EIGHT

The Behavior of Surface Artifacts: Building a Landscape Taphonomy on the High Plains

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> The material remains of past civilizations are like shells beached by the retreating sea. The functioning organisms and the milieu in which they lived have vanished, leaving the dead and empty form behind. An understanding of structure and function of ancient societies must be based upon these static molds which bear only the imprint of life.
>
> (WILLEY 1953:1)

MORE THAN A HALF-CENTURY AGO, Gordon Willey exhibited a thorough awareness of the nature of the relationship between archaeological materials and the people who discarded them. Just as a modern-day paleobiologist would not analyze Willey's "beach" as the home habitat for the "functioning organisms" that built the shells, archaeologists must consider artifact contexts as different from the "milieu in which they lived." Willey's opening paragraph to the Virú Valley settlement pattern survey represents a precocious recognition of the role of formation process studies, or taphonomic perspectives, applied to the study of landscapes. The wisdom in Willey's observations on the nature of archaeological context has not been fully appreciated by the traditions of settlement pattern analysis and archaeological survey he inspired. Here, we build on Willey's observations regarding the nature of artifact populations and apply them to the landscape of the northwest High Plains. We contend that

Willey's implied taphonomic orientation is as essential in landscape archaeology as it is in fine-grained analyses of individual sites. Just as paleobiological inferences regarding the context and histories of the "shells on a beach" would be incomplete without interpreting taphonomic processes such as wave action and shifts in ocean currents and temperatures, so too is it unwise to infer distributional patterns of artifacts on landscapes as yielding information on past human actions without assessing the taphonomy of those artifact-bearing landscapes. We refer to this perspective as *landscape taphonomy* and see it as an approach explicitly confronting Willey's shell/beach interpretive dilemma, a fundamental concern in archaeological survey and the study of landscape-level patterns (a more detailed definition is given later).

We discuss the landscape taphonomy perspective as it developed during our survey project on the Oglala National Grassland (ONG) of northwestern Nebraska (Figure 8.1). This survey project began as an attempt to extend the scale of traditional taphonomic studies of the Hudson-Meng (25SX115) bison bonebed (Todd and Rapson 1999) to interpretations of the surrounding grassland. The geologically complex nature of North America's High Plains provides an ideal setting to demonstrate the value of this perspective for large-scale archaeological investigation. Our surveys on the ONG began with basic experiments aimed at investigating the accuracy and experimental control of archaeological survey methods, a precursor to evaluating observed archaeological patterning in terms of prehistoric behaviors. Archaeological survey is defined as field investigation consisting of archaeologists walking systematically over a landscape looking for exposed cultural material and is here considered the primary field technique of landscape archaeology, as it was for Willey in Virú.

While some see taphonomic investigations as providing cautionary tales that restrain interpretation, we hope to illuminate exploratory research questions that build a more holistic and interdisciplinary field, ultimately providing archaeology with a richer interpretive palette. Of particular relevance is avoiding the common interpretive pitfall of an initial optimistic overemphasis on human causality while bringing an understanding of long-term human-landscape interaction to the forefront. This approach to archaeology is capable of contributing widely to researchers and planners who also study landscape change (e.g., Endter-Wada et al. 1998; Field et al. 2003; Forester and Machlis 1996; Holling and Gunderson 2002; Milne 1992; Naylor 2005; Norton 1998; Stohlgren et al. 1997; Swetnam, Allen, and Betancourt 1999; Turner 1989), many of whom explicitly seek collaboration with the social sciences.

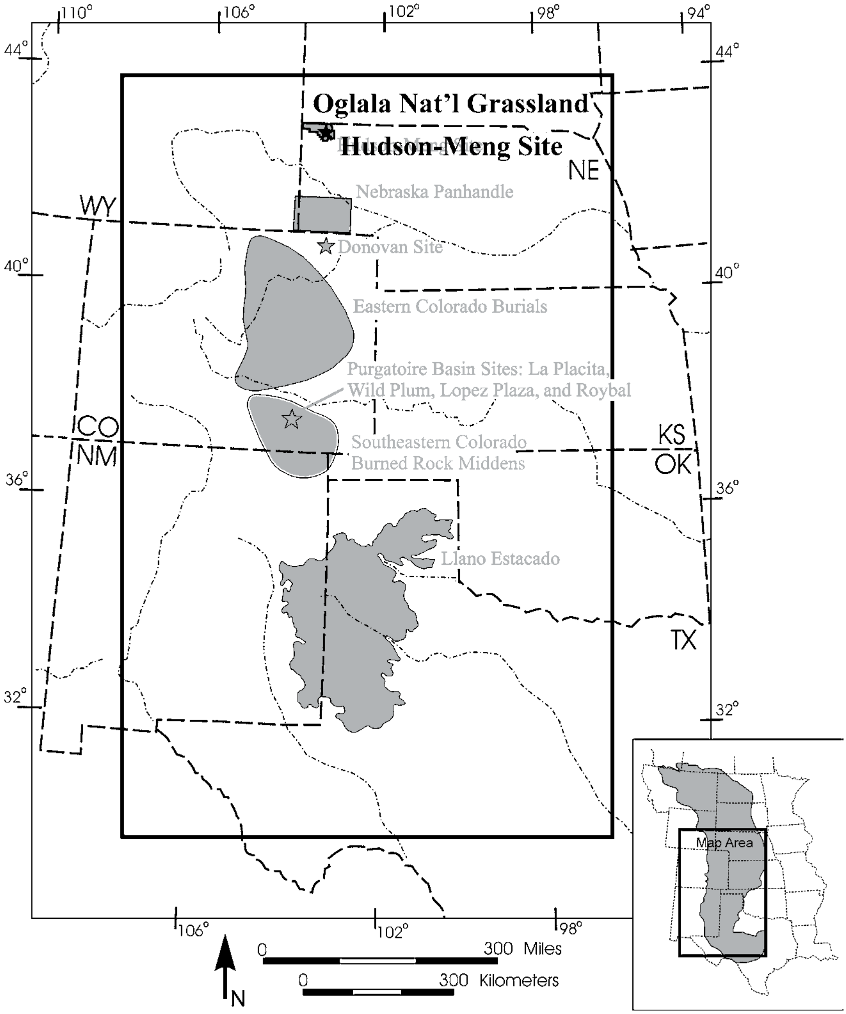

FIGURE 8.1.
Map of the High Plains, highlighting the location of the Oglala National Grassland within the western United States. Illustration by Kevin Gilmore.

TAPHONOMY AND THE PROCESS OF ASSIGNING MEANING TO PATTERN

Any claim regarding the origin of patterning is relative to a given perspective, but one certainty is that most patterns can have many possible sources. Different processes can form similar patterns (equifinality), and elements of patterns can be the non-intuitive result of numerous interacting, scale-dependent processes (emergence). These observations suggest that caution should be exercised when assigning behavioral meaning to artifact patterning (whether intra-site or regional in scale) and that the more reliable inferences will be based on a dynamic understanding of multiple interacting agents of change.

Taphonomic studies have demonstrated the danger of making a priori assumptions about the nature of archaeological deposits (Behrensmeyer, Gordon, and Yanagi 1986; Brain 1981; Hill 1979, 1989; Marean and Cleghorn 2003; Oliver 1989; Todd and Rapson 1999; Yellen 1996). In spite of these realizations at the scale of the individual site, human action is often given interpretive primacy when studies are conducted at the landscape scale. An equally fundamental interpretive problem occurs when distributional patterns are consequences of methodological error, such as an inappropriate sampling frame, coarse screen size, or other systematic bias introduced by the archaeologist. Before interpreting the behavioral meaning of archaeological context, archaeologists need to evaluate (1) how methodological decisions determine the nature of the samples they wish to interpret, (2) which among several possible agents could have generated the pattern in question, and (3) the relative contribution of those multiple agents.

Any archaeological analysis could benefit from addressing the influence of method and taphonomic variables on archaeological interpretation, but these concepts are not generally explicit or sufficiently emphasized in landscape archaeology (but see Barton et al. 1999, 2002). A taphonomic perspective provides the needed means of critically evaluating the ways meaning is assigned to pattern. Landscape taphonomy is relevant both for experimental design and for developing more inclusive understandings of the various processes of landscape formation. The steps in building a landscape taphonomy are initially conceptual, but all have concrete implications for field methodology. The linkage between concept development and methodology is reflexive—one informs the other. Many archaeologists have tended to use human action as a default null model by assuming that human action is responsible for observed patterns until conclusive evidence to the contrary is demonstrated. A more sensible view places human action as one among many important landscape variables (Barton et al. 2002).

THE PROBLEM OF ANTHROPOCENTRIC BIAS

Examples of assumptions overemphasizing human causality are common in archaeological definitions of the term "landscape." For instance, one view is that a landscape exists "by virtue of its being perceived, experienced, and contextualized by people" (Knapp and Ashmore 1999:1) and that "*landscape* is a conceptual and behavioral process" (Potter 2004:322, original emphasis). This view is phenomenological and emphasizes human consciousness and sources of cultural meaning that people may project upon landscapes. We agree with this perspective in so far as it highlights the need to include the role of culture in landscape formation and change, which should be one of archaeology's great strengths as *the* field positioned at the interface of the socio-natural sciences (van der Leeuw and Redman 2002). On the other hand, this perspective is also unnecessarily anthropocentric in viewing landscapes as solely the result of human perception and experience. It also implies that landscapes are static background templates that preserve only the complex social workings of one particular species: humans. Landscape elements contain historically contingent palimpsests of meaning in addition to being palimpsests of formational processes (Barton et al. 2002). To meet anthropological goals and to contribute to other fields, archaeology must incorporate the importance of culturally constructed meaning with an understanding of physical and biological processes that also shape landscape properties. To be fair, there is certainly more than one way to approach the study of landscapes, and the difference here (between ours and those cited earlier) is largely one of emphasis. However, defining a landscape in exclusively anthropocentric terms is ultimately short-sighted and incomplete, and it limits the potential for more holistic, transdisciplinary understanding.

Defining landscapes as the exclusive result of human perception and/or solely within the confines of human action makes at least three problematic assumptions: (1) that human actions are the only relevant archaeological processes on the landscape, (2) that anthropology is the only field that might study such landscapes, and (3) that archaeology cannot benefit from, or contribute to, other disciplines also investigating the human role in landscape change. A taphonomically oriented approach can alleviate these biases by seeking to understand multiple processes and their interactive effects on what archaeologists observe and interpret.

Human actions are significant components of landscapes, but they are not the sole component. All archaeologists should be comfortable with the notion that archaeological patterning is the result of numerous agents, only some of which derive from humans—this is the basic lesson of the growth of taphonomic and formational studies during the last quarter of the twentieth century. Landscape taphonomy promotes collaboration with researchers of the natural sciences. The inherently interdisciplinary nature of archaeology is one of its greatest strengths (Schiffer 1988; van der Leeuw and Redman 2002), and we should look to build bridges, not barriers, to outside perspectives.

LANDSCAPE TAPHONOMY DEFINED

> Landscape structure must be identified and quantified in meaningful ways before the interactions between landscape patterns and ecological processes can be understood. The spatial patterns observed in landscapes result from complex interactions between physical, biological, and social forces. Most landscapes have been influenced by human land use, and the resulting landscape mosaic is a mixture of natural and human-managed patches that vary in size, shape, and arrangement.
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> (TURNER 1989:174)

Monica Turner is a landscape ecologist, yet her view encapsulates much of the basis for landscape taphonomy and is a strong tribute to the potential and necessity for interdisciplinary collaboration in the investigation of landscape structure and process. Our definition of landscape is a version of the definition of the fossil record in Anna Behrensmeyer and Susan Kidwell's (1985:105) discussion of taphonomy. Like the fossil record studied by paleobiologists, a landscape is the result of a "complex, evolving, integrated system of biological, [cultural, climatological,] and sedimentological processes" (1985:105). This definition emphasizes the dynamic nature of the records preserved within and upon landscapes. Landscape archaeologists usually focus on cultural aspects of this formation, but it is beneficial to research biological and physical processes that also contribute to landscape patterning (Figure 8.2). Taphonomy is the field that has traditionally investigated the complex interaction of such dynamics (physical, biological, and cultural) on the formation of records preserved within and upon landscapes. Taphonomy is "the study of processes of preservation and how they affect information in the fossil [and archaeological] record" (Behrensmeyer and Kidwell 1985:105). Sampling design influences the information returned from a surface or matrix. As it influences information loss, it needs to be included in our understanding of taphonomic processes (Burger and Todd 2006). Taphonomy provides an avenue for achieving more inclusive understandings of landscape-scale processes across temporal, spatial, and methodological arrays (Barton et al. 2002).

Landscape-scale records are always multi-authored, but the taphonomic perspective outlined here divides the contributors into three camps: biological, physical, and cultural (Figure 8.2). Physical elements of the landscape include climatic, geologic, geomorphic, and sedimentological variables (Naylor 2005).

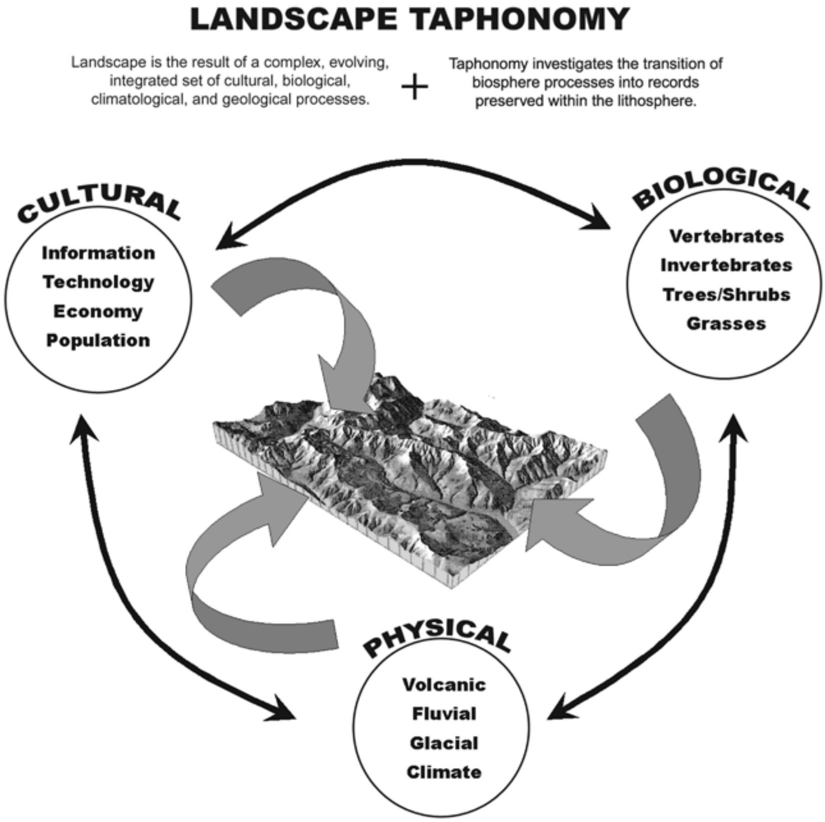

FIGURE 8.2.
Landscape taphonomy, a conceptual model.

The landscape elements in the biological compartment of Figure 8.2 include the complex network of living organisms from all phyla, which not only co-reside with humans, thus influencing their actions and beliefs, but also alter the form and content of the physical landscape. For example, soil development involves physical and biological processes, and landscape variability in pedogenesis results from interactions among climatic, biotic, topographic, and geological state factors as they change through time (Jenny 1941). A perusal of these state factors in soil development makes it all the more clear that archaeological patterns are influenced by physical and biological variables. Human actions of the past and present can influence and compound these processes in a variety of ways. Thus any investigation of the landscape must account for complex interacting variables, and considering a landscape solely as a stage for a prehistoric play or only as the product of human perception will not only fail to meet management concerns but is wholly inappropriate for the investigation of past human action.

In one sense, one could argue that the cultural compartment of Figure 8.2 should be placed among the biological elements because humans are necessarily part of the biological world, a point often missed by the more phenomenologically inclined. However, we separated cultural processes into their own compartment in the landscape taphonomy model because (1) understanding cultural processes is an important area of opportunity for anthropology to inform other fields and the general public, (2) the role of humans in landscape dynamics requires specific attention for anthropological interpretation and for broader issues of resource management and planning, and (3) cultural modifications of the landscape often tend to be of exceptional magnitude.

Cultural processes include traditional anthropological themes such as settlement patterns and place-use histories, but the elements of culture especially relevant for landscape taphonomy include the role of populations, their economic systems, and uses of technology and information in the human-landscape interaction (Figure 8.2). Couching investigations of the human past within this research strategy facilitates articulation with ecologists who are also studying the evolution of landscapes. This can improve the ability of archaeology to inform disciplines (and be informed by disciplines) that tend to underestimate the role of humans in landscape change. For example, ecologists have traditionally tended to seek "pristine" ecosystems for analysis, which are methodologically defined as those unaffected by humans. Some have asserted that any ecosystem that has changed as a function of human action cannot be considered "natural" in the first place (Jenkins 2003). Policy directives are often targeted at returning a modern ecosystem to some previous and static state. An unfortunate by-product of this tendency is that "pristine" is implicitly defined as unaffected by European cultures, implying that indigenous cultures either did not alter ecosystems or altered them in a "natural" way. Additionally, the notion that Native American groups did not influence ecosystems relates to a traditional view of hunter-gatherers as the original affluent society (Kelly 1995) and also carries a more deeply routed implication that non-Westerners were simply unwilling or unable to alter their ecosystems.

Humans often become an important ecosystem variable to ecologists only when their behaviors reach a scale that significantly influences other ecosystem variables (e.g., anthropogenic soil change, global warming, changes in the carbon cycle, and similar factors), but people tend to impact any ecosystem they inhabit (Redman 1999; Smith and Wishnie 2000). The subtleties of the assumptions regarding the pristine ecosystem bias in ecology will not be fully understood by ecologists without integration with social sciences (Field et al. 2003; Norton 1998). Likewise, anthropology can benefit from the ecological tools and perspectives for analyzing ecosystem change. Thus archaeology's interdisciplinary structure is ideal for correcting a number of historical biases that overlap with both the social and natural sciences (van der Leeuw and Redman 2002).

In sum, landscape taphonomy as depicted in Figure 8.2 is an alternative to traditional settlement pattern surveys by highlighting these concepts:

- Landscapes are complex formational mosaics that cannot be seen exclusively as cultural, biological, or physical entities.
- Nontrivial landscape research, regardless of its ultimate goals—whether archaeological, geological, or biological—must incorporate aspects of each of the major contributory realms.
- Landscape properties are constantly in flux at multiple spatial and temporal scales and require continuous monitoring.
- Methods to research landscapes must be collaboratively developed with significant inputs from disciplines based in the social, biological, and physical sciences.

The time has passed when archaeologists can focus solely on human activities as generators of archaeological patterns without considering the complex noncultural components of archaeological formational histories. The history of research and interpretation at the Hudson-Meng bison bonebed is presented in the next section as a case study that demonstrates how a taphonomic perspective can productively alter the meaning assigned to material patterns.

BUILDING A LANDSCAPE TAPHONOMY

Lessons from a Bonebed

Hudson-Meng is a research center encasing the largest documented Paleoindian-period bison bonebed in the Americas. At this site, over 600 bison of an extinct subspecies (*Bison antiquus*) are contained within loess deposits dating to nearly 10,000 radiocarbon years before present (Agenbroad 1978; Buenger 2001; Jahren, Todd, and Amundson 1998; Thomas and Kelly 2005:242–245; Todd and Rapson 1999). The research center is the hub of our landscape survey project on the surrounding grassland. The history of research at Hudson-Meng is used as a reference to demonstrate the value of taphonomically informed research strategies and high-resolution recording methods. This example will be used as a springboard from which to enter our discussion of the applicability of similar methodological and conceptual approaches to the study of landscapes.

The first published interpretation of Hudson-Meng's formational history emphasized an observed association between stone artifacts and bison bone (Agenbroad 1978). This led to the conclusion that the two classes of material were unambiguously behaviorally associated and that the humans who had made the artifacts were undoubtedly the same as those who had killed the bison as part of a single event (or a closely related series of events). This interpretation of the site, as a Paleoindian kill and processing location, emphasized the cultural elements of landscape change at the expense of biological and physical processes of decay, weathering, and sedimentation. Subsequent investigations of the bonebed, aided by developments of technology and taphonomic principles, led to a revised interpretation of the site's formational history (Todd and Rapson 1999). A more controlled documentation program and several observed archaeological patterns indicated that the accumulation of the main layer of bones was most likely not a result of human hunting and that the archaeological materials were a subsequent behavioral event (Todd and Rapson 1999).

Thankfully, the original excavators left most of the bones in place in the bonebed (they were not removed for further analysis but were identified in situ and reburied). Portions of the site were excavated in the 1990s to allow for an interpretation center to be constructed over the bonebed. During the later excavations, new discoveries played a role in the reinterpretation of Hudson-Meng. For example, it was found that the gradually sloping hill to the west of the site did not enclose the cliff assumed to be the kill location of the bison in the original interpretation (Agenbroad 1978). Some standard archaeological comparative analysis also implied that the site was very atypical for a kill location. Bruce Huckell's (1978) analysis of the chipped stone suggested the assemblage seemed like a camp rather than a kill in that it contains an abundance of bifacial thinning flakes and almost no unifacial retouch flakes (he also thought there might be multiple events at the site)—the opposite of the pattern typical of other Paleoindian kill sites on the northern High Plains. Hudson-Meng also has an anomalously low number of points per bison (Todd and Rapson 1999) compared with other kill sites. Such observations are important, and they emerged in part as a result of a more critical awareness of the process of assigning meaning to pattern that accompanied the advent of taphonomic investigations in archaeology but that are also a function of a larger sample of sites with which to make comparisons. Additional aspects of the reinterpretation are derived directly from taphonomic research on bonebed formation processes.

Taphonomic analysis of the materials from the 1990s excavations demonstrated that many nonhuman factors contributed to the site's formational history. As the site was first interpreted before the development of taphonomy, observing stone and bone in spatial proximity was a sufficient starting condition to assume that any subsequent patterning was caused by humans. For instance, skeletal element representation in processing locations is generally considered to reflect the concerns of transport and often consists of high-return elements and the lower-ranked parts attached to them (Binford 1978; Lupo 2001; Marean and Cleghorn 2003; Monahan 1998). At Hudson-Meng, the most underrepresented skeletal parts were third phalanges, complete crania, and caudal vertebrae—the lack of which was interpreted as resulting from human selection in the process of transporting the carcasses from the kill to the processing locality (Agenbroad 1978). This interpretation implied that after successfully killing several hundred bison, the Paleoindians who formed Hudson-Meng removed only the crania, toes, and tails to facilitate transport of the carcasses. This is especially anomalous for a kill site because the amount of effort required to separate a third from a second phalanx and to remove part, but not all, of the skull (tooth rows and occipital portions are common in the bonebed) would be considerable, and the remaining carcass would still be quite large and heavy. Furthermore, such a butchery strategy would be highly atypical given what has been observed among contemporary foragers and within other archaeological contexts.

It was later shown that the underrepresentation of these element classes could be parsimoniously accounted for by processes such as in situ weathering and deterioration (Todd and Rapson 1999). Crania have higher weathering profile heights than most skeletal elements (i.e., it takes much more sediment to bury a bison cranium than most other bones in the body) and are also composed of cavities and thin plates of bone. Thus an additional and fairly plausible explanation for the missing crania is that they were exposed for longer periods of time and were more susceptible to breakage from freeze-thaw cycles and the trampling that undoubtedly occurred because of the site's nearness to a major spring.

An additional taphonomic observation aided by developments in recording strategy was the high incidence of tibia-patella-femur articulations and of fully articulated carcasses in general. Taphonomic research has shown that if an animal is skinned or defleshed, it is extremely unlikely for the patella to remain in contact with the patellar groove of the femur (Hill 1979; Todd 1983). The fact that these articulations are common at Hudson-Meng suggests that many of the bison died and were buried without being butchered (Buenger 2001).

Taphonomically informed interpretations often require the use of high-resolution field documentation to account for the numerous distinct sources of information contained in an archaeological deposit. Many aspects of the reinterpretation of Hudson-Meng were made possible by the use of a total station and computer-processing ability that allowed efficient and accurate gathering of point provenience on all excavated material, deemed necessary by the growing awareness of the complexity of formational processes. For instance, these technological developments allowed identification of the decomposed crania as clusters of bone splinters surrounding the many preserved tooth rows (Todd and Rapson 1999). The fine-scale documentation of vertical spatial relationships also influenced the archaeological interpretation of the site's stratigraphy. Artifacts were definitely observed in close association with the bones in the bonebed. Some of these artifacts appear to be on the same ground surface as the bones, and a few bones bear evidence of human butchery. However, the cultural material recovered during excavations in the years 1991–2000 is an average of 12 cm above the bonebed level, and all of the bones that show signs of cultural modification recovered during this same period are in the upper elevations of the bonebed and are generally better preserved than the bones within the main bonebed (unfortunately, comparable data are not available from those portions of the site excavated in the 1970s). The dearth of evidence for human butchery, the lack of a cliff, and the absence of other lines of supporting evidence indicate that the bonebed cannot be unambiguously interpreted as the result of human actions. There is currently no analytical support for anything other than a natural mortality that occurred close to a spring where a group of Paleoindians camped some years later (Todd and Rapson 1999). The Paleoindians dispatched and butchered bison and other animals that contribute a small number of elements to the total observed at the site, but these elements are also stratigraphically above the bonebed level. Importantly, the taphonomic reinterpretation sees the site as two closely spaced events, whereas the original interpretation argued for a single episode. Human action is highly ambiguous in the level containing the bonebed but is clearly present in a level closely above it.

Any difficulty in applying the valuable lessons of taphonomy evident in the history of research at Hudson-Meng to the study of landscapes lies only in the larger spatial extents sampled. The changes in archaeology that have occurred since the 1970s led to changes in the process of assigning meaning to pattern. Since the time of Hudson-Meng's first excavations, methods of contextual analysis and the consideration of equifinality and formational processes have become more robust (e.g., Yellen 1996). Indeed, the interpretations of many sites are likely to undergo significant alterations in light of new concepts and technologies, through no necessary fault of the original investigators. The assumption that artifacts and association are the only requirements to infer human causality has become less common in all areas of archaeological investigation but is still often the primary interpretive guideline in archaeological survey. In the study of landscapes, the spatial extent and the added complexity of surface records being modified, buried, and re-exposed at variable rates and spatial scales add further challenges to adopting a taphonomic perspective and the detailed analysis it entails. This may be why the assumptions regarding artifacts, context, and human action have been less carefully examined in landscape archaeology than in other major subdivisions of archaeological fieldwork.

From the Bonebed to the Landscape

The perspectives and lessons of Hudson-Meng were incorporated into a survey project of the surrounding grassland (Burger 2002). The first goals of the survey were to evaluate methodological accuracy and the effects of spatial scale on archaeological pattern recognition. As the survey developed, taphonomic processes relevant to the study of landscapes were specifically investigated (discussed later). Like much of the High Plains environment, northwestern Nebraska is an active, evolving landscape. The grasslands surrounding the bonebed were extensively modified by mid-Holocene erosion that culminated at around 5,500 B.P. (based on radiocarbon dates: e.g., LaGarry and LaGarry 2001; LaGarry, LaGarry, and Swinehart 2001; Richardson, LaGarry, and LaGarry 2001). Any archaeological materials contained within the eroding sediments would have been redeposited on Oligocene-age sediments of the region's badlands. In some cases, these deflated archaeological materials were subsequently reburied by later Holocene sediments. Thus archaeological materials that have undergone major rearrangement from erosional processes are now encased in a stratified sod table. Consequently, the assumption that buried artifacts are "better" or in primary context is problematic, as the artifacts on the surface in some locations may be closer to their original depositional setting than the artifacts buried below them.

On the ONG, archaeological visibility tends to be greatest in areas of deflation, slow deposition, and low vegetation cover. These areas often occur as eroding late Holocene sod tables, deflated Oligocene surfaces, or the windward side of stable ridges. Difficulties of deposition are compounded by biological agents such as the gophers that constantly cycle sediment both vertically and horizontally and by large herbivores whose hooves scatter and modify surface and near-surface materials. Thus any study of landscape patterning, just like bonebed patterning, must acknowledge a suite of contributing processes. A taphonomic perspective that focuses on the agents of change over time and on multiple accumulators of archaeological materials facilitates this integration.

Archaeological survey, as the method for studying landscape-level patterns, should be equipped to understand complex formational histories and not just to discover artifacts or sites (Barton et al. 1999, 2002; Burger et al. 2004; Foley 1981; Given et al. 1999; Thomas 1975). This involves conceptual and methodological challenges because virtually all patterns of archaeological interest occur at scales that are inconvenient for direct investigation. One of archaeology's great strengths is the ability to study change at scales larger than humans can directly perceive in their own life spans (Shennan 2002). Yet even at these large temporal scales, perceived landscape archaeological patterns may be more the product of sampling design or other taphonomic processes than the direct result of human land use.

SURVEY AS SAMPLING

Methodological sampling decisions must be evaluated in a taphonomic study of landscapes. To understand the nature of archaeological samples, it is important to document where surveyors looked and how intensively. Archaeological survey is a multistage process (Given et al. 1999; Schiffer, Sullivan, and Klinger 1978), and one of these stages should ideally be aimed at high-resolution glimpses of the record. These observations at a finer scale can be used to augment the norm of coarser-grained samples that favor area at the expense of accuracy (extensive versus intensive survey coverage). In this sense, one requirement of archaeological survey is the discovery of material, while another is experimental investigations aimed at understanding the properties of the record (see Burger et al. 2004 for further discussion of property- vs. discovery-based investigation). Property-based methods include evaluating the influence of taphonomic agents on archaeological distributions and the effects of methodology on the accuracy of surface samples (Burger et al. 2004). While we favor detailed recording strategies in many settings (i.e., point proveniencing of surface artifacts and attribute-based artifact description), we are not arguing against the use of coarse-grained transect methods as the focal component of surveys. Many of the important patterns of archaeological interest could not be identified without an understanding of large spatial-scale, coarse-grained patterns (Willey 1953). Property-based methods are emphasized here because they are also important, are relatively underdeveloped in archaeology, and are fundamental to the building of a landscape taphonomy.

The most commonly manipulated element of archaeological survey is transect spacing, or the distance between pedestrian surveyors. However, there seems to be little consensus regarding the optimal transect spacing or, for that matter, the rate of movement of a survey team over the landscape (Banning, Hawkins, and Stewart 2004; Burger, Todd, and Burnett 2004). Artifacts pass between surveyors, but we lack the tools for assessing how many (Banning 2002; Burger et al. 2004). What is the significance of overlooked materials, and how does their elimination from the regional sample impact interpretations? To assess the extent to which past human behaviors (as opposed to contemporary "behaviors" of the archaeologists who select the survey design) contributed to the properties of artifact distributions, we require an understanding of how basic elements of survey design, such as transect spacing, influence attributes of the sample. Survey without a finer-grained examination of what the coverage design misses is akin to excavation without using a screen—no matter how much is recovered, you still have no idea what types of information have passed unnoticed.

During the archaeological survey on the Oglala National Grassland, we attempted to build on the tradition of "siteless" survey as pioneered by David Hurst Thomas (1975) and Robert Foley (1981) (see also Dunnell and Dancey 1983; Ebert 1992). Siteless or distributional survey tactics are much less assumption-bound regarding the nature of landscape distributions and are well suited for property-based investigation. Siteless survey naturally complements a taphonomic perspective on landscape archaeology:

> The material record will almost certainly be acted upon by a series of partially overlapping depositional and postdepositional processes of widely varying scales. These processes will combine the products of behavior episodes; blur or sharpen (and in fact probably create) their apparent boundaries; and differentially affect the placement of artifacts, depending on their sizes and shapes. These effects are all-important, for they determine where we see sites and what these sites look like. They also may be responsible for the fact that we think we see "sites" at all in many places. (Ebert and Kohler 1988:126)

Just as technological developments facilitated formational analysis of bonebeds, siteless survey tactics have become much more feasible to implement as a result of developments in GPS (Global Positioning System) technology.

Because artifacts, as opposed to sites, are the units of measure in siteless or distributional surveys, an accurate and efficient means of documenting provenience is needed. The system we used for the ONG survey (Locus® by Thales Navigation©) provides subcentimeter UTM coordinates (post-processed) on every documented artifact. Such resolution is valuable for addressing fine-grained patterns, investigating survey accuracy, and studying the formational histories of artifact accumulations. Additionally, the use of the UTM grid for regional documentation has the advantage of applying a single grid system to locate artifacts, thereby removing the numerous difficulties of cluster-specific grid coordinates (i.e., site-based provenience). However, the perspectives of landscape taphonomy can still be implemented with less precise and less expensive technology.

SCALE

Archaeological Scales

The study of landscapes generally requires inferences of large-scale processes based on small-scale observations. Scaling up, in this sense, requires explicit attention because a change in scale leads to changes in the properties of the pattern as well as in the processes responsible (Gardner 1998; Schneider 1998, 2001; Schneider et al. 1997; Wiens 1989, 2001). Additionally, both recognition and interpretation of archaeological patterns require the formulation of concepts and models well "outside the familiar spatiotemporal range" in which everyday experiences are "mechanically grounded" (Church 1996:150).

Scale is an important consideration for any interpretation of the archaeological record. Many fundamental properties of the patterns recorded in the field can be largely determined by the scale used for documentation and measurement (Burger and Todd 2006). Consequently, scale is initially an issue of sampling design because assemblage properties can change with the size of a sampling frame (Banning 2002; Hodder and Orton 1976; Wiens 1989). A distribution may seem homogeneous at one scale and more variable at another. Sites themselves are scale-dependent phenomena in that clustering of material can occur at any reasonable scale above that of the individual artifact, and the scale at which clustering is considered significant determines the nature of the relationship between clusters (Ebert 1992). The problem of assuming that we can attribute meaning to clusters of cultural material based on initial impression while field recording is compounded by a tradition of addressing patterns from a single scale of observation. Understanding properties of archaeological distributions requires multiple scales of observation and analysis.

Using a Sampling Frame Designed for Plants

Plant ecologists have rigorously investigated the relationships between a sampling design and the properties of the sample. Because the spatial heterogeneity and small unit size of plants are analogous to artifact distributions, it follows that a method that is exceptionally good for sampling plant communities can be conceptualized as appropriate for property-based archaeological surveys (Foley 1981:174). For these reasons, the Modified-Whittaker multiscale sampling plot was used to investigate the properties of the ONG archaeological landscape (Figure 8.3). It has proved ideal for developing property-based archaeological investigation (Burger 2002). The nested subdivisions in the plot's framework are designed to gather observations at the spatial scales of 1, 10, 100, and 1,000 m^2 (Figure 8.3; Stohlgren, Falkner, and Schell 1995). This progression from smaller to larger subplot sizes facilitates evaluating the influence of spatial scale on pattern and accuracy (and other properties). Additionally, the spatial arrangement of the 1 m^2 subplots reduces the amount of spatial autocorrelation between samples (Stohlgren, Bull, and Otsuki 1998; Stohlgren et al. 1997). In plant ecology, the Modified-Whittaker plot has drastically improved vegetation surveys by finding more rare or exotic species than traditional survey methods uncover (Stohlgren, Bull, and Otsuki 1998; Stohlgren et al. 1997; Stohlgren, Falkner, and Schell 1995). The multiscale layout is valuable for analyzing community structure and for understanding the influence of spatial scale on the properties of the sample.

SUMMARY OF THE OGLALA NATIONAL GRASSLAND SURVEY PROJECT

Survey Strategies

During the summers of 1999–2002, fourteen Modified-Whittaker plots were placed in various locations on the grassland surrounding Hudson-Meng. A few were completed each summer as exercises for an archaeological field school through Colorado State University. These were the experimental units for investigating issues of sampling design and taphonomy. The major methodological points have been presented elsewhere (Burger et al. 2004), but a few need to be summarized here. We covered these plots with a "nested-intensity" survey design. That is, each plot was covered with a series of observational intensities to evaluate the effects of method on the accuracy of our documents (e.g., transect spacing, walking vs. crawling, screening of the taphonomically active zone to assess the "actual" artifact counts). These experiments demonstrated

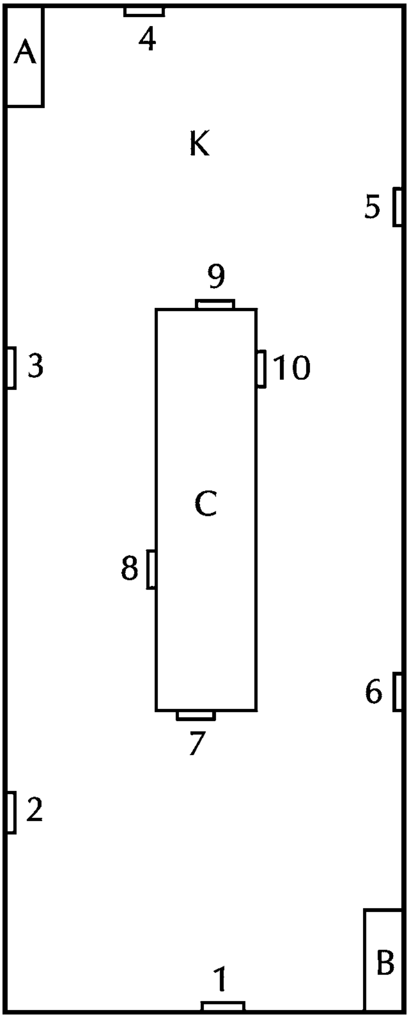

FIGURE 8.3.
The Modified-Whittaker multiscale vegetation sampling plot. The numbered subplots (1–10) are 2 × 0.5 m, subplots A and B located in opposite corners are 2 × 5 m, the central C subplot is 5 × 20 m, and the outer K plot is 20 × 50 m. This allows the properties of samples to be evaluated at the spatial scales of 1, 10, 100, and 1,000 sq m. Subplots 1–10 are arranged to reduce the amount of spatial autocorrelation in the sample.

that conventional transect surveys overlook major amounts of material and further support LuAnn Wandsnider and Eileen Camilli's (1992) observations that even very narrow transect widths systematically underrepresent low-density portions of the surface record. Our experiments involved comparing the results of a systematic walking survey with a spacing of 70 cm between crew members with those of a crawl survey that covered the same areas with a different crew. For the crawl survey, crew members covered the demarcated subplots (1–10, A, B, and C; Figure 8.3) on hands and knees with shoulders touching (i.e., 0 cm transect spacing). After each survey, additional artifact discoveries could be made while recording the systematically discovered items.

Because of our intensive recording strategy, similar to that used in the Hudson-Meng bonebed (in some instances recording over twenty attributes per item), the ground surface around the systematically discovered items was intensely resurveyed. The crawling surveys seemed to find all items on the surface in the first pass, whereas the walking survey missed considerable amounts of material (Burger et al. 2004). In fourteen trials, the crawl survey found between 170 and 1,000 percent more material, with a mean increase of about 350 percent. This comparison is for the combined artifact counts from the systematic and nonsystematic discoveries (i.e., those found during the documentation phase rather than during the survey phase). If only the systematic coverage is included, the percentage increase in recovery rate is much larger for the crawling survey. This provides a starting point for analyzing the effects of transect width on the recorded artifact population.

Additionally, we wanted to address the question: What do we "miss" during a survey? This requires a high-resolution sample (Cowgill 1990; Dunnell and Dancey 1983). We are not arguing that all surveys should be conducted at a crawl but rather that one phase of a sampling design that assesses the rate of "failure to discover" needs to be incorporated into archaeological survey. With such variance in small-scale artifact recovery and the magnitude of materials that pass between surveyors, parameters as basic as mean or median surface artifact density are wholly unknown with conventional methods. It may be that survey intensity influences patterning as much as spatial scale and taphonomy do (Burger et al. 2004; Burger and Todd 2006). Property-based methods are essential to landscape taphonomy surveys because they aid in identifying the many complex factors that influence properties of samples that become the basis of anthropological interpretation, but survey in any context can benefit from a property-based approach.

Two Experiments with Taphonomic Agents: Ants and Cattle

Thus far, we have shown how scale is a methodological and conceptual problem that is better dealt with by adopting the appropriate tools. We need to blend this with actual applications that help identify the multiplicity of sources contributing to landscape-level patterning from a taphonomic perspective. Specifically, we are interested in cumulative effects that compound with time to influence the landscape of the ONG and the effects of different agents that accumulate and modify cultural materials. Because nonhuman agents are generally underestimated in interpretations of landscape patterns but are essential to realize the model of landscape taphonomy outlined earlier (Figure 8.2), we focus on two important behaviors that leave distinctive signatures: harvester ant foraging and cattle grazing (or other large herbivores in the past). These two modest studies are small parts of a much bigger puzzle, and neither on its own answers the interpretive and managerial challenges archaeologists face; but the role of such processes is important for any study of artifact patterning on landscapes or within excavations.

Ants. Harvester ants (*Pogonomyrmex occidentalis*) are excellent teachers for lessons of scale. For instance, when one looks at the distribution of mounds at a neighborhood scale (neighborhood from the ant's perspective), the spatial distribution is nonrandom in that the mounds repel one another through competitive exclusion (Taber 1998). However, if one increases the scale, ant mounds across a larger area will seem to cluster together because they have similar niche preferences. The key point here is that as one's perspective shifts scale, it is not just the pattern that changes but also the processes responsible (Allen 1998).

A study of ants is also particularly relevant to the landscape taphonomy approach because of their tendency to collect and accumulate cultural debris during their foraging rounds (Burris 2004). Consequently, many archaeologists have been taught to look at ant mounds for small flakes or beads, often with the idea that the artifacts represent windows into subsurface materials. Part of the ONG survey project involved evaluating this conventional archaeological wisdom from a landscape taphonomic perspective by investigating how ants forage for such materials. From how far away do ants bring artifacts, what do they bring, how quickly do they accumulate, and are they collecting from the surface or are the mounds only backdirt from the subterranean burrows?

An initial test with colored beads placed in concentric circles around an ant mound demonstrated that ants will go far beyond the vegetation-cleared patch surrounding the mound (this area is known as the disc, Figure 8.4). This preliminary test placed beads to a total distance of 80 cm from the center of the mound, and all the beads were gathered within just three days. A second experiment was then devised to investigate how ant foraging impacts chipped stone movement. In this second experiment, beads were placed in concentric circles around an ant mound at 50 cm for every interval out to 5 m. The beads from each ring were a different color, which identified each bead's minimum transport distance upon arrival on the mound. Ant foragers were returning home with colored beads before we had finished placing them on the ground.

FIGURE 8.4.
*Example of a harvester ant (*Pogonomyrmex occidentalis*) mound.*

At the end of a week, the majority of beads from all the circles out to 5 m were on the mound, and all the beads had been collected within a month. This is an area of 80 m^2 that the ants had thoroughly cleaned of appropriate building materials brought to the mound's surface. One of our beads showed up at a neighboring mound and had a total transport distance of about 18 m. These preliminary studies have been expanded upon and are reported by Lucy Burris (2004), who found that the collection radius tended to be about 12 m but could be as far as 20 m. In another part of this study, we investigated the chipped stone contained within ant mounds and found an average flake length of about 6 mm, but a few flakes in ant-gathered assemblage were over 1 cm. A particularly dense mound contained over 100 pieces of chipped stone. Thus ant foraging is a small-scale process with significant long-term effects on archaeological distributions (Burris 2004; Schoville and Todd 2001). Over archaeologically relevant timescales, the operation of multiple generations of mound colonies has the potential to significantly redistribute many of the smaller pieces of debitage across a landscape. This potential for size sorting can eliminate smaller flakes from some artifact scatters and accumulate them in very dense clusters at others.

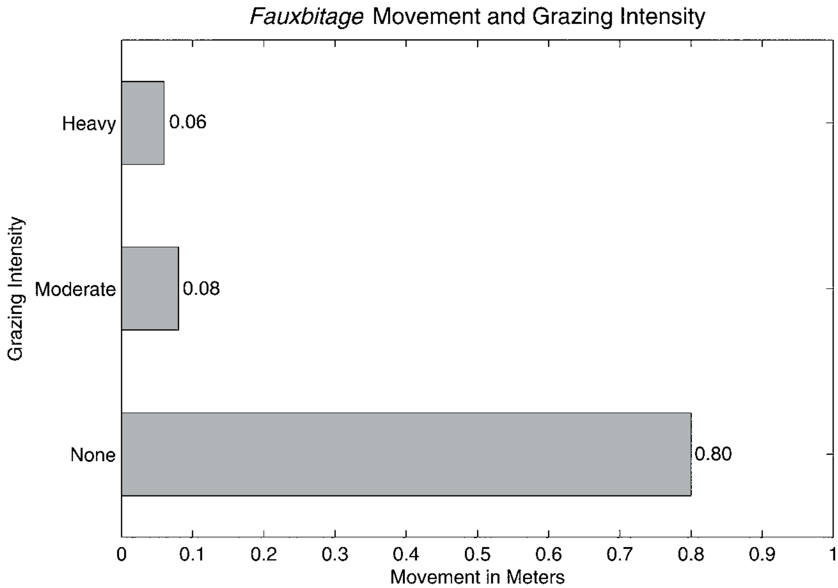

FIGURE 8.5.
Influence of grazing intensity on artifact displacement during the study period.

Cattle. A second study investigated the influence of large-bodied herbivore grazing on the properties of artifact distributions. As with the ant study, conventional archaeological wisdom (and common sense) tells us that cattle (*Bos taurus*) can influence artifact distributions. Cows kick things around, can influence erosional patterns, and have a variety of effects on surface visibility. With regard to artifact displacement, we began our study with the aim of answering questions such as: How much, and how far? Three Modified-Whittaker plots were placed in locations designed to answer these questions. One of the plots was ungrazed (within a fenced enclosure), the second was moderately grazed (in a pasture away from water tanks and fences), and the third was placed in an intensively grazed setting (adjacent to a water tank). The plots were surveyed early in the summer and then resurveyed after a single season of grazing.

In the intensively grazed plot, the average movement of our artificially introduced and individually numbered aluminum *fauxbitage* (fake debitage) was over 60 cm, and one in particular moved over 2.5 m (Figure 8.5). Moreover, thirteen of twenty-four of the *fauxbitage* could not be relocated. This is likely a result of the effects of scattering from trampling and from the high rate of cow

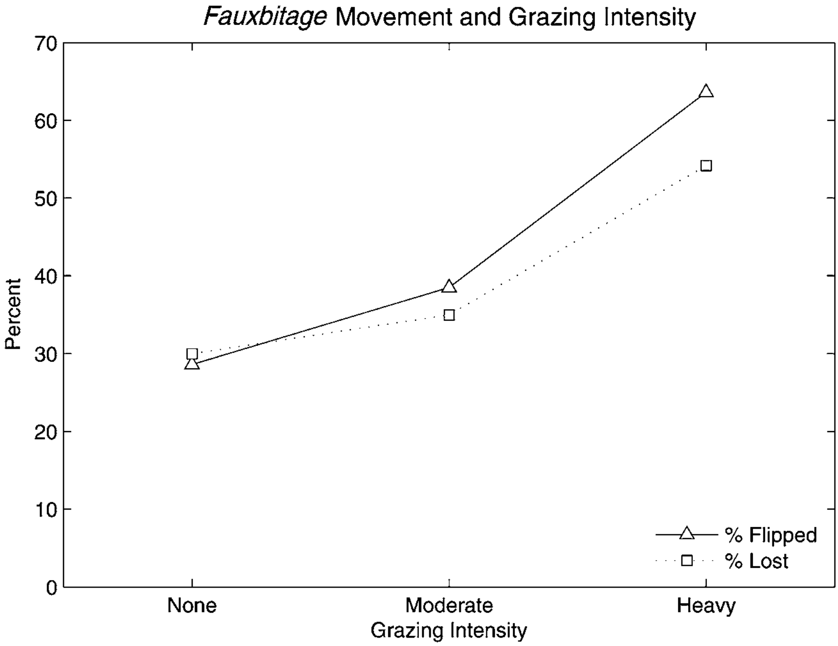

FIGURE 8.6.
Grazing intensity also influenced artifact recovery. As intensity increased, the number of fauxbitage *that were not relocated increased. We did not use a metal detector and assume that the* fauxbitage *are covered by sediment, excrement, or both. More of the subset of artifacts recovered were flipped side-up as grazing intensity increased.*

pie deposition in the plot (cow pies were mapped in each plot and served both as a measure of how much surface area was obscured and as a proxy measure of grazing intensity). In the moderately grazed and ungrazed plots, a few of the *fauxbitage* were not found during the second year's survey, but the number lost increased with grazing intensity (Figure 8.6). However, *fauxbitage* movement and loss in the moderately grazed plot were only slightly greater than in the ungrazed plot (6 of 20 lost in the ungrazed plot and 7 of 20 in the moderately grazed plot).

Part of the experimental investigation of multiple landscape-modifying agents is an evaluation of the experiment itself, as there is always a strong possibility that unaccounted-for intrusive effects have influenced the results (Hurlbert 1984). Figure 8.7 suggests that the plots were actually grazed at the intensities suggested in the design of the experiment. Cow pie density plots are

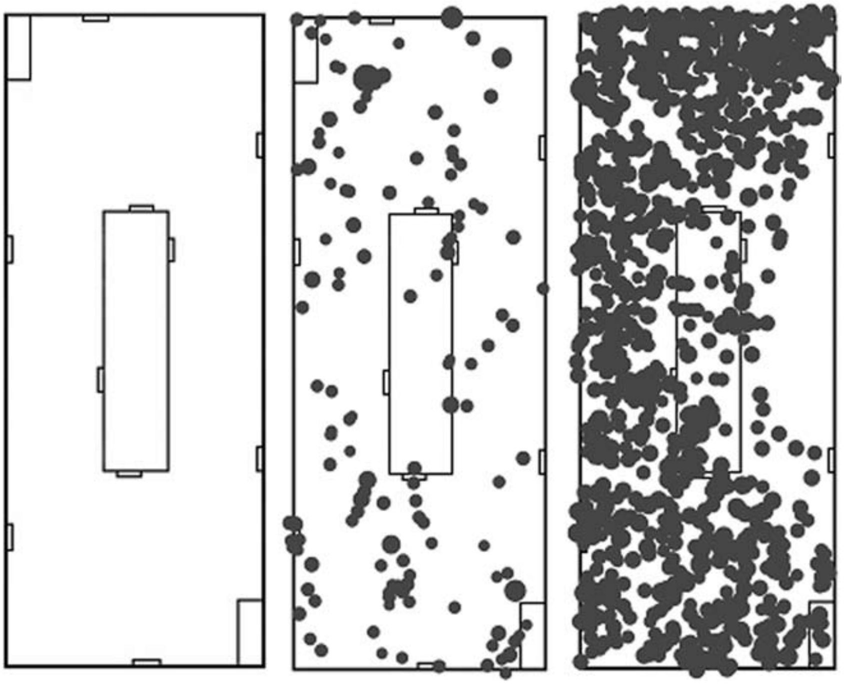

FIGURE 8.7.
Cow pie density plots. The ungrazed plot (left), moderately grazed (middle), and heavily grazed (right). The density of cow pies on each plot suggests that the experimental effects met the needs of the design. The empty area in the right of the heavily grazed plot is the location of the water tank.

an accurate measure of where cattle spend time. While they serve to evaluate the control of the experiment, they also could have a more practical application for future grazing-intensity studies. Perhaps a threshold level of grazing impact could be determined, and grazing intensities above that value should not be allowed on the surface of cultural properties. A relatively quick means of assessing grazer impact is provided by the readily identifiable telltale signs of their presence (Figure 8.7).

Because the *fauxbitage* were numbered on one surface, we could also record the minimum number that had been flipped over during the grazing episode (of course, it is possible that some were flipped and subsequently flipped back to the numbered surface upward position). Again, the moderately grazed plot exhibited slightly greater flipping than the ungrazed plot, and the heavily grazed plot was the most severely altered (Figure 8.6). Future studies could assess the possibility that sites located away from cattle trails or sources of water or food are not significantly impacted by grazing. On the other hand, this brief study demonstrates that sites located in heavily grazed settings will be heavily impacted. As in other property-based evaluations of landscape properties, these results need to be scaled up to assess the long-term influence of grazing. Would the moderately grazed setting become as altered as the heavily grazed setting over a number of years? Hoofed grazers have been a part of the Plains landscape for longer than there have been chipped stone artifacts; hence, evaluating their impacts is of fundamental importance, especially with regard to potentially compounding effects over time.

SUMMARY AND CONCLUSIONS

We have outlined five basic steps for building a landscape taphonomy. The first of these is the need to embrace distributional archaeology and the realization that sites represent archaeological decisions rather than observations of the surface record (Dunnell and Dancey 1983). The early practitioners of these approaches made valuable strides toward investigating what the record is really like, a necessary first step for an inclusive landscape perspective. The second step is a critical evaluation of the process of attributing meaning to pattern, which is accomplished by adopting a taphonomic perspective that places biological, physical, and cultural processes on equal ground in terms of their ability to influence material patterning on the landscape. The third step is the investigation and experimental exploration of the formational properties of landscape samples. The properties of the sample confine the range and types of pattern that will be identified, and methodological decisions can create situations where these patterns are products of observational inaccuracies. The fourth step is to evaluate the influence of scale on the nature of pattern with property-based investigations and to adopt techniques for bridging across scales. The fifth step is to investigate the specific ways various agents influence archaeological patterns. These steps are by no means exhaustive, but they touch on the highlights of our approaches to these issues.

Documented patterning in archaeological materials can have many possible causes. Among these are scale, taphonomic agents, sample size, and survey intensity. All of these are part of understanding the archaeological record, its nuanced structure, and the behavioral information it contains. Interdisciplinary research should continue to be one of archaeology's hallmark traits (van der Leeuw and Redman 2002). None of the research presented here would have been possible without some degree of interdisciplinary collaboration. The concept of taphonomy itself comes from another field. Many models, perspectives, and methodologies will be discarded in the process of evaluating methodological accuracy and aspects of equifinality. As anthropological archaeologists, we often have humans in mind when we record field information and when we interpret the acquired data, but we should attribute cultural meaning to elements of pattern only after appropriate consideration of the complexity of the record (e.g., Yellen 1996). "It is rarely, if ever, the case that the appropriate notion of pattern is extracted from the phenomenon itself using minimally biased procedures. Briefly stated, in the realm of pattern formation 'patterns' are guessed and then verified" (Crutchfield 1994:3).

While the models, ethnographic data, and preconceived visions of the past exist at one set of spatial and temporal scales, the archaeological data relevant to past human action generally represent very large scales (Figure 8.8). Yet the use of the appropriate set of conceptual and methodological techniques can aid in bridging the gap between behavioral models confined to the range of scales relevant to everyday human perception and the large-scale behavioral patterning in the archaeological record. While the spatial and temporal variability represented by all of taphonomy is far greater than the actions of individual human behaviors, the variability of both can be investigated and understood. We need to see taphonomy as a domain of investigation that enhances our ability to decipher complex landscapes composed of interacting cultural, biological, and physical processes rather than as a laundry list of things obscuring a portrait cultural landscape.

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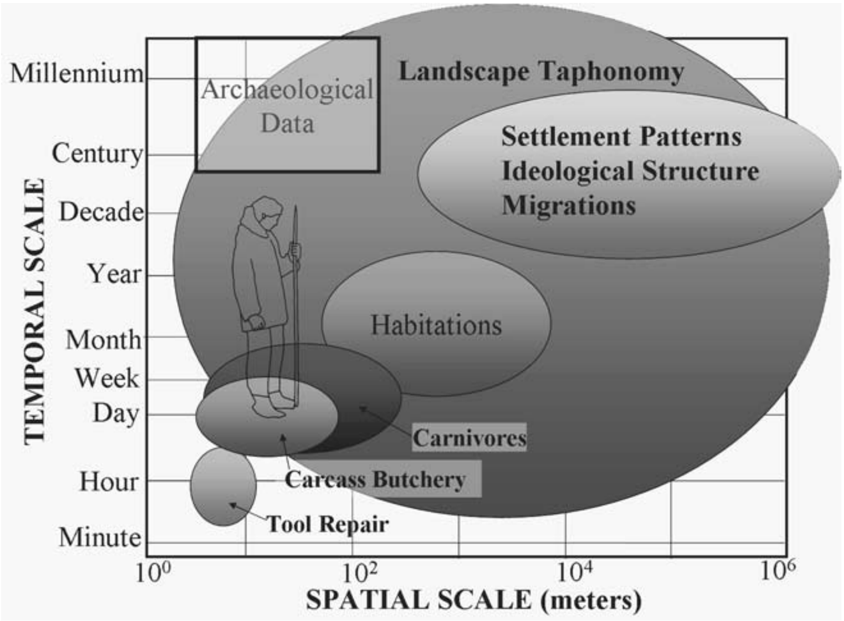

FIGURE 8.8.
Human behavior and archaeological data in space and time. (Note: the axes are logarithmic, so incremental increases on each axis represent an order of magnitude increase in scale.) Many of archaeology's behavioral models are designed for small-scale explanation and recognition of behavioral variation that would be confined to the lower left portion of the figure, but the archaeological record consists of patterns represented at very large scales. Day-to-day human behavioral events obscure the variation in other processes. The human figure is scaled to represent the approximate extent of the space and time a human might generally influence during a lifetime.

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