2009. In 1986 the Atkin family (Luen Atkin Woodbury and Floyd Atkin, daughter and son of William Atkin respectively) donated several objects (two sandals, a net fragment, and a wooden “rabbit club”) to the Museum of Peoples and Cultures at Brigham Young University. At one point a significant portion of the Atkin collection was provided to Jim Johnson for a private museum in St George. After Johnson’s death, some of the collection was returned to the Atkin family.

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