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Raptor Nests, and Archaeological Sites in the
Great Basin**

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**COMPARISON OF LEPORID BONES IN RAPTOR
PELLETS, RAPTOR NESTS, AND ARCHAEOLOGICAL
SITES IN THE GREAT BASIN**

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ABSTRACT

Leporid (cottontail and hare) bones deposited on the landscape in raptor pellets may exhibit more forelimb than hindlimb bones, few complete bones, more subadult than adult bones, and abundant vertebrae. In contrast, raptor nest assemblages may exhibit more tibiae than forelimb bones, few incomplete bones, more adult than subadult bones, and few vertebrae. Approximately 1 to 2 percent of leporid bones deposited in either raptor nests or raptor pellets are likely to exhibit puncture marks. Leporid bone assemblages created by humans in the Great Basin may exhibit large numbers of adult *Lepus* or adult *Sylvilagus* tibia diaphysis cylinders, many burned and unidentifiable fragments of bone, few identifiable vertebrae and sacra, and assemblages that consist primarily of adult animals. These data suggest that archaeologists should be able to identify leporid bone assemblages that were created largely or solely by the deposition of raptor pellets, by the deposition of unswallowed bones under raptor nests, or by the deposition of bones by humans. Assemblages created by any combination of these three processes, however, will be more difficult to interpret.

Raptors and humans may both deposit hundreds of small to medium-sized bones in sheltered caves and rockshelters and in open-air sites (Andrews, 1990; Avery, 1991; Brain, 1981; Guilday, 1982; Guilday and Parmalee, 1965; Hockett, 1993, 1994; Kusmer, 1990; Miller, 1929; Simonetti and Cornejo, 1991). As a result, reliable interpretations of prehistoric subsistence patterns at sites that exhibit large numbers of small to medium-sized bones partly depend on our ability to

distinguish those bones modified by humans from those modified by raptors. Although numerous taphonomic studies have been conducted on raptor-mice interactions during the past twenty years (for example, Andrews, 1990; Dodson and Wexlar, 1979; Duke et al., 1975; Hoffman, 1988; Korth, 1979; Kusmer, 1990), similar studies on raptor-leporid (cottontail [*Sylvilagus* sp.] and hare [*Lepus* sp.]) interactions have been comparatively few (see Hockett, 1991 for a review).

Previous research suggested that leporid bone assemblages created by the deposition of raptor pellets displayed the following taphonomic traces: 1) cottontail (*Sylvilagus* sp.) tibia diaphysis cylinders may be present; 2) punctured bones generally exhibit beak and talon punctures on only one side; 3) innominates are often punctured directly behind the acetabular fossa; 4) shearing damage may be present principally to innominates and proximal femora; 5) there will be a higher relative frequency of forelimb bones than hindlimb bones present; and 6) there will be more subadult than adult bones present (Hockett, 1991). In contrast, prehistoric bone processing behavior in the Great Basin tended to create hare (*Lepus* sp.) tibia diaphysis cylinders, many burned and unidentifiable fragments of bone, and assemblages that consist primarily of adult animals (Hockett, 1991).

Described below is the analysis of nearly 4,000 leporid bones that were excavated from a hearth/trash pit feature at archaeological site 26Ny3393, southern Nevada, and the analysis of four additional leporid bone assemblages that were largely or solely created by raptors. These data indicate that archaeologists should be able to identify leporid bone assemblages that were created largely or solely by the deposition of raptor pellets, by the deposition of unswallowed bones under raptor nests, or by human processing behavior.

LEPORID BONE ASSEMBLAGES CREATED BY HUMANS IN THE GREAT BASIN

During processing of leporid carcasses, prehistoric peoples of the Great Basin sometimes created adult *Lepus* (hare) tibia diaphysis cylinders, many burned and unidentifiable bone fragments, and assemblages with predominantly adult bone specimens (Dansie, 1991; Hockett, 1991; Schmitt, 1990a). Based on recent analysis of several leporid bone assemblages recovered from open-air archaeological sites in the Great Basin, humans sometimes created large numbers of adult *Sylvilagus* (cottontail) tibia diaphysis cylinders, and they often differentially destroyed the vertebrae and sacrum of the axial skeleton. This processing strategy removed most of the latter two elements from the identifiable bone assemblage (Dansie, 1991; Hockett, 1992; Schmitt et al., 1986).

For example, archaeological site 26Ny3393 is located in southern Nevada (Figure 1). The site consisted of a prehistoric gabled wooden lodge, a hearth/trash midden, and an open-air lithic scatter (DuBarton, 1992). Excavation of thirty-two 1 m by 1 m units centered around the hearth recovered 3,973 identifiable and

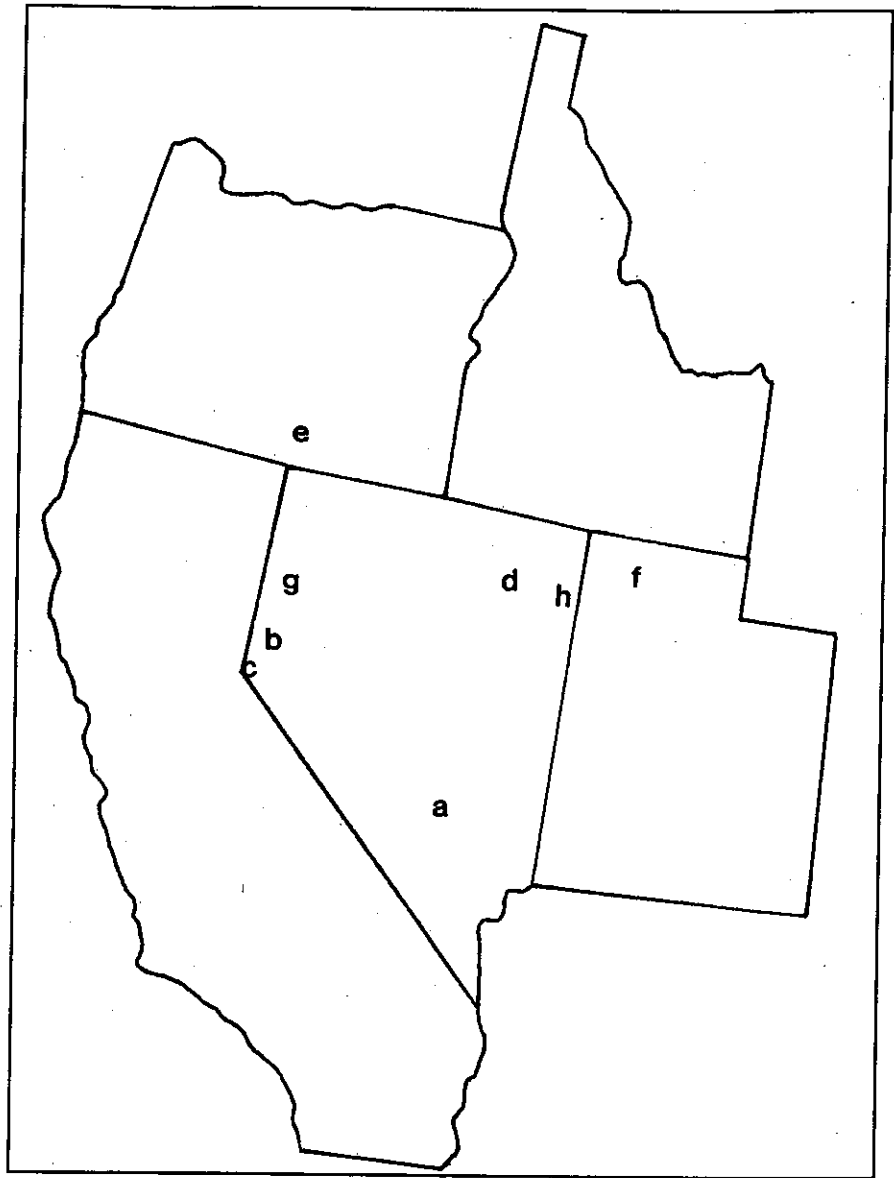


Figure 1. Location of sites discussed in text: a) archaeological site 26Ny3393, southern Nevada; b) Vista and Huffaker Hills sites near Reno, Nevada; c) Washoe village sites, California/Nevada border; d) James Creek Shelter Nevada; e) archaeological site 35Lk2579, and Waterfall Roost, Oregon; f) Hogup Cave, Utah; g) Two Ledges, Two Ledges Chamber, and Matrac Roost, Nevada; h) Dondero Shelter, Nevada.

unidentifiable leporid-sized bone fragments (Hockett, 1992). The vast majority of these bones belong to adult cottontails (*Sylvilagus* sp.).

Based on NISP counts, Table 1 reports that mandibles, tibiae, scapulae, skull fragments, and ribs were the most common identifiable elements recovered from 26Ny3393. In contrast, vertebrae and sacra show extremely low NISP counts. Humans deposited at least forty-seven individual leporid animals at the site, yet only one sacrum and nineteen vertebrae were recovered from the excavations. Schmitt et al. (1986) have previously reported this same taphonomic pattern at the Vista site near Reno, Nevada (Figure 1), and Dansie (1991) has reported this pattern at the Huffaker Hills site near Reno, and at several Washoe village sites located near the California-Nevada border (Figure 1).

Several taphonomic processes could have caused low numbers of vertebrae and sacra to be recovered in these archaeological sites, including screen bias, preservational bias mediated by bone density, and carnivore ravaging. These taphonomic processes, however, probably did not greatly effect the number and types of bones recovered from 26Ny3393. All sediment from the site was sifted

Table 1. Number of Identified Leporid Specimens and Minimum Number of Leporid Elements (in parenthesis) from Archaeological Site 26Ny3393, Two Raptor Pellet Localities, and Two Raptor Nest Localities

Element	Archaeological Site	Raptor Pellets		Raptor Nests	
	26Ny3393	Dondero Shelter	Two Ledges Chamber	Matrac Roost	Waterfall Roost
Mandible	136 (90)	29 (24)	175 (129)	0	12 (11)
Maxilla	38 (38)	18 (18)	103 (103)	2 (2)	5 (5)
Innominate	36 (27)	46 (36)	86 (72)	9 (9)	12 (12)
Sacrum	1 (1)	11 (11)	20 (20)	8 (8)	5 (5)
Femur	26 (10)	51 (22)	209 (88)	15 (15)	14 (11)
Tibia	118 (73)	51 (21)	201 (79)	38 (32)	44 (26)
Calcaneus	30 (30)	23 (23)	143 (143)	34 (34)	18 (18)
Astragalus	20 (20)	12 (12)	62 (62)	33 (33)	17 (17)
Scapula	116 (73)	27 (26)	92 (89)	2 (2)	2 (2)
Humerus	39 (36)	58 (29)	249 (156)	3 (3)	15 (14)
Radius	65 (25)	52 (44)	112 (67)	6 (6)	10 (10)
Ulna	41 (31)	40 (32)	138 (138)	6 (6)	11 (10)
Skull	293	—	49	0	0
Teeth	152	—	44	0	0
Vertebra	19	125	463	24	39
Rib	281	136	30	3	0
Carpal/Tarsal	22	13	28	172	86
Metapodial	202	142	384	144	102
Phalange	166	72	282	432	205
Total NISP	1801	906	2870	930	597

through one-eighth inch screens. Few leporid-sized bones will fall through screens of this size (Shaffer, 1992). Additionally, the bones from 26Ny3393 were very well preserved. Many complete or nearly complete bones with the soft, cancellous epiphyses attached were recovered from the site. The single sacrum and three of the nineteen leporid vertebrae recovered from 26Ny3393 displayed discoloration and corrosive damage caused by gastric digestive fluids (Andrews, 1990; Andrews and Evans, 1983; Schmitt and Juel, 1994). This suggests that these bones were last deposited in the site in carnivore scats. Only ninety-five (2.4%) of the leporid bones from 26Ny3393, however, were interpreted as scat bones. Additionally, the ninety-five bones were recovered from single excavation levels within three separate units. These bones may therefore represent the remains of only three carnivore scats (Hockett, 1992).

Prehistoric human processing of bone is instead the likely cause of the low numbers of vertebrae and sacra recovered from 26Ny3393. Historic Native Americans in the Great Basin sometimes pounded the axial skeleton (except for the skull) with milling stones more frequently than the appendicular skeleton (Steward, 1941; 1945). This behavior would have produced a greater abundance of identifiable limb and skull bones, and a scarcity of identifiable vertebrae and sacra. Steward (1941:232) mentioned that for the Nevada Shoshoni, "Soft bones, especially joints and vertebrae, were ground and cooked; . . ." Steward (1945:304) later stated that the Lemhi Shoshoni and Northern Paiute-speaking Bannock of Idaho, and the Grouse Creek Shoshoni, Promontory Point Shoshoni, Cache Valley Shoshoni, and Skull Valley Shoshoni of Utah ground the vertebrae of small game. Steward (1945:364) then specifically stated that the Northern Paiute-speaking Bannock, the Grouse Creek Shoshoni, and the Pahvant Ute pounded leporid vertebrae into "bone meal" to be eaten.

Ribs were probably pounded along with the vertebral column. For example, the majority of ribs at 26Ny3393 were small fragments of bone that measured less than 3 cm in length. Complete ribs probably shattered into several identifiable segments during the pounding of the vertebral column, and this behavior would account for their relatively high NISP counts at this site.

In contrast to the removal of many vertebrae and sacra from a bone assemblage, prehistoric bone processing behavior in the Great Basin sometimes created large numbers of adult *Sylvilagus* tibia diaphysis cylinders (STDC's). There were forty-two STDC's recovered from 26Ny3393. These bones constituted 2.3 percent of all the identifiable leporid bones recovered from the site. The ends of the *Sylvilagus* tibiae may have been pulverized with milling stones mainly to extract the nutrients from the cancellous epiphyses, rather than to extract the marrow contained within the medullary cavity itself. Whatever the reasons behind the creation of STDC's, prehistoric people in the Great Basin sometimes created large numbers of STDC's and *Lepus* tibia diaphysis cylinders (LTDC's). For example, LTDC's were common at the Vista site, Nevada (Schmitt, 1986), James Creek Shelter, Nevada (Schmitt, 1990b), site 35Lk2579, Oregon (Hockett, 1990; 1993),

and at Hogup Cave, Utah (Hockett, 1993) (see Figure 1 for the location of these sites).

The grinding of long bone epiphyses has also been documented ethnographically. Steward (1941, 1945) stated that several historic Native American groups that occupied either the Great Basin or the southern Columbia Plateau region ground both vertebrae and "joints" into "bone meal."

Based on actualistic studies, raptors sometimes create STDC's and LTDC's (Hockett, 1991, 1993). LTDC's created by raptors are discussed in more detail below. Hockett (1991, Figure 1) diagrammed three STDC's that were recovered from raptor pellets in the Smoke Creek Desert of northwestern Nevada (Two Ledges in Figure 1). The STDC's from the raptor pellets, however, were much smaller in diameter and much less robust than the STDC's recovered from site 26Ny3393. The STDC's from the raptor pellets were most likely from subadult animals (or less than 1 year in age), while those from 26Ny3393 were most likely from adult animals. The deposition of large numbers of adult STDC's, therefore, may be more common in archaeological sites than in raptor pellet assemblages.

LEPORID BONES DAMAGED BY RAPTORS IN THE GREAT BASIN

Raptors systematically dismember leporid carcasses (Hockett, 1989); leporids are simply too large for raptors to swallow whole (Hockett, 1991). During consumption of the carcass, raptors sometimes swallow bones. Limb bones are rarely swallowed unbroken. These bones are later deposited (regurgitated) on the landscape in pellets unless first destroyed by the gastric fluids during digestion. Bones that are not swallowed are discarded at kill, feeding, or nest sites.

Do leporid bone assemblages created largely or solely by the deposition of raptor pellets differ from those created by the deposition of unswallowed bones at nesting or roosting sites? This section compares the taphonomic traces of raptor pellet versus raptor nest bones by examining four leporid bone assemblages created by raptors. Two of these sites are raptor pellet assemblages. They are designated as "Two Ledges Chamber" and "Dondero Shelter" in Figure 1. The other two sites are raptor nest assemblages, and they are designated as "Matrac Roost" and "Waterfall Roost" in Figure 1.

Raptor Pellet Assemblages

For this analysis, leporid bones were extracted from eighty modern Great-Horned Owl (*Bubo virginianus*) pellets collected from the surface of a rockshelter, and a chamber located directly beneath an active raptor roost was partially excavated. The Great-Horned Owl pellets were collected from Dondero Shelter (Figure 1). This site is located south of Wendover, Utah.

Two Ledges Chamber is located in the Smoke Creek Desert, northwestern Nevada (Figure 1). The chamber lies approximately 2.5 m below Two Ledges, the name given to the two tufa blocks that form the ceiling of the chamber. Two Ledges was the subject of a previous analysis of a leporid bone assemblage derived from raptor pellets (Hockett, 1991). The surface of the chamber was littered with dozens of leporid bones and intact raptor pellets. The majority of the pellets had bounced or rolled into one of several crevices that form passage-ways between Two Ledges above and Two Ledges Chamber below. Barn owls (*Tyto alba*) currently roost on a rock ledge located approximately 3 m above the chamber. Excavations were conducted in the chamber in 1990 and 1991. Five 1 m by 1 m units were opened during the two field seasons. Bedrock was reached approximately 1.3 m below present ground surface in two of the units. All sediment was screened through 1/8 inch mesh screen.

Table 1 reports that 906 identifiable leporid bones were identified in the eighty pellets collected from Dondero Shelter. There were approximately equal numbers of cottontail and hare bones in the Dondero Shelter pellets.

Table 1 reports that 2,870 identifiable leporid bones were recovered from Two Ledges Chamber. Approximately 75 percent of these bones were from cottontails, and approximately 25 percent were from hares.

The pellet assemblages from Dondero Shelter and Two Ledges Chamber shared nearly identical taphonomic patterning with the pellet assemblage described in Hockett (1991), with one exception. More adult specimens were found in the Great-Horned Owl pellets from Dondero Shelter than were found in the barn owl pellets from Two Ledges and Two Ledges Chamber (Figure 2; Hockett, 1991). Great-Horned Owls are large, powerful birds. These owls can probably kill adult leporids more consistently than barn owls (Andrews, 1990; Voous, 1988), and this is probably the reason why more adult leporid bone specimens were found in the Dondero Shelter pellets than in the Two Ledges Chamber and Two Ledges bone assemblages.

Dondero Shelter, Two Ledges Chamber, and Two Ledges (Hockett, 1991) shared the following taphonomic traces: 1) more forelimb bones than hindlimb bones were present (Figure 3); 2) vertebrae were relatively abundant (Table 1); 3) punctured bones were present (Table 2); 4) one of the most frequently punctured bones was the innominate (Table 2); and 5) the majority of punctured innominates displayed a single puncture mark directly behind the acetabular fossa (Table 2).

Raptor Nest Assemblages

"Matrac Roost" is located in Dry Valley, northwestern Nevada (Figure 1). "Waterfall Roost" is located on a rock ledge that overlooks northern Warner Valley, Oregon (Figure 1). The Dry Valley nest contained three golden eagle (*Aquila chrysaetos*) feathers, hundreds of leporid bones, and two golden eagle

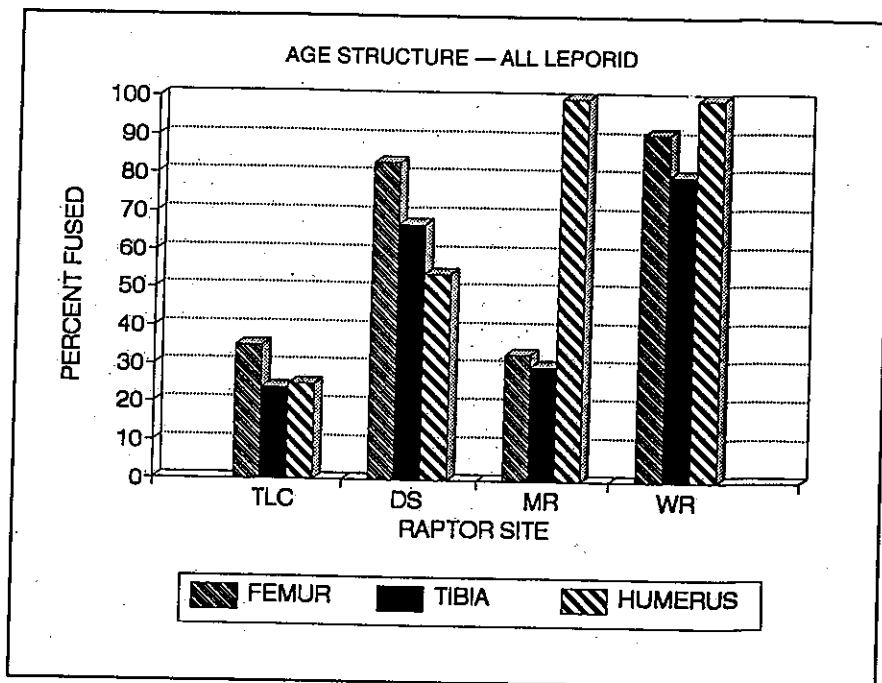


Figure 2. Percent of distal femora and proximal tibiae and humeri fused at two raptor pellet assemblages (Two Ledges Chamber [TLC] and Dondero Shelter [DS]), and two raptor nests (Matrac Roost [MR] and Waterfall Roost [WR]).

chicks. Beside the chicks were three skinned and decapitated leporid carcasses. The Warner Valley nest was occupied by Prairie falcons (*Falco mexicanus*) during my visits to the nest, but other raptors such as Great-Horned owls may also use this nest.

Table 1 reports that 930 and 597 leporid bones were identified from Matrac Roost and Waterfall Roost, respectively. The combined samples total 1,527 leporid bones.

Large numbers of articulated hind limb segments were recovered from both nests. For this reason, tibiae generally outnumbered forelimb bones in the nest sites, while in the pellet assemblages forelimb bones outnumbered tibiae (see Figure 3).

Tibiae were specified instead of the femur-tibia hindlimb segment because femora were uncommon in both the raptor nest and raptor pellet assemblages (Figure 3). Hockett (1991) stated that leporid hindlimb bones are probably relatively uncommon in raptor pellets because the tibia and femur are large bones that

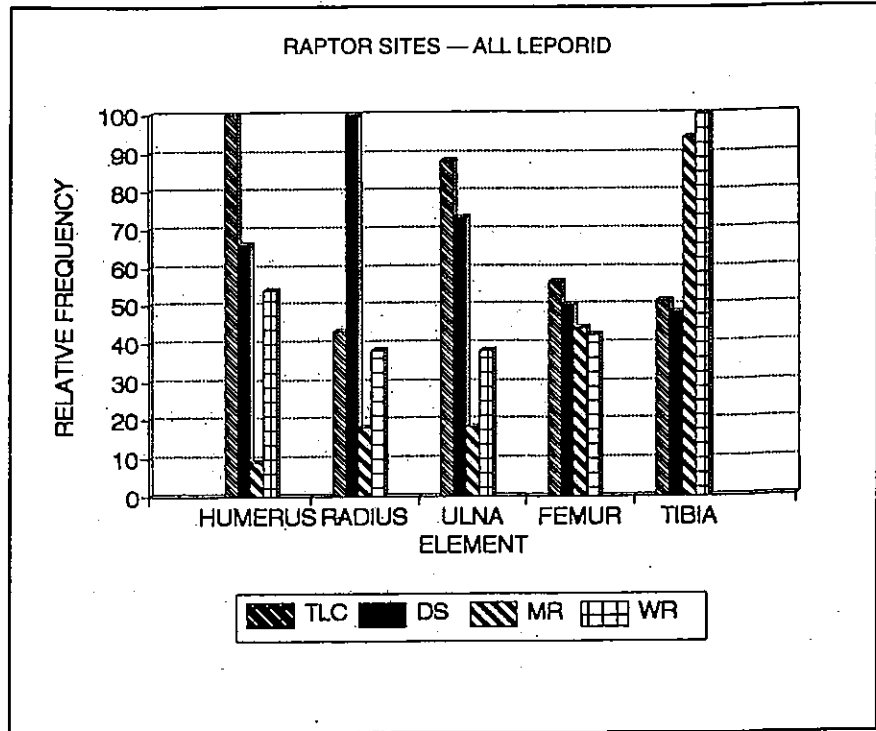


Figure 3. Relative frequencies of the forelimb and hindlimb bones from two raptor pellet assemblages (Two Ledges Chamber [TLC] and Dondero Shelter [DS]), and two raptor nests (Matrac Roost [MR] and Waterfall Roost [WR]).

Table 2. Punctured Bones from Three Raptor Pellet Assemblages

Pellet Assemblage	N	Number Punctured	Percent Punctured	Number Innominates Punctured	Number Innominates Punctured Behind Acetabular Fossa
Two Ledges	2201	11	.05	5	4
Dondero S.	906	8	1.0	3	2
Two Ledges C.	2870	39	1.4	9	7

most raptors would find more difficult to break and swallow than the smaller forelimb bones. At the raptor nests, however, the femora and especially the pelvic girdle were disarticulated from the rest of the hindlimb unit, and subsequently deposited away from the nest. This patterning may be caused by the raptors "housecleaning" their nests to help prevent injurious insects from invading the nest and attacking the chicks.

In addition to exhibiting higher frequencies of tibiae, overall the raptor nests exhibited more adult specimens (Figure 2), more complete or nearly complete bones, and fewer mandibles than the raptor pellets. Observations of raptors decapitating leporid carcasses (Mayhew, 1977; Brain, 1981) helps explain why few mandibles were present in the nests.

Based on the size of the bones, two adult LTDC's (Figure 4b, c) and six subadult LTDC's were recovered from Waterfall Roost. (One adult LTDC was

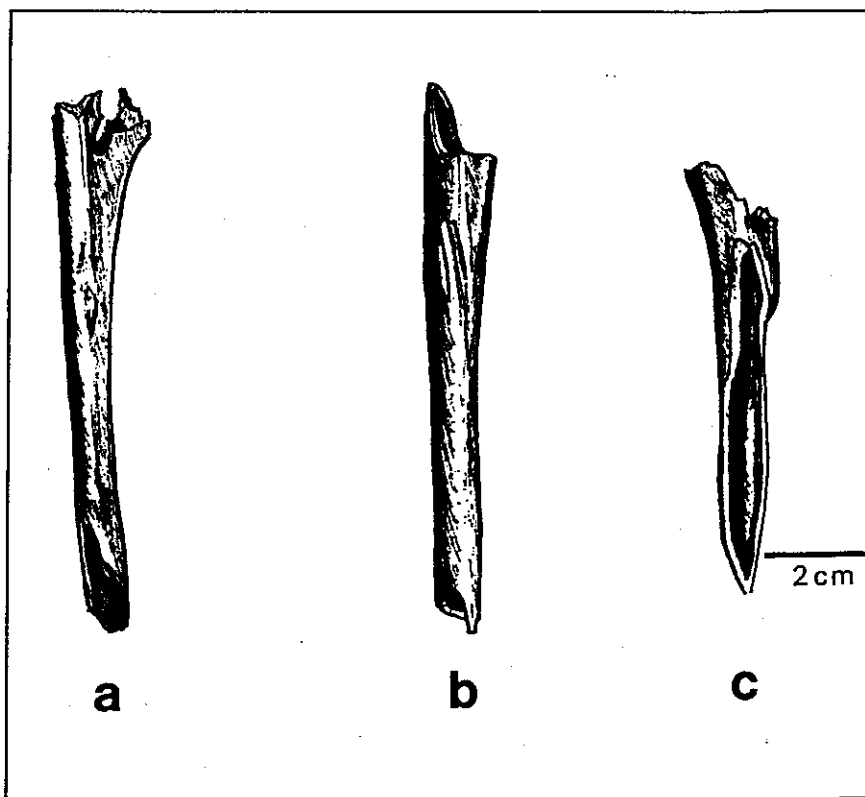


Figure 4. *Lepus* tibia diaphysis cylinders from a) Two Ledges Chamber, and b, c) Waterfall Roost.

also recovered from Two Ledges Chamber [Figure 4a]). This means that although adult LTDC's have been found in strong cultural contexts such as within prehistoric hearths, house structures, and trash dumps in the Great Basin (Hockett, 1991; Schmitt, 1986), they are not diagnostic of human behavior.

Although raptors and humans both create adult LTDC's, humans appear to create them far more frequently than do raptors. The two adult LTDC's from Waterfall Roost and the single adult LTDC recovered from Two Ledges Chamber morphologically resemble those recovered in strong cultural contexts (Figure 5; also see Hockett, 1991:669, Figure 1). Only three of the 7,504 (.0004, or .04%) identifiable leporid bones collected from five raptor localities (Two Ledges, Two Ledges Chamber, Dondero Shelter, Matrac Roost, and Waterfall Roost), however, were LTDC's.

In contrast, the adult LTDC's shown in Figure 5 were recovered from the remains of a single burned pole and thatch structure at site 35Lk2579, Warner Valley, Oregon (Figure 1) (see Fowler, 1993 for details of the site). A total of nine adult LTDC's were recovered from this structure alone.

SUMMARY

Table 3 summarizes six attributes of the leporid bone assemblages derived from raptor pellets, raptor nests, and archaeological sites in the Great Basin. These data indicate that archaeologists should be able to identify leporid bone assemblages that were created largely or solely by the deposition of raptor pellets, by the deposition of unswallowed bones under raptor nests, or by the deposition of bones by humans. Assemblages created by a combination of regurgitated bones and unswallowed bones below raptor nests, or by a combination of raptor and human activity, however, will be more difficult to interpret. For example, several taphonomic traces of raptor pellet and raptor nest assemblages appear to be mirror images of each other. Raptor pellet assemblages tend to exhibit more forelimb than hindlimb bones, few complete bones, more subadult than adult bones, and abundant vertebrae. In contrast, raptor nest assemblages tend to exhibit more tibiae than forelimb bones, few incomplete bones, more adult than subadult bones, and fewer vertebrae.

The taphonomic differences that are evident between the individual raptor pellet and nest bone assemblages would not be evident in a leporid bone assemblage created by raptors bringing prey remains to a nesting site and also regurgitating large numbers of pellets in the same locale. That is, a hypothetical combined assemblage would not show these clear differences to the same extent.

CONCLUSION

Distinguishing leporid bones that were deposited in archaeological sites by humans from those deposited by raptors is important for a number of reasons. In

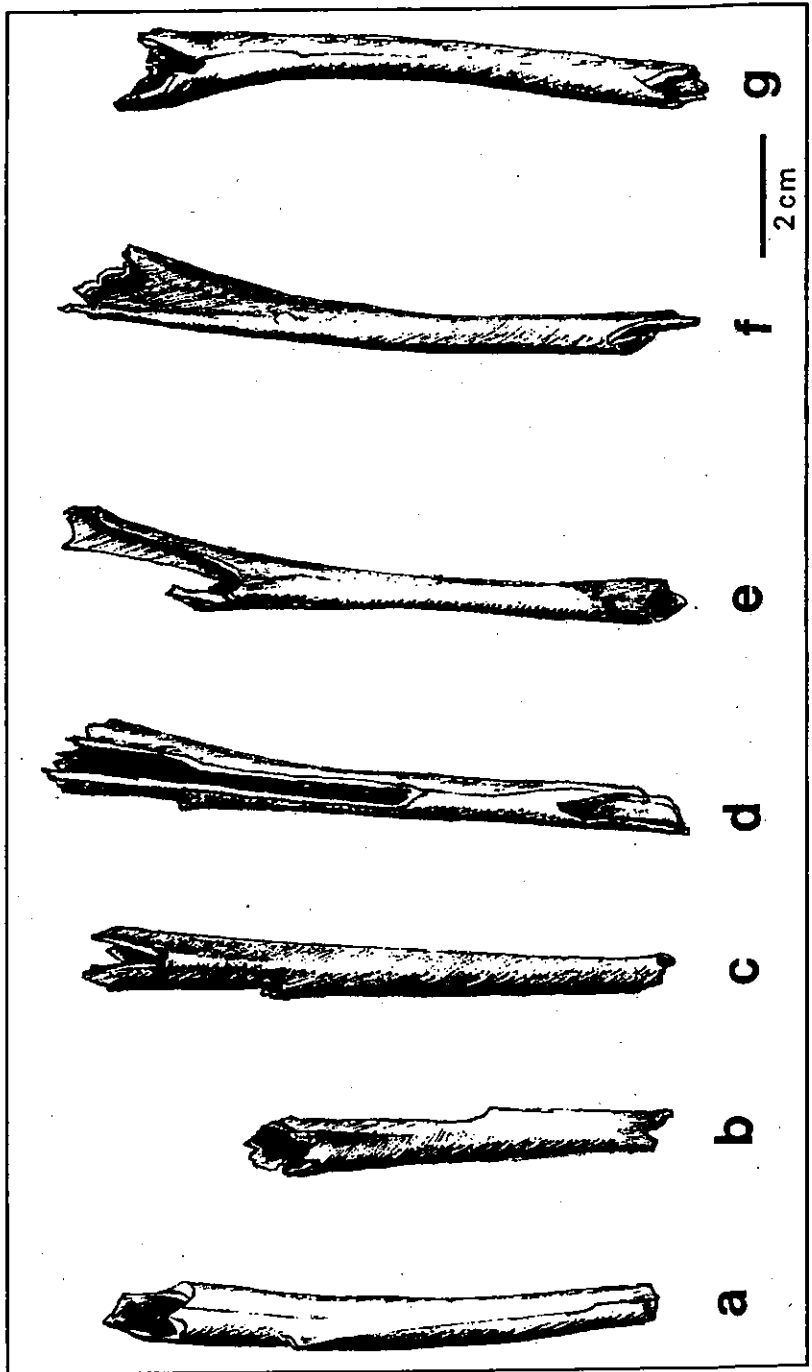


Figure 5. *Lepus* tibia diaphysis cylinders from archaeological site 35LK2579, Oregon.

Table 3. Comparison of Six Attributes of Leporid Bones Derived from Raptor Pellets, Raptor Nests, and Archaeological Sites in the Great Basin^a

Attribute	Raptor Pellets	Raptor Nests	Archaeological Sites
Age structure	More juvenile	More adult	More adult
Forelimb bones/ tibia	Forelimb more common	Tibia more common	About equal numbers
Vertebrae	Common	Uncommon	Uncommon
Punctured bones	1%-2%	1%-2%	Absent
Adult LTDC's	Very rare	Rare	Common
Adult STDC's	Very rare	Absent	Common

^aAttribute abundances are ordinaly ranked by comparing each set of assemblage against each other.

regions such as the Great Basin, leporids were present in sufficiently large numbers that they may have formed a significant component of the aboriginal diet. Similarly, however, leporids are the preferred prey of a number of raptor species. Because both humans and raptors occupied and accumulated bones in similar sites in the past, many sites that are archaeological, and in particular many caves and rockshelters, probably contain bones that were deposited by both humans and raptors. I have argued elsewhere (Hockett, 1990; 1993) that raptors (and probably woodrats [*Neotoma* sp.] as well), and not mammalian carnivores, may have deposited many of the larger, nonculturally accumulated leporid bones in western North American caves and rockshelters.

This article has compared leporid bone assemblages created by several species of raptor to those created by prehistoric cultures that occupied the Great Basin of North America. It would be beneficial to compare leporid bone assemblages created in the Great Basin to those created in different regions of the United States. It would also be beneficial to compare leporid bone assemblages created by prehistoric cultures of the Great Basin to assemblages of similar-sized animals created by prehistoric cultures in other parts of the world. For example, as noted above prehistoric cultures in the Great Basin often pounded leporid vertebrae with milling stones. Although the !Kung San of Africa also live in a desert environment, Yellen (1991) reported that they generally ignore the vertebrae of leporids and other similar-sized animals. Why? Further comparisons may illuminate differences in the way leporid carcasses were processed between unrelated cultures, and perhaps illuminate similarities in the treatment of medium-sized animal carcasses between unrelated cultures that occupied very different ecological landscapes.

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