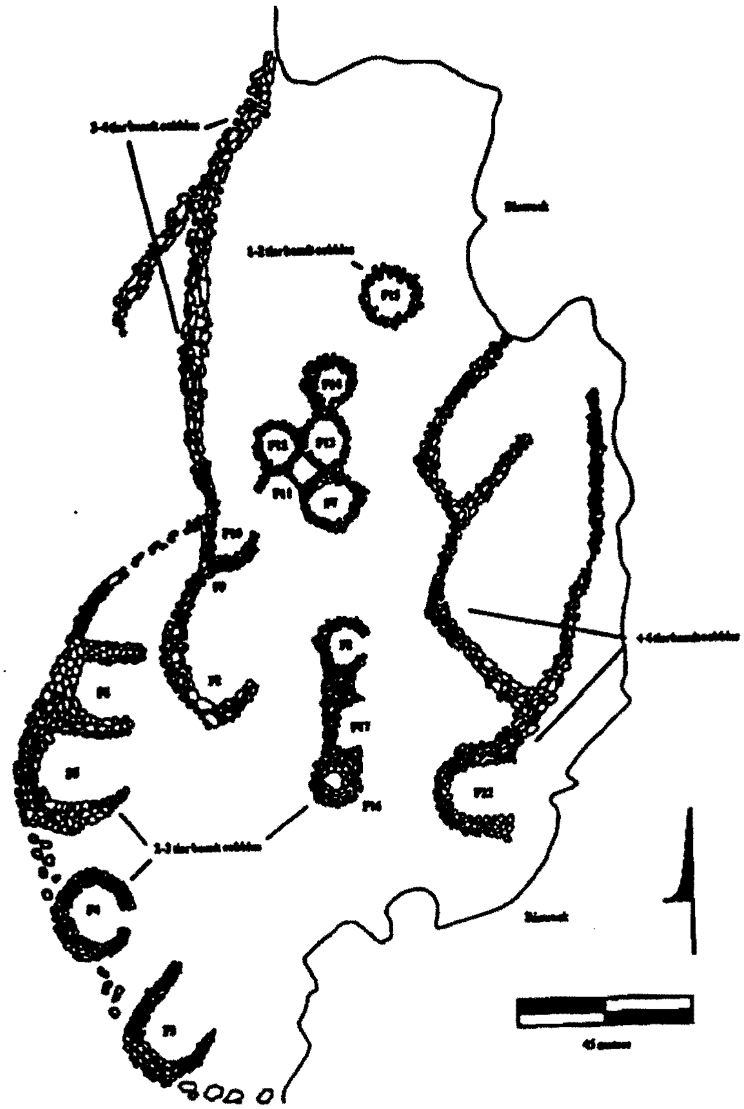
ARCHAEOLOGICAL INVESTIGATIONS IN WARNER VALLEY, OREGON, 1989-1992

AN INTERIM REPORT

Edited by Don D. Fowler



35Lk690 Lynch's Rim Site

University of Nevada, Reno
Department of Anthropology
Technical Anthropology Reports 93-1

Archaeological Investigations in Warner Valley, Oregon, 1989-1992
An Interim Report

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Appendix A

Bone Accumulations in Open-Air Sites: A Case Study from the Northern Great Basin

Bryan S. Hockett

A TAPHONOMIC RESEARCH PROJECT was conducted during the 1989-91 field seasons in Warner Valley, Oregon as part of the University of Nevada, Reno archaeological field school. Field school activities included extensive surveys and test excavations at several sites.

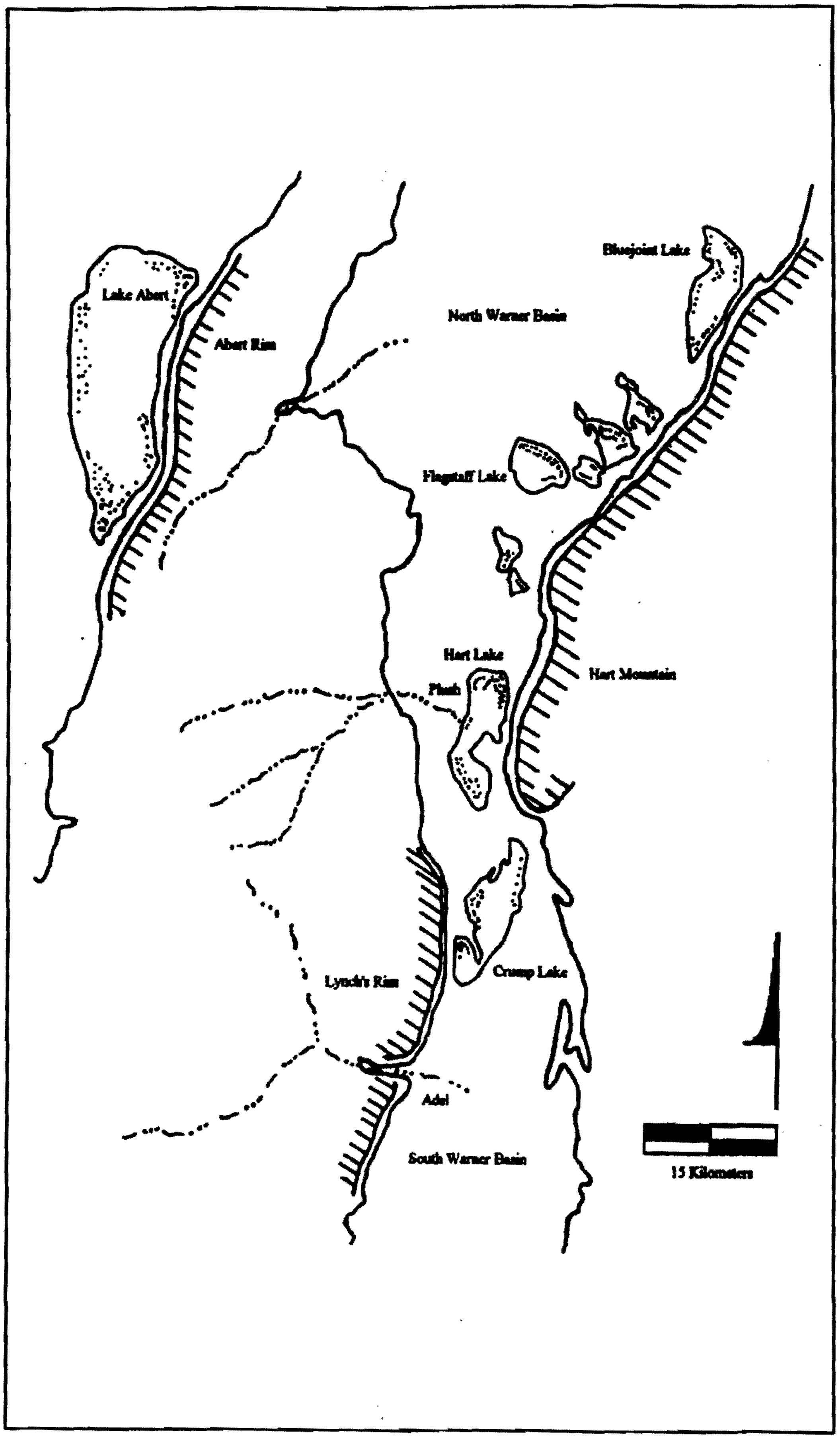
Test excavations at the Flagstaff Lake Dune (35Lk2204) site recovered 256 faunal specimens, including a pronghorn mandible associated with a piece of woven textile. The Campbell Lake Dune (35Lk558) site excavations recovered six *Lepus* sp. bones associated with two hearths (Fowler, Hattori, and Creger 1989). Associations between artifacts and "unworked" faunal remains do not necessarily imply that humans deposited the bones with the artifacts (Binford 1981; Brain 1969, 1981). Previous studies of site formation processes clearly show that many noncultural processes may alter the original composition of archeological sites. In the process, items such as bones and lithic artifacts may be redeposited together, even though they were originally deposited in different areas by different agents (Schiffer 1972, 1983, 1987). For example, several upper Warner Valley sites are located on dunes, where deflation and other wind-related processes may mix artifacts and nonculturally accumulated organic remains together, despite the fact that they were originally deposited chronologically and spatially separate from one another (Boggs 1987; Erlandson and Rockwell 1987; Shelley and Nials 1983; Wandsnider 1988). As discussed below, the Warner Valley beaches have been subjected to deflation and the re-working of sedimentary deposits as well.

With these cautions about post-depositional mixing in mind, the author conducted walkover surveys of land surfaces in upper Warner Valley in 1989, 1990, and 1991, in order to estimate the numbers of noncultural bones currently accumulating at or near the known archeological sites. Bone surveys were conducted around Flagstaff, Campbell, Swamp, and Mugwump Lakes (Figure a.1). The survey area may be further divided into two general microenvironments: 1) the beach environment immediately surrounding the upper Warner Valley lakes, and 2) the dune environment located between, and buttressed against, the lake-beach environment. The taphonomic study discussed below focuses on details of bones collected during these surveys.

Methods

Warner Valley is a north-south trending valley that contains a series of interconnecting lakes, marshlands, and dunes. In northern Warner Valley, Hart Mountain is located along the valley's eastern flank, while the Coyote Hills run along its western flank. The lakes and sloughs of Warner Valley form over 480 kilometers of freshwater shoreline (Weide 1975). Dunes are numerous in northern Warner Valley, and the prevailing southerly winds accumulate wind-borne sediments in great quantities along the northern edges of lakes. The majority of the dunes in Warner Valley are stable; stability of the dunes is maintained largely by seasonal rains which saturate and adhere the silt-clay particles to one another,

FIGURE A.1
North Warner lakes.



and by roots from abundant vegetation which grows on the dunes (Weide 1975).

Extant fauna in Warner Valley is numerous and diverse, and includes many species of waterfowl (pelicans, herons, ducks, geese, coots, ibis), raptors (eagles, hawks, owls, falcons), four endemic species of fish, freshwater clams, and abundant reptiles, including the Great Basin rattlesnake (*Crotalus viridis*). Mammals observed on the valley floor in 1989, 1990, and 1991 include blacktail jackrabbit (*Lepus californicus*), cottontail (*Sylvilagus nuttalli*, and possibly *Sylvilaqus idahoensis*, mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), and numerous rodents such as kangaroo rats (*Dipodomys* sp.) and ground squirrels (*Spermophilus* sp.). Mountain sheep (*Ovis canadensis*), bobcat (*Lynx rufus*), and cougar (*Felis concolor*) occur on Hart Mountain adjacent to Warner Valley, but at present are seldom observed on the valley floor. (Pronghorn are also confined mainly to Hart Mountain, but are occasionally spotted on the valley floor.)

In 1989, the University of Nevada, Reno, field school conducted archeological surveys along the northern and eastern beaches of Flagstaff Lake, and on the dunes adjacent to and between the upper Warner Valley lakes. During these surveys, I participated as a member of the survey teams. I helped locate concentrations of lithic artifacts while the field school students helped locate bones for my taphonomic study. As a result, large areas of the beach and dune environments in upper Warner Valley were systematically surveyed for bones. Approximately 25 percent of the beaches and 10 percent of the dunes were surveyed for bones.

As noted earlier, the bones discovered during the surveys were divided into two categories: those found on the beach, and those found on the dunes. Beach and dune bones were collected and bagged separately because the beach and dune environments displayed a number of important differences (sedimentary particle size and content, the degree to which water affects surface objects, amount and type of vegetation etc.). It was therefore anticipated that bones deposited on the two environments would be subjected to different geomorphological processes that might affect bone preservation, and therefore their likelihood of being buried and preserved in archeological sites.

Dunes located along the eastern flanks of Swamp, Flagstaff, and Campbell Lakes received attention in 1989 because these were areas surveyed by the field school. In addition, I also conducted one-person surveys (zig-zagging across the landscape) along the southern and western flanks of Flagstaff Lake. Because the large dunes in Warner Valley are relatively stable, no major geomorphological changes were noticed in this environment between 1989 and 1991. In contrast, the morphological character of the eastern and northern *beaches* of Flagstaff Lake changed drastically between 1989 and 1990. These changes had dramatic effects on the numbers of bones recovered during my surveys. In 1989, the Flagstaff Lake shoreline was approximately 30 meters from the large dune fronts. The 1989 surveys along the northern and eastern beaches of Flagstaff Lake resulted in the collection of over 200 mammal bones from the beach. I also surveyed the southern and western beaches of Flagstaff Lake, as well as the beaches of Swamp and Campbell Lakes, but few bones were found in these areas.

In 1990, I returned alone to Flagstaff Lake to conduct a second survey along Flagstaff's eastern and northern beaches, since this area produced the vast majority of beach bones recovered during the previous survey. When I arrived in early June of 1990, dramatic geomorphological changes had already taken place. Flagstaff Lake was completely dry. (The lakes fill with water from south to north; during dry years, the southern lakes will retain water, while the northern lakes will progressively dry up from north to south.) Previous photographs of Flagstaff Lake taken in 1987 and 1988 show that the lake had been progressively drying since at least 1987. Although precise measurements were not taken, the Flagstaff Lake shoreline receded approximately 20-30 meters laterally between 1987 and 1989. The lake then dried between 1989 and 1990. It must also be pointed out, however, that Flagstaff's water level has previously been higher than its position in 1987. In 1987 the shoreline was just in front of the large, stable dune fronts. If the water level had been any higher, and remained at this high-stand position for any length of time, then waves cutting into the dunes would cause slumping and reworking of dune deposits along Flagstaff's shoreline. Given this situation, Flagstaff's waters would deposit bones and lithic artifacts from the dunes onto the beaches, mixing together items that were originally deposited separately on the beaches and dunes, respectively (Fowler, Hattori, and Creger 1989).

As noted earlier, the 1989 beach surveys found approximately 200 mammal bones. By June of 1990, when Flagstaff Lake was completely dry, the prevailing southerly winds had already formed new dune fronts at the bases of the larger, stable dunes along Flagstaff's eastern and northern shores. In front of the new dunes was a 20 meter-wide deflated corridor; behind the new dunes (between the new dunes and the large stable dunes) were many 5 to 10 meter diameter blowout areas. These deflated areas exposed hundreds of (primarily) *leporid* bones that were buried under beach sand before 1990. In fact, in 1990, I found over two-and-one-half times the number of bones that were found on the same beaches in 1989.

In short, the dramatic fluctuations in lake levels have a significant impact on the geomorphological character of the upper Warner Valley beaches and dunes. These geomorphological changes will also affect the biological character of the beaches and dunes, and in turn affect the character of bone accumulations in these areas. For example, between 1987 and 1989 the receding waters of Flagstaff Lake opened areas between the shoreline and the dune fronts to plant colonization. Increased amounts of beach vegetation apparently also triggered increased herbivore traffic along Flagstaff beach. In 1989 and 1990, numerous jackrabbits and five pronghorn were found feeding on the succulents and grasses growing along the beach. Increased herbivore traffic would undoubtedly attract carnivores as well, so it is not surprising that several leporid limb segments with attached fur, and one freshly-killed leporid carcass were found lying on the eastern and northern beaches of Flagstaff Lake. Interestingly, leporid limbs and carcasses were not found on the southern and western beaches of Flagstaff Lake. Their presence on the northern and eastern beaches may be directly related to the combination of increased succulent vegetation growing on the beaches and the presence of highstanding dunes along this portion of Flagstaff Lake. Greater numbers of leporid kills on the northern and eastern beaches may simply be due to the presence of greater numbers of animals that were attracted to the beach vegetation for food, and to the large dune fronts for protection. On the other hand, since the large dune fronts were the only escape route for leporids when they forage on the beach, carnivores coming down off the dune fronts onto the beach may be able to more easily pin the animals between themselves and the shoreline, thereby increasing their chances of catching their prey.

Taphonomy and Discussion

The 1989 - 1991 Warner Valley bone surveys focused mainly on the collection of mammal bones. All mammal bones except cattle (*Bos*) were collected during the surveys. Accumulations of fish and bird bones were noted, but these bones were only occasionally collected. A summary of observations of the fish and bird bones encountered during the surveys will be given, and these data will be followed by a detailed taphonomic analysis of the mammal bones collected on the Warner Valley beaches and dunes.

Fish and Bird Bones

Fish bones were common on Flagstaff Lake's northern and eastern beaches, but few fish bones were present on the dunes. The most common fish elements were isolated fish heads or skulls, although postcranial elements and whole carcasses were ocasionally found. The lack of abundant postcranial fish bones may be due to their smaller size. Postcranial fish bones may be more easily buried under the beach sand, making them unnoticable during surveys. The fish carcasses probably washed onto the beaches after the animals died of natural causes. Several coyote scats that were collected on Flagstaff's beaches contained abundant fish bones, indicating that coyotes occasionally scavenged fish carcasses, or perhaps caught live fish that had become trapped as the water receded. Coyotes may therefore deposit fish bones on the dry portions of beaches or on the dunes by carrying fish carcasses, or by defecating fish bones away from the shoreline. Other processes that could have deposited fish bones on the Warner Valley dunes include high-water lake levels that penetrated the dune environment, and raptors and other birds that scavenged fish carcasses from the shoreline. Weigelt (1927:93) noted that raptors and scavenging birds such as gulls often carry fish carcasses some distance inland to feed on them. Bird carcasses encountered during the surveys were usually of recent origin and fairly complete specimens, though they were often scattered over several meters on the beaches (and occasionally on the dunes as well). Similar to the fish carcasses, most of the bird carcasses probably washed onto the beach after the animals died of natural causes. Weigelt (1927) discovered many recent bird carcasses washing ashore at Smither's Lake, Texas, and attributed the bird deaths to exhaustion, since many of the carcasses were from migratory waterfowl. Warner Valley is a major stopover for migratory birds as well, so many natural bird deaths can be expected in Warner Valley. The bird bones found on the Warner Valley dunes were probably deposited there by high-water lake levels, and by the scavenging activities of other birds and carnivores.

The largest bird bones encountered were white pelican (*Pelecanus* *erythrorhynchos*) humeri. Four pelican humeri were found on the Flagstaff and Swamp Lake beaches, and one was found on the dunes alongside Flagstaff's eastern flank. All of these bones displayed gnawing damage or multiple tooth punctures, which probably indicates that coyotes scavenged the bird carcasses. The proximal portion of one nearly complete pelican humerus (missing the distal one-third of the bone) had 19 punctures - seven punctures on the anterior surface, and 12 on the posterior surface of the bone.

In general, smaller bird bones from the beach showed fewer signs of weathering damage than larger bird bones, perhaps because they were more easily buried in the sand, and thus protected from solar radiation and other destructive agents. In addition, the most common and one of the best preserved bird elements was the humerus. The presence of abundant numbers of bird humeri may be partially due to the sequence of disarticulation in birds that die in open water. Weigelt (1927:46) notes that the lower legs of dead birds will constantly dangle underwater, so they are vulnerable to dismemberment by decay and by water insect activity before the carcasses reach the shore. Wing bones, and bones of the abdomen and head may differentially float ashore in greater numbers than leg bones.

Mammal Bones

Table a.1 shows the number of identified specimens of mammalian bones recovered from the Warner Valley beaches and dunes. A total of 1,151 mammalian bones were collected. Leporid bones dominate both samples, representing 90.5 percent and 91.0 percent of the total number collected from beaches dunes, respectively. Table a.2 shows the mammalian bone elements other than leporid collected from Warner Valley. Only three rodent bones were collected; all muskrat (*Ondatra zibethica*) tibiae. One muskrat tibia was found on the Campbell Lake beach, while the other two bones were collected on Flagstaff beach. All three bones were extremely polished and solid (lithified) specimens. Despite the paucity of beach and dune rodent bones collected, many rodent bones were undoubtedly present but missed during the surveys. For example, many

TABLE A.1 *Number of identified specimens of mammalian bones.*

ANIMAL	NISP	NISP	TOTALS
	Beach	Dune	
Leporid	810	232	1042
Ungulate	47	19	66
Carnivore	36	4	40
Rodent	3	0	3
TOTALS	896	255	1151

TABLE A.2 *Mammalian bone elements other than Leporid.*

Element	Carnivore		Ungulat		Rodent	
	Beach	Dune	Beach	Dune	Beach	Dune
Skull Fragment	3	0	2	0	0	0
Mandible	5	1	0	0	0	0
Vertebra	6	0	2	0	0	0
Ribs	1	0	0	0	0	0
Humerus	4	0	0	1	0	0
Radius	2	1	0	0	0	0
Ulna	1	1	0	0	0	0
Tibia	2	0	0	0	3	0
Calcaneus	1	0	0	0	0	0
Astragalus	1	1	0	0	0	0
Metapodial	5	0	4	1	0	0
Phalange	5	0	1	0	0	0
Unidentified Cylinder Fragments	0	0	38	17	0	0
Totals	36	4	47	19	3	0

recent rodent burrows were noticed on the new dunes that had formed on Flagstaff beach in 1990 and in 1991. In addition, one complete, dessicated rodent carcass was found on a deflated surface on Flagstaff beach. The rodent had apparently died at some earlier time in its burrow. Subsequent deflation of the sand and gravel surrounding the burrow exposed the carcass. Finally, several weathered coyote scats contained dozens of small, identifiable and unidentifiable rodent bones, but these scats were not collected. Natural deaths and carnivore defecation were probably the two most important processes that deposited noncultural rodent bones on the Warner Valley beaches and dunes.

Table a.2 shows that 36 of the 40 carnivore bones (90.0 percent) were recovered on the beaches. All carnivore bones were from coyotes. Two of the three skulls found on the Flagstaff beaches were from coyote pups. In each case, the skulls and several other bones lying nearby suggested that the pups had been killed. It appeared as if a large portion of these carcasses were consumed at the kill site, or perhaps carried to another location. The pups may have been killed by adult coyotes.

Table a.2 shows that ungulate bones were common on both the beaches and dunes. The majority of these bones were unidentifiable long bone cylinder fragments (83.3 percent of all beach and dune ungulate bones recovered). Most of these cylinder fragments are probably extensively fractured mule deer bones, although some of them may be fractured pronghorn bones. Although many of these bones probably were produced by noncultural activities such as carnivore gnawing, weathering, and trampling, some of the cylinder fragments could have been produced by prehistoric people breaking limb bones to extract marrow, or to manufacture bone grease (Vehik 1977). Only four long bone fragments were burned, however, and even those could have been burned by natural fire (Connor, Cannon, and Carlevato 1989). If the bone fragments were burned by natural fire, then they may have been redeposited on the beach after high-water lake stands scoured them from the dune fronts, since natural fires probably burned more bones on the dunes than on the damper beaches. If the four burned ungulate bones represent human food waste, then they could have been either redeposited on the beach from the dunes via natural erosional processes, or directly discarded on the beach by human activity.

A number of general taphonomic characteristics exemplified the ungulate bone assemblage. First, more beach bones appeared mineralized than others (rather than simply ithified). These bones have a dark brown color, and a more rock-like feel and appearance. Many other ungulate bones were simply bleached white by the sun. Combined with the large number of Miocene-aged ungulate fossils, the ungulate beach bones may represent a time-averaged assemblage of bones. Second, several ungulate beach bones were bluish in color. Guthrie (1990) notes that vivianite, an iron phosphate, causes bones to have a bluish tint, so vivianite may be present along the northern Warner Valley beaches. Third, few marks of any kind were present on the ungulate bones. One metapodial has carnivore puncture and pitting marks, and several bones display etching marks caused by plant acids. The presence of only a few carnivore chewing marks, however, does not discount mammalian predators as the main accumulator of these bones. Haynes (1980, 1983) has shown that ungulate long bone cylinder fragments can be created by carnivores with minimal puncture, scoring, and pitting marks left on the bones. Further, even if scoring and pitting marks were once visible on some of the ungulate long bone fragments, repeated wave action and sandblasting by high winds would polish the bones, and would probably obliterate any evidence of carnivore gnawing (or human-inflicted cut marks) on the bones. Indeed, the majority of the ungulate beach bones were extensively polished, probably by both wave action and by sand blasting. Finally, the ungulate dune bones displayed more advanced weathering damage than did the ungulate beach bones. The portions of bones that were buried in dune sand were more solid than the exposed portions of the same bone, however, and therefore some of the dune bones showed differential weathering stages on the same bone (see also Behrensmeyer 1978; Lyman and Fox 1989). In contrast, the ungulate beach bones were more uniform in appearance, displayed far fewer split-line weathering cracks, and were generally more polished and solid than were the ungulate dune bones. In sum, the extensively fragmented ungulate bones were probably created by carnivores that gnawed on them, by solar radiation (weathering) that broke bones into several smaller fragments, and perhaps by trampling from other ungulates. Several ungulate bones may represent human food waste, particularly the four burned bone fragments, although these bones could have been burned by natural fire. In addition, the ungulate bones lying on the Warner Valley beaches probably represent an extensively time-averaged assemblage of bones.

Table a.3 shows the number of identified leporid specimens recovered from the Warner Valley beaches and dunes. Based on NISP counts, Table a.3 shows that mandibles, maxillae, scapulae, humeri, innominates, femora, tibiae, and calcanei were the most common leporid bones recovered. The majority of leporid bones were found as isolated specimens, but two exceptions may be noted. First, ten different articulating bone units were found on the beaches. The articulating units of bones included segments that had been bleached white by the sun, but they retained enough ligament to hold the bones together. Also, less weathered segments were found with fur and hair attached to the bones. Specifically, the

TABLE A.3
Number of identified specimens of Leporid bones.

Element	Beach	Dune
Skull Fragments	12	8
Mandible	92	34
Maxilla	56	8
Vertebra	40	32
Sacrum	4	5
Ribs	5	0
Scapula	26	4
Humerus	66	14
Radius	24	9
Ulna	16	5
Innominate	61	28
Femur	58	20
Tibia	70	17
Calcaneus	33	7
Astragalus	6	5
Metapodial	79	18
Phalange	120	7
Unidentified Cylinder Fragments	42	11
Totals	810	232

articulating units of bones were as follows: three femur to proximal tibia units, two ulna/radius to phalanges units, two tibia to phalanges units, one femur to phalanges unit, one femur to metapodials unit, and one pelvic girdle with five lumbar vertebrae attached. The articulating limb units that contained metapodials and/or phalanges also contained all of the carpal or tarsal bones. The bones from these ten units totalled 108 of the 1042 leporid bones recovered, or about 10% of the sample. Second, on several occasions a number of leporid bones were found lying next to one another in a very restricted area. In some cases, it was apparent that the bones all belonged to a single individual animal, and had originally been deposited as an articulated segment of the carcass. For example, on Flagstaff beach, one tibia, one calcaneus, four metapodials, and two phalanges were all found within 25 centimeters of each other. Further, the bones were all neatly arranged in a pattern which suggested that an articulated segment of tibia to phalanges had initially been deposited on the beach. The ligaments eventually decayed away, and deflation subsequently exposed the bones on the surface. The bones had separated from each other after the ligaments disappeared, but noncultural processes such as wave action (after a return to high lake levels) had not yet occurred to widely separate the bones from one another.

Differences in the numbers of individual bones recovered probably reflect the end-effects of many interrelated agents and processes. These agents and processes include 1) natural deaths, 2) food waste left by avian and mammalian predators, 3) burial of some bones but not others because of the place of deposition of bones on the landscape, 4) smaller bones being more easily missed during the surveys than larger bones, and 5) the randomness factor of actualistic studies such as this (where and when the taphonomic surveys happened to take place).

There was little indication that humans had deposited the leporid bones recovered during the surveys. None of the leporid bones were burned, and none had cut marks. Nevertheless, two of the eight tibial diaphysis cylinders recovered (Table a.4) cannot be discounted as human food waste (see Hockett [1991] for further details). Two of the eight tibial diaphysis cylinders were Lepus, and one of these bones closely resembled leporid diaphysis cylinders from clearly cultural contexts (Hockett 1991). This bone was 9.0 centimeters in length, only slightly

TABLE A.4 *Leporid long bone portions.*

Element										
Portion	Femur		Tibia		Humerus		Radius		Ulna	
	Beach	Dune	Beach	Dune	Beach	Dune	Beach	Dune	Beach	Dune
Complete	19	5	19	1	21	3	8	5	6	2
Proximal	15	7	14	3	9	4	4	3	10	3
Distal	21	7	30	12	38	6	11	1	0	0
Diaphysis	3	1	7	1	0	1	1	0	0	0

shorter than the 9.5 centimeters to 10.5 centimeters length of Lepus tibial diaphysis cylinders from the Vista site near Reno, Nevada, and from Warner Valley, Oregon (Hockett 1990, 1991). The other Lepus tibial diaphysis cylinder from Flagstaff beach was only 4.3 centimeters in length. It is possible, however, that this bone was originally 9 to 11 centimeters in length, and suffered increased breakage over the years while lying exposed on the beach. The other six tibial diaphysis cylinders were *Sylvilagus*, and one of these bones still had fecal material from coyote scat attached to the bone. None of these bones resembled leporid diaphysis cylinders that have been recovered from cultural contexts. In short, the two Lepus tibial diaphysis cylinders from Flagstaff beach could have been produced by humans breaking the bones open to extract the marrow, or by noncultural processes such as wave action and trampling. Even if both bones did represent prehistoric human food waste, this means that 1,040 of 1,042 of the identifiable beach and dune leporid bones (99.81 percent) cannot be positively attributed to cultural activity. The majority of leporid bones probably accumulated by noncultural processes because many more bones can be positively attributed to noncultural agents than to cultural activity (though it is probably wiser to err on the side of caution in this matter).

For example, evidence that raptors, carnivores, and natural deaths damaged and/or deposited leporid bones on the northern Warner Valley beaches and dunes include: 1) personal observation of turkey vultures (*Cathartes aura*) feeding on fresh hare carcasses on the northern Warner Valley dunes; 2) the discovery of a fresh hare kill site on Flagstaff beach. The carcass consisted of the discarded intestines, the front limbs which had been stripped of skin and fur, thirteen vertebrae, and four ribs. This pattern is similar to raptor-damaged leporid carcasses identified from Borderfield State Park, southern California (Hockett 1989); 3) the discovery of ten articulating bone units mentioned earlier. These could have been the remains of either raptor or carnivore kills; 4) the discovery of a complete, undamaged hare carcass on Flagstaff beach. The animal probably died of natural causes; 5) the presence of raptor or carnivore punctures on three mandibles, two femora, one tibia, one innominate, and one ulna; and 6) the sighting of golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo amaicensis*), northern harriers (*Circus cyaneus*), great-horned owls (*Bubo virginianus*), and turkey vultures, all of which are known to kill or scavenge leporids (Andrews 1990; Herron *et al* 1985).

In addition to the six observations mentioned above, there were indications that many of the smaller identifiable leporid bones were originally deposited on the beaches and dunes in coyote scats. Table a.5 shows the number of identifiable leporid bones extracted from 50 modern coyote scats. Forty-three of the coyote scats were collected on the northern Warner Valley beaches and dunes, and nine scats were collected in San Diego County, California. In this sample, nearly 160 identifiable leporid bones were deposited in open-air sites in only 50 coyote scats. The Warner Valley beaches and dunes are currently littered with hundreds (indeed thousands) of coyote scats. As these scats disintegrate, thousands of leporid bones will be deposited on the Warner Valley beaches and dunes. Schmitt (1988) has

TABLE A.5 *Identifiable Leporid bones from 50 coyote scats from Warner Valley, Oregon, and San Diego County, California.*

Element	Number of Bones/Teeth
Premaxilla	5
Mandible	12
Maxilla	7
Isolated Teeth	24
Vertebra	21
Sacrum	1
Ribs	14
Scapula	7
Humerus	10
Radius	0
Ulna	3
Innominate	3
Femur	4
Tibia	5
Calcaneus	3
Astragalus	3
Carpal/Tarsal	1
Metapodial	13
Phalange	23
Totals	159

recently outlined the characteristic features on bones that have passed through a coyotes' digestive tract. These features include corrosion of the bone surface, polishing of surfaces, and brown staining on the outside of bones. Twenty-five humeri, twenty-two mandibles, six calcanei, five tibiae, four scapulae, four ulnae, four femora, and one innominate collected during the bone surveys show characteristic scat features such as corrosion and staining. In addition to these identifiable bones, many of the unidentifiable cylinder fragments probably came from coyote scats as well. Coyote scats may contain up to several dozen unidentifiable leporid bone fragments. Finally, some of the bones that resembled scat bones may have been broken by trampling rather than by carnivore mastication. For example, 24 of the 25 humeri mentioned above were nothing more than the extreme distal ends of the bones. Although these bones are common in coyote scats, some of these bones may have been broken by ungulates or other leporids that stepped on them. Dry bones are generally more brittle than fresh bones, so the trampling of dry leporid bones may create small bone fragments that resemble some of the bones found in coyote scats.

Approximately 25 percent of the leporid beach bones were etched by plant acids. In contrast, none of the leporid dune bones were etched in the same manner. This difference is probably due to the sizable accumulations of vegetative matting that washes ashore on the northern Warner Valley beaches. This matting may become draped over bones, and subsequently may etch them. As mentioned earlier, the Warner Valley dunes contained abundant vegetation, but apparently few surface dune bones become etched until, perhaps, they become buried by the sand, and roots subsequently grow over them.

The leporid beach bones were more polished and solid overall than the leporid dune bones (similar to the differences between the ungulate beach and dune bones as discussed earlier). The leporid dune bones were less polished, more brittle, and displayed more advanced weathering cracks than the leporid beach bones. It may be pointed out, however, that bones that accumulated on unstable, frequently-shifting dunes would probably be more polished by sand grains than bones lying on the stable dunes of northern Warner Valley.

Table a.6 shows that a total of 37 proximal humeri, 37 proximal tibiae, and 52 distal femora of leporids were recovered from the beaches and dunes. The percentage of unfused distal femora, and unfused proximal humeri and tibiae will estimate the percentage of subadult leporids in the sample, or those that died before they reached one year in age (Driver 1985; Hale 1949; Sowls 1957). In the northern Warner Valley sample of leporid bones, 18 of 37 proximal humeri (49 percent), 16 of 37 proximal tibiae (43 percent), and 25 of 52 distal femora (48 percent) had unfused epiphyses. There were therefore about equal numbers of adult and subadult leporid bone specimens collected during the bone surveys. Hockett 1991 argues that prehistoric cultural activity such as "rabbit drives" probably netted large percentages of adult leporids. If true, then the age structure of the bones collected here may be representative of a largely nonculturally

TABLE A.6 *Age structure of the Leporid bones from Warner Valley, Oregon.*

	Femur		Tibia		Humerus	
Proximal	Beach	Dune	Beach	Dune	Beach	Dune
No. of missing epiphyses	20	4	15	1	14	4
No. of fused epiphyses	14	8	18	3	16	3
Distal						
No. of missing epiphyses	22	3	14	3	5	0
No. of fused epiphysis	18	9	35	10	52	9

accumulated assemblage of leporid bones. Finally, the leporid beach bones were generally found in isolation, although in some cases articulating units of bones were also present on the beaches. The majority of the leporid dune bones were also found as isolated elements. Nevertheless, 102 of the 232 total leporid dune bones were found scattered around a single woodrat (*Neotoma lepida*) house. The woodrat house was built around a single sagebrush (*Artemisia* sp.) plant. This circular feature measured approximately one meter in diameter. The leporid bones were incorporated into the house structure, along with sticks, twigs, grasses, and rocks. All bones of the leporid body were found lying within or nearby the woodrat house. The majority of bones were separated elements, but one pelvic girdle with attached lumbar vertebrae, three forelimbs (minus the manus in all three segments), and two hind feet (calcaneus to phalanges) were also found in the woodrat house. The hind feet segments lacked most of the phalanges, suggesting that phalanges were the first bones to become disarticulated from the rest of the hind feet bones during natural weathering processes. Similar to the other 130 dune bones, the majority of the leporid bones from the woodrat house displayed advanced split-line weathering cracks. Natural fires igniting woodrat houses such as the one just described would create a circular feature with many burned leporid bones lying among the ashes. These features could easily be mistaken for unprepared hearths or pits made by humans (as Heizer and Brooks [1965] suggested for the Lewisville locality in Texas). This combination of events may be an uncommon occurrence in northern Warner Valley, but must be considered when interpreting the taphonomic history of burned leporid bones from the Warner Valley dunes.

Discussion and Conclusion

This paper has two very simple points to make, points crucial to understanding the taphonomic history of bones excavated from open-air contexts. First, extensive numbers of noncultural bones may accumulate in open-air settings. Put another way, bones from open-air sites are just as likely to represent palimpsest assemblages as are bones from caves and rockshelters. Collectively, caves and rockshelters may contain greater percentages of noncultural bones than many open-air archeological sites. This assumption has not however been adequately tested. Despite the lack of research on the prevalence of noncultural bones in open-air versus closed archeological sites, some archeologists are presently engaging in myth-making (Binford 1981) by assuming that fewer noncultural bones accumulate in open-air settings.

A recent example may be found in the analysis of the faunal remains from Rye Patch Reservoir, Nevada (Rusco and Davis 1987). Therein, Dansie (1987) discusses why the vast majority of Rye Patch faunal remains were deposited by human activity, and not by noncultural processes.

> There are two basic kinds of archaeofaunas, those that are predominantly natural deposits of animal remains and those that are predominantly cultural deposits of bones used by humans. The former (common in rock shelters and caves) may be best suited to standard paleontological

> analysis...In contrast, open midden sites, such as Sand Island and the Sandy Bank site, can be expected to yield culturally distorted archaeofaunas very difficult to relate to natural population composition. The faunal remains from Rye Patch are from open sites far removed from geographic features that might concentrate natural faunal remains, such as cliffs or outcrops providing roosts for predatory birds, nesting areas for carnivores or crevices for packrat nests...I believe the Rye Patch faunal assemblages would be virtually nonexistent had humans never set foot on the three sites.

I am not questioning the validity of Dansie's conclusion that 98 percent of the bones from the Rye Patch sites were deposited by cultural activity - this interpretation may well be true. What is in question is the nature of the "evidence" that is used to support the conclusion that the majority of Rye Patch bones accumulated by human activity. Put another way, many assertions have never been adequately tested. According to Dansie: 1) most archeofaunal assemblages are either predominantly cultural or predominantly noncultural in origin; 2) caves and rockshelters contain predominantly noncultural bone accumulations, and are therefore best left to the paleontologists; 3) open-air sites contain predominantly cultural bone accumulations; 4) open-air sites far removed from bedrock ridge systems do not contain large numbers of noncultural bone accumulations; and 5) raptors, carnivores, and woodrats do not accumulate large numbers of bones in open-air sites. Data presented herein specifically called into question assertions 3, 4, and 5. This paper argues for caution when interpreting the taphonomic history of bones recovered from open-air contexts. The fact that a researcher has recovered bones from open-air sites does not give faunal analysts the green light to interpret them as deposited solely by human behavior. Dunes, in fact, are notorious for containing extensive numbers of noncultural bone accumulations. Leporids, for example, find many food resources located on dunes. Raptors kill and dismember leporids directly on open-air dunes. Coyotes dig dens, hunt and kill leporids and other animals, and defecate directly on open-air dunes. Woodrats build houses on open-air dunes, and may accumulate as many as 100 or more bones within a one meter diameter locality. Haynes (1990) has recently addressed the kinds of problems found in some taphonomic reports, such as the one just discussed above:

> In 1981, Lewis Binford presented an argument that modern archaeologists describe, interpret, and explain by means of "myths", which are fervent beliefs that certain past human behaviours were responsible for producing the concrete traces that remain in the archaeological record. The fervent beliefs become mythology because they are not fully based on knowledge of events in the past that created the archaeological record - they are based mainly on agreed-upon conventions that are untested and unproven... Perhaps most importantly, taphonomic analysts often misread partial signals, or data that are only suggestive, and in their minds supply the nonexistent rest of the message from the fossils. This is a psychological

> phenomenon called "closure"- the assumption that the rest of the message must also be present. One's expectations direct and shape one's perceptions (Haynes 1990:13-14).

Archeologists should not expect more culturally-accumulated bones from open-air sites than from caves and rockshelters simply because a site is located in an open-air location. When such assumptions guide scientific research, then myth-making begins.

Finally, controlled experiments on the geomorphological processes that affect bones deposited on dunes may enhance the accuracy of our interpretations of sites located on dunes. For example, Shelley and Nials (1983) and Wandsnider (1988) concluded that lithic sites deposited on dunes may have very low integrity by the time they are excavated by archeologists. Bones deposited on stable dunes may disintegrate more rapidly than bones that are promptly buried in unstable dunes. Because bone is an organic substance more susceptible to decay than lithics, climatic conditions that produce greater artifact integrity (such as a stable dune environment) may produce lower artifact diversity by destroying the faunal remains and other ecofacts deposited along with the lithic artifacts.

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