Interest in Paleoindian sites in the New World is understandable for several reasons. The sites are 10,000 to 12,000 years old and represent the oldest thoroughly accepted evidence of human occupation in the New World. The sites were occupied during a period in which the environment was strikingly different from today and when large animal species which are now extinct were present and evidently used as a food and tool resource by Paleoindians (Agenbroad, 1984; Antevs, 1953; Frison, 1976; Frison and Todd, 1986; Haury, 1953; Haury et al., 1959; Hester, 1972; Johnson, 1987; Leonhardy, 1966; Saunders, 1977). Although it is obvious that archaeologists have overemphasized the importance of big-game hunting to Paleoindians, our comprehension of the relationships between humans and these extinct mammals will be enhanced if we examine all significant archaeological and paleontological sites which have been preserved.

This paper explores the potential of small, low-visibility sites which can provide valuable additional information about the details of Paleoindian hunting and scavenging tactics. These sites have poor visibility in two respects. They are small and represent a single hunting, butchering, or scavenging event. Secondly, they may contain few or no obvious artifacts. The greatest challenge at sites like these is to demonstrate that they are archaeological sites and not simply fossil localities. Because they lie at the edge of our ability to reconstruct the past, they are poor candidates for arguments about the earliest entrance of people into the New World. For the Paleoindian Period, however, where human presence is universally accepted, they may provide a crucial piece of the puzzle concerning the subsistence and procurement practices of peoples 10,000 to 12,000 years ago.

Potential of Low-profile Sites

Archaeologists recognize that the study of the past involves analyzing not just the artifacts, but the debris generated as byproducts of human
activities as well. Furthermore, it is not just these materials which are important, but the patterns of artifacts and debris that are created by those activities. At times, among the debris are lost or abandoned stone tools, pottery, or other materials that indicate definitively that people lived at a particular place. At other times, human activities produce only debris of a biological nature, without recognizable stone tools or lithic debitage. Unless patterns in the distribution or nature of the debris can be securely identified as the result of human behavior, these low-profile sites are essentially invisible to the archaeologist.

The problem created by low-profile sites is considerable for those cultural groups which tended to leave behind minimal evidence of the tools they used in their activities. In general, people who maintain and repair their tools rather than simply discarding them when they become dull or broken, as most hunting and gatherers did, will leave less direct evidence behind of their presence. As an example, Lewis Binford (1977) made inventories of the gear taken on 47 trips taken by Nunamiut Eskimos. The purpose of the trips was to search for game, check trap lines, retrieve meat from caches, or obtain firewood. The trips were generally made by snowmobile and the gear consisted of modern items like rifles, binoculars, axes, and tins of sardines. In only 20 of the 47 trips was any item of gear left behind. As would be expected, items left behind were typically things which were no longer useful, such as empty sardine tins or spent cartridge cases. If one looks at the distances traveled, slightly over half of the trips were short (round trip distance of ≤80 km), and gear was left behind in only one trip in five (Binford, 1977). The archaeological record of the Nunamiut will therefore be biased since only the longer trips away from the winter base camp will be recognized. While Paleoindian hunters did not use snowmobiles or rifles, they did expend considerable effort on the manufacture of their tools, and it is reasonable to expect that they curated their tools with similar care. Fagan (1991:80), for instance, postulated that Clovis points would be reshARPENed and used again and again. If such conservatism was practiced, many Paleoindian sites could be preserved which have few or no artifacts in association, and those which were recognized on the basis of cultural debris could be biased towards those sites where more materials were used and a wider range of activities occurred. Sites where fewer materials were used or the range of activities was limited probably are under-represented, irrespective of their importance for understanding Paleoindian subsistence patterns.

The problem is exacerbated by artifact preservation, since wooden tools, for example, are typically lost from the archaeological record. Frison and Todd (1986) and Johnson (1982) have identified bone expediency tools used and abandoned at butchering sites, and similar tools of wood could have been used to separate joints and to break large bones.
The importance of these low-profile sites may not be immediately apparent. After all, the same problem affects the archaeological evidence for any time period. With Paleoindians, however, the number of sites is small to begin with; consequently, each additional site recognized enhances our knowledge of Paleoindians. Furthermore, the role of big-game hunting by Paleoindians is the basis for a considerable controversy regarding the role of human hunting practices in causing the extinction of one or more large animal species at the end of the Pleistocene. The controversy hinges on the hypothesis that substantial, wasteful hunting of big game, such as *Mammuthus columbi*, caused or helped cause these Pleistocene extinctions (Martin, 1973, 1984; Mosimann and Martin, 1975). This interpretation implies that big game were hunted with drives and mass kills in which more individuals were killed than may have been reasonably eaten or preserved by the hunters. In fact, however, such sites are relatively rare. If Paleoindian hunters killed big game only occasionally and took single rather than multiple animals, then the kill sites themselves would be smaller or less obvious. The degree to which big-game hunting was practiced will be more accurately estimated if some of the smaller sites at which it occurred are not ignored.

There also has been a growing awareness that scavenging from carcasses may have been a significant source of food or of raw material for tools of early human populations and probably for hunters and gatherers in general (Blumenschine, 1986, 1987, 1989; Cavallo and Blumenschine, 1989; Shipman, 1983, 1984, 1986; Shipman and Phillips-Conroy, 1977; Shipman and Rose, 1984). Because scavenging requires only the dismemberment of the animal, this activity would require little or nothing in the way of tools. If we rely only on those sites with unequivocal lithic tools (which are usually projectile points, not processing tools), then we may well be missing a significant aspect of the relationship between Paleoindians and these extinct faunas.

**Context**

Identifying human activities at a site in the absence of stone tools or other distinctive artifacts is not a straightforward task (Binford, 1981:87–181; Bonnichsen, 1973, 1982; Bonnichsen and Will, 1980; Haynes, 1983a; Johnson, 1985). As with all aspects of archaeology, the bony items which are recovered during excavation have been subjected to a number of destructive processes or transformations. To understand the modifications created by both human and nonhuman activities, archaeologists have increasingly turned to the study of the present to help interpret the patterns preserved in archaeological sites composed principally of bony remains. Many of these studies have focused on the formation processes which...

Most of these studies have concentrated either on attempting to identify uniquely human patterns of bone modification, or on documenting that the proposed human patterns of modification can be produced by other agents. In both cases, the studies have concentrated on structural changes to the bone itself, rather than the context in which the bones are found. Reviewing these studies, Steele (1990) emphasized that searching for uniquely human patterns of bone modification may be like searching for the holy grail because most if not all forms of bone modification can be caused by many taphonomic agents. He noted, however, that the probability of identifying agents causing bone modification could be improved considerably if the context in which the modification occurred was used to help identify the taphonomic agent.

The difficulty is that the context in which a bone is recovered may not be the context in which it was modified. For example, an animal may be killed in one location and the bones modified by a predator. Then, the bones might be scavenged by another predator and moved to a different location where further modification occurred. If the bones become buried at this second location, that context will only help to determine the cause of the modifications which happened there. What happened previously cannot be inferred from that context. As another example, an animal may have been killed by a predator, the bones modified at the same location, and then buried there as well. In this instance, the context in which the bones are recovered is also the context where the modifications occurred; therefore, context can be used to help determine the taphonomic agent responsible for the modifications. To distinguish such dissimilar contextual circumstances, Steele (1990) proposed the concepts of primary and secondary taphonomic provenience (Fig. 1.). Those sites where the bones have been transported during a succession of events, such as in the first example, are in secondary taphonomic provenience.

Sites, such as the second example above, where the bones become buried at the locality where all modifications to the bones occurred are in primary taphonomic provenience. In these sites the context can be used to help identify all taphonomic agents which have acted upon the bone, and to help eliminate potential taphonomic agents which could not have been active at the site. It would appear then, that low-profile human-activity sites where bones are recovered in primary taphonomic prove-
Fig. 1.
—Model illustrating primary and secondary taphonomic provenience and some possible pathways that bone can take during its taphonomic history.

ience have a greater potential of being recognized because both the pattern of modification to the bones and the context in which they are found can be used to recognize and interpret the human activities. The difficulty is that it is the archaeologist's responsibility to make inferences based both on context and the structural alterations to the bones.

Processes of Site Formation

Michael Schiffer's (1987:265–304) research into site formation processes also provides insights which facilitate the analysis of low-profile sites. Objects become part of the archaeological record when they are abandoned or discarded or when they drop to the ground as a result of some activity. They may enter the archaeological record at the place they were used, but this is not always the case. Once abandoned, items may be disturbed or displaced if the area is cleaned up or if the site is reoccupied by people at a later time. A critical part of making inferences about the past is the identification of the various processes responsible for the creation of the archaeological or fossil record.

Identification of formation processes involves an analysis of the various properties of a particular deposit of bones or artifacts in terms of the
processes which may have generated them. Schiffer (1987) classified these various properties into three groups: (1) simple properties of materials involving aspects of a single object, (2) complex properties of materials involving the location of the object in a deposit and its relationships to other objects, and (3) properties of the matrix containing the deposit.

Simple properties include object size, shape, and surface modification. For example, smaller objects can be removed from the deposit by moving water while the larger ones remain (Schiffer, 1987:267–279). Erosional and other disturbance factors can also result in objects being sorted by size. The density of objects, another simple property, can affect their susceptibility to decay and destruction by various factors. In particular, bones of higher density are more likely to survive the destructive ravages of gnawing animals, such as canivores or rodents, than those which are lighter and more fragile. Object shape may affect preservation or displacement because some processes, such as wind and flowing water, are more likely to displace objects with a greater surface area. The orientation and dip of an object in the deposit can provide information on context because wind and flowing water can force a consistent orientation on objects which were originally deposited with random orientations. The damage observable on an object provides evidence of modification and use. Cutting a bone, gnawing on it, or using a tool until the edge becomes worn all result in a modification of the original shape and surface of the object. These damages can reflect the processes which create them which in turn help to determine which processes created the assemblage.

Much research in taphonomy and archaeology has focused on issues involving damage to bones. Distinctive patterns of destruction, like gnawing by large or small animals, may readily be identified (Binford, 1981; Haynes, 1980a, 1980b, 1983b). Since bone breaks differently after it has dried, breaks in fresh bone can generally be distinguished from older breaks and breaks resulting from impacts can generally be distinguished from breaks resulting from static loads such as soil pressure (Bonnichsen, 1982; Johnson, 1985). Hack and chop marks made by stone tools are usually quite distinctive, but cut marks made by stone tools can be much more difficult to distinguish (Shipman and Rose, 1984). In many cases, it is not simply the mark, but its location on the bone which is important (Binford, 1981). For example, possible cutmarks are more likely to occur at a joint than cutmarks in the middle of a long bone.

The simple properties of an object in an archaeological or fossil deposit are applicable to single specimens. Often they can be identified independently of the context of the object. This does not mean, however, that each property can be unambiguously assigned to a single formation process. Ethnoarcheological and taphonomic studies have identified diverse
formation processes which can create similar patterns of damage. More importantly, these studies have shown that some patterns, which were initially believed to be clear indicators of human activity, could be duplicated by natural processes or by nonhuman animals under certain circumstances (Fiorillo, 1989; Haynes, 1983a; Myers et al., 1980; Oliver, 1989; Shipman and Rose, 1984).

Complex properties are those which involve the spatial position of the object in relation to other objects present in the deposit (Schiffer, 1987:279–287). The simplest of these is the quantity of artifacts. The number of bones in a deposit may indicate that some process involved which concentrated them into a restricted area. Secondly, deposits may be distinguished by the number and kinds of species they contain. The vertical and horizontal distribution of materials in a deposit can provide important clues to the ways in which the deposit formed. Another complex property is inventory, the kinds of objects in the deposit. Related to inventory is diversity, the relative abundance of the different kinds of objects present in the deposit. These two properties are particularly important in the study of faunal deposits because each animal is made up of a number of different bones. Differences in which bones are present can provide considerable information on the processes which led to the creation of the deposit.

For example, Brain (1976, 1981) provided information on the differential preservation of the various bones in antelopes (Cervidae) after dogs (Canis Familiaris), porcupines (Atherurus and Hystrix), and various other animals had gnawed on them. Ethnoarcheological studies of hunter–gatherers have shown that certain parts of an animal may be selected for processing through drying or smoking while other parts are likely to be selected when only a part of the animal can be carried back to the campsite (Binford, 1978). Differences in the representation of the skeletal elements can, therefore, provide valuable clues regarding the processes which resulted in the deposit. The final property of a deposit is its degree of organization or disorganization. This property is more difficult to measure, but for faunal assemblages it can refer to measures of articulation (i.e., which bones are in their correct anatomical positions with respect to one another) and to measures of how bones are dispersed or concentrated in a site.

Schiffer's third category includes properties of the sediments which contain the archaeological or fossil deposit (Schiffer, 1987:288–292). This includes such things as distributions of particle sizes which indicate how the sediments were deposited. It also includes inclusions in the sediments, such as pollen, which provide information about the surrounding environment when the deposit was formed. Geochemical properties of
the sediments may provide information about their source and history as well. Finally, properties of the site or locate such as its slope, aspect, elevation, and proximity to flowing water may provide important information.

Examination of the various properties of an archaeological or fossil deposit provides the basis for reaching conclusions about how intact the deposit is and the degree to which the materials have been disturbed or transported from their original resting place. Reorganizing the order of the lines of evidence described by Schiffer, we can identify the basic steps in the identification of the formation process responsible for a deposit as follows: (1) provenience and context, (2) properties of the cultural or fossil material, (3) assemblage and association, and (4) comparison with models.

When possible, all four lines of evidence should be examined. By provenience and context, we refer to the locality in which the cultural or fossil material was found. The locality has a stratigraphic place in the region in which the site is located. This stratigraphic position provides contextual information regarding major geographic and geological events in the area which may be relevant to the locality. It also includes information on when the materials in the locality may have been deposited. The local environment of the site includes information about the stratigraphic position of the site and the characteristics of the sediments in which the cultural or fossil materials are located. Horizontal and vertical variation in the characteristics of the deposit is also relevant to documenting the provenience and context of the locality or site.

The important properties of the materials found in the site or locality include their position, orientation, and condition. Position includes not only horizontal and vertical coordinates, but the stratigraphic unit in or on which the material lies. Position also includes observations regarding any local variations in the texture, color, or inclusions of the stratigraphic unit around the specimen. Orientation includes both the dip and strike of the material. Condition of the material involves properties of the material such as breakage, pits, scars, gouges, scratches, and evidence of scorching.

Although the information provided by groups one and two (provenience and details of the specimens) is important, it is insufficient to identify particular formation processes. An inventory of the materials which were collected from the locality along with information concerning the relative spatial positioning of those materials is also necessary. A major advantage in working with faunal materials is that we know what anatomical parts should be present if the entire animal was originally present. For this reason, the parts which are missing can be as informative as the parts which are present. Because the original relationships of the parts are also
known, the degree of disarticulation and dispersement of the elements also provides information regarding the formation processes responsible for the deposit. The location of artifacts and features, when present, with respect to the faunal elements provides important information regarding associations between the two sets of data.

Identification of formation processes and taphonomic provenience requires all of these lines of evidence, but the evidence is not enough. In order to infer that a formation process is applicable to a particular deposit, a model or theory is required which associates particular observations with the formation process. The model indicates under what conditions the particular observations are relevant. The model also should indicate the relative weight to be given to the various lines of evidence. Taphonomy and ethnoarchaeology provide the basic real-world observations from which such models are constructed. For example, a model of the effects of flowing water over a site would indicate what kinds of strata are likely to contain materials deposited or redeposited by flowing water of various velocities. They would also provide expectations regarding the condition of the bone and other materials as well as the orientation of those materials. Furthermore, the model would indicate what elements would be likely to be missing from such a site and what the overall distribution of the materials would be. The model must provide sufficiently detailed expectations so that several independent lines of evidence can be compared to the model.

The Duewall-Newberry Site, an Example

As an example, a number of these issues can be used productively to examine the mammoth (*Mammuthus columbi*) remains at the Duewall-Newberry site in Brazos County, Texas (Steele and Carlson, 1989a, 1989b). Twenty-one square meters of the site were excavated in 1983, revealing the remains of one mammoth resting on muddy sands and sandy muds of a natural levee of the Brazos River. Overlying these levee deposits are approximately 7.5 meters of red clayey silt alluvium. The site appears to date 12,000–10,000 years ago, although insufficient collagen is present in the bone to obtain a chronometric age estimate. No stone tools, lithic debitage, or charcoal were recovered in the excavation. The single adult mammoth (Fig. 2), recovered in its primary taphonomic provenience, was represented by both tusks and dentition, the remainder of the scapulae, humeri, one radius, one femur fragment, one tibia, six ribs, 13 vertebrae, and one calcaneus. Additional elements may extend to the east and south of the excavation area, and portions of the skeleton may have been washed away by the Brazos River.
Despite the absence of tools, a number of features suggest human activity at the site. The mammoth appears to be a near-adult male with no identifiable lesions which affected the bone. Considering first the simple properties of the deposit, there is no evidence of size sorting or reorientation of the bones as a result of water flowing over the bone. Very small bone flakes were recovered which would have been easily displaced by moving water. Elongated bones show no consistent orientation further supporting the inference that the site was not subjected to any substantial current.

Whereas size and orientation provide negative evidence, damage to the bone clearly indicates several different processes at work. The articular surfaces of several bones show clear evidence of gnawing by a carnivore, possibly a canid (Fig. 3). Destruction of the cancellous bone and clear tooth-drag marks indicate that the mammoth was scavenged after its death. More extensive weathering on the tusks than on the other bones suggests that the skull and tusks remained unburied and exposed to the elements for a longer period than the remaining elements which were probably buried fairly soon after the animal’s death. The humeri and the femur show evidence of green bone breaks, indicating that these bones were fractured shortly after the death of the animal. On the femur, the
Fig. 3.
—A: Carnivore gnawings on the epiphyseal head of the right humerus of Mammuthus columbi from the Duewall-Newberry site. B: Carnivore gnawings on the distal end of the left humerus of Mammuthus columbi from the Duewall-Newberry site.
cortex is 2-cm thick, indicating the force required to break the bone would have been considerable. Related to the green bone fractures on the femur are two impact scars on femur fragments, indicating that the bone was struck by a substantial force (Figs. 4 and 5). The positioning of the impact points is analogous to those found ethnographically on caribou (*Rangifer tarandus*) femurs which have been split open for the marrow (Binford, 1981:159–161).

The complex properties of the site are also informative. That the site consists of one individual further corroborates the inference that the deposit is in primary taphonomic provenience and does not represent miscellaneous faunal materials washed into a natural trap. Some of the elements present are fragile, including some unfused vertebral epiphyses and the scapulae. These are elements which would be readily destroyed if the bones had been exposed to trampling or had been washed downstream. The vertical distribution of the material shows that it was deposited on a level surface. Only the skull and tusks extended much above this surface and, as noted, the tusks showed evidence of weathering. Weathering had reduced the skull to small bone chips which were encountered during the excavation in the levels above that at which the remainder of the bone lay. The property of disorganization is particularly interesting. Scavenging typically leads to disarticulation of a skeleton and its gradual scattering over a broad area. Though there is some scattering of the mammoth at Duewall-Newberry, there is an unusual concentration of bone around the remnants of the skull and tusks (Fig. 6). The right scapula and four ribs are in front of the skull beneath the tusks. The left scapula, a rib, a vertebra, the right ulna, and part of the right femur lie just to the right of the skull. This pile is similar to the bone piles reported for other sites where stone tools confirm the presence of human hunters (Frison and Todd, 1976).

The third property includes aspects of the matrix containing the bones. At Duewall-Newberry, the sediments in which the bones were deposited consist of muddy sands and sandy muds which were deposited under low-velocity conditions, such as sediments on a levee or the landward margin of a point bar. This further supports the inference that rapidly flowing water was not responsible for scattering the bones at the site or for their breakage.

The various lines of evidence from Duewall-Newberry indicate that the mammoth died or was killed some distance from the river channel. The animal was disarticulated by some unidentified force, then humans piled the bones around and beneath the skull and broke the long bones. The resources sought by the humans could have been meat, marrow, bone grease, or cortical bone. Because the piling of the bones and break-
Fig. 4.
— A: Segments of *Mammuthus columbi* right femur from the Duewally-Newberry site which articulate with one another. B: Two articulated *Mammuthus columbi* femur fragments with points of impact from Duewally-Newberry. Distance between impact points is 14.0 cm.
Fig. 5.
—Close-up views of the two impact points on Mammuthus columbi femur shaft from the Duewall-Newberry site which were depicted in Fig. 4.
ing them could have been accomplished whether or not meat was present, and there is no direct evidence of meat processing, the simplest answer would be that the resource sought was marrow, grease, or cortical bone for use in tool manufacture. Shortly before or after the animal died, the site was visited by carnivores who gnawed portions of the bones and possibly dragged others away. The bones then were buried relatively quickly except for the tusks and skull which were exposed to weathering. If this interpretation is correct, it further documents that Paleoindian lifeways involved encounter hunting or scavenging of single mammoths at least some of the time. Although this site provides no final answers to the question of Pleistocene overkill or the big game hunting strategies of Paleoindians, it apparently documents human interaction with mammoths at yet another site, and documents the interaction at a low-profile site. The site suggests that Paleoindians may have been involved in scavenging, an activity not typically considered one conducted by Paleoindians.

More significantly, these concepts could be, and in some cases have been, applied to other sites where extinct faunal remains have been found and human activity at the sites has been suspected. Fig. 7 and Table 1 document the distribution of 14 North American sites where human activity associated with mammoths has been suspected. In all of these sites,
Fig. 7.
—Locations of possible archaeological sites in North America identified wholly or in part on the basis of patterns of bone modification. Numbers on map identify sites listed in Table 1.

examination of context as well as the form of modification of the bones has led the original investigators to suspect human activity. In some of these sites, specifically Colby (Frison and Todd, 1976) and Lange/Ferguson (Hannus, 1989, 1990), associated lithic tools confirmed the presence of humans at the site, but the interpretation of the human activities at the site was based upon the pattern of modification to the bones and the context in which they were found. In the other sites, except for material from the Yukon Territory (Morlan, 1980, 1986), the fact that the bones had not been removed from the original location of the site (they were in primary taphonomic provenience) allowed researchers to interpret activities at the site based upon both context and structural changes to the bone. The material from the Yukon Territory was recovered in secondary taphonomic provenience, and human association with these remains, which has proven controversial, has been argued solely on the basis of the structural changes to the bone.

Our ability to interpret low-profile sites in primary taphonomic prove-nience depends heavily on observations reported by ethnoarcheologists and taphonomists in field studies. Modern ethnoarchaeological and taphonomic studies have often been used to provide cautionary tales for the unwary archaeologist, documenting that a wide range of taphonomic
agents can alter bone in the same or very similar ways. John Yellen (1977:8–9) referred to this use of analogy as the "spoiler" approach in which an inferred interpretation is disproven by evidence that another interpretation is possible. Although these studies have proven invaluable and will continue to do so, they have not encouraged researchers to review faunal assemblages suspected of reflecting human activity in terms of both context and structural changes to the bones. Both context and structural changes to bone must be considered for us to more effectively apply our observations of the present toward an understanding of the past.

Literature Cited


