

LATE PLEISTOCENE/EARLY HOLOCENE SITE STRUCTURE IN BERINGIA: A CASE STUDY FROM THE BROKEN MAMMOTH SITE, INTERIOR ALASKA

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ABSTRACT

Intrasite spatial analysis and the characterization of site structure at archaeological sites consider the relationship between archaeological material to derive connections between economic and social behavior through the prehistoric use of space. This paper examines the spatial distribution of hearth features, débitage, and faunal remains in the late Pleistocene and early Holocene cultural components of the Broken Mammoth site, near Big Delta in interior Alaska. *K*-means analysis was used to reconstruct activity areas including lithic workshops, meal preparation areas, and refuse zones. Site organization suggests Broken Mammoth was a semipermanent base camp for early colonists of eastern Beringia.

KEYWORDS: spatial analysis in archaeology, prehistoric activity areas, *K*-means cluster analysis, Beringia, Paleoindian archaeology, Broken Mammoth Site

INTRODUCTION

Most research on late Pleistocene and early Holocene sites in eastern Beringia has focused efforts on technological connections to Siberia and Northeast Asia (Goebel et al. 1991; Hoffecker et al. 1993; West 1996; Yi and Clark 1985). Studies of intrasite artifact distributions and site structure have seen much less research emphasis, but a few notable exceptions exist (Higgs 1992; Hoffecker 1983a, 1983b; Potter 2005; Reanier 1992; Thorson 2006). Intrasite structure has bearing on the nature of land use, mobility, and settlement patterns for the earliest Alaskan colonists. Combining technological studies with detailed information from site organization produces enhanced descriptions of adaptive behavior by better separating individual activities from otherwise palimpsest assemblages.

The Broken Mammoth site, located near Big Delta in the central Tanana Valley of interior Alaska, provides an excellent case study for the analysis of site organization of early Alaskan inhabitants because of the presence of nu-

merous hearth features in well-stratified contexts, relative lack of postdepositional taphonomic disturbance, and faunal preservation (Yesner et al. 1992). This paper addresses the spatial structure of lithic and faunal patterns in the two oldest components of the Broken Mammoth site, cultural zones 3 and 4, dated between 12,000 and 9,300 ¹⁴C yrs BP. In doing so the following questions are addressed:

1. Are activities spatially segregated in each cultural zone?
2. How intensely was the site used during each period of occupation?
3. Can individual activities help to discern occupation type?
4. Did the function and structure of the site change over time?

Archaeological remains are patterned because of patterned human behavior, and therefore site organization reflects the underlying use of space and can relate to larger

issues of settlement and economy (Binford 1978a; 1978b; Clarke 1977; Schiffer 1972). Detailed spatial analyses, when employed in conjunction with behavioral frameworks developed through ethnoarchaeological research, have the ability to augment interpretations of site structure, site function, human behavior, chronology, and taphonomy. Further, spatial analysis can establish the limits of activity areas and identify tool kit associations (Carr 1984). Data this specific can be employed to identify behavioral change through time. For example, *k*-means clustering analyses of European Middle and Upper Paleolithic sites demonstrate social change between these periods, partly through a change in archaeological site structure and organization. Middle Paleolithic sites such as Mauran contain only simple hearths that did not serve as the central point for activity. Variation in cluster density and content was also lacking (Simek 1987). In contrast, Upper Paleolithic sites such

as Abri Pataud and Le Flageolet each contained multiple hearths that served as focal points for artifact deposition with associated material scattered in fan-shaped patterns away from the hearths. Further, cluster content, density, shape, and size were highly variable (Gamble 1999; Simek 1987). Hearth-centered activities in the Upper Paleolithic are indicative of a shift in the cognitive use of space with an ability to compartmentalize separate activity areas at a level not present in the Middle Paleolithic.

In eastern Beringia, spatial analyses have been applied to late Pleistocene and early Holocene sites in various regions of interior and northern Alaska. Artifact concentrations in Components I and II at the Dry Creek site, Nenana Valley, have been demonstrated to overlap, suggesting the possibility of postdepositional sediment and artifact mixing (Hoffecker 1983b; Thorson 2006). Also in the Nenana Valley, three discrete artifact concentrations

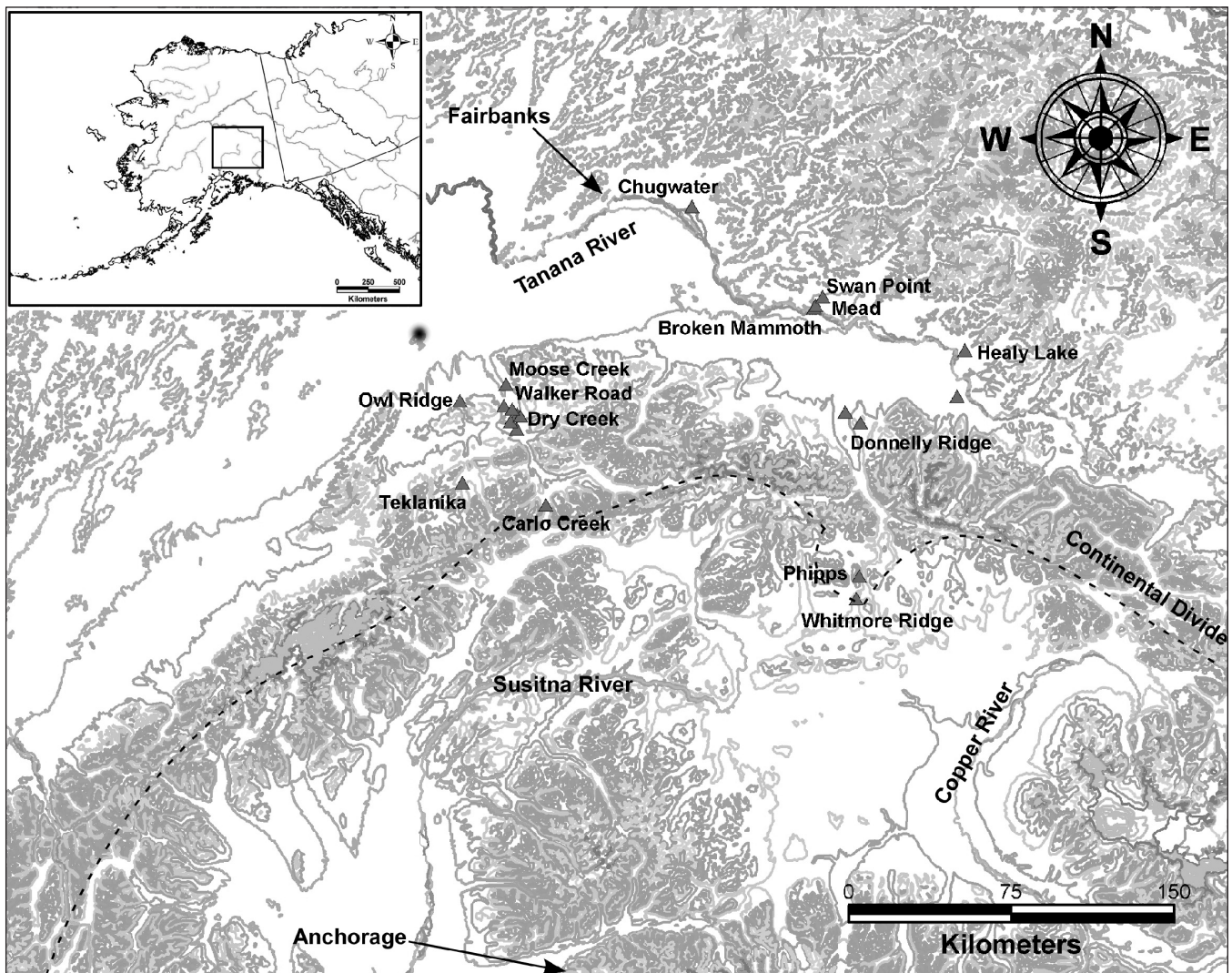


Figure 1. Early Sites in Interior Alaska. Modified from Wygal 2003:19.

were identified at the Walker Road site. Refitting studies demonstrated that these clusters were meaningful units, because materials found in clusters were only found to refit with other material from the same concentration (Higgs 1992). Spatial analysis from the Mesa site in northern Alaska demonstrated that a microblade assemblage there represented a separate occupation from the Paleoindian Mesa Complex occupation (Bever 2006; Kunz et al. 2003). While the primary Mesa Complex artifact concentration was spatially segregated from the microblades, Mesa Complex artifacts also occurred within the microblade scatter. They are interpreted as two separate occupations, because postdepositional downslope movement was demonstrated by refit studies. Further, raw materials used to produce the microblades were absent in the Paleoindian assemblage (Bever 2006; Kunz et al. 2003). Most recently, closer to the Broken Mammoth site in the Tanana Valley, detailed spatial analyses at the Gerstle River Quarry site demonstrated that contemporaneous, spatially separate faunal clusters were related to different stages of carcass processing (Potter 2005, 2007). These sites and other late Pleistocene/early Holocene archaeological sites from interior Alaska are depicted in Fig. 1. The present study uses a similar approach to identify differences in site structure and function at the two earliest components of the Broken Mammoth site.

THE BROKEN MAMMOTH SITE

Holmes and McAllister discovered the Broken Mammoth site in 1989 when highway construction exposed paleosols, hearths, animal bones, and cultural material, including fragments of mammoth ivory. The site (Fig. 1) sits on top of a 30 m bluff overlooking the confluence of Shaw Creek and the Tanana River (Holmes 1996; Yesner 1996; Yesner and Stone 2001). Like other late Pleistocene and early Holocene sites in interior Alaska, Broken Mammoth has a view of a broad river valley and the Alaska Range from the south face of a bluff. Fittingly, the Tanana Athabascan name for the site means “place where one can see far” (Yesner 1996).

Four cultural zones (hereafter abbreviated “CZs”) occur within approximately 2 m of stratified aeolian silt (loess) overlying late Pleistocene sands (Fig. 2). Excellent organic preservation at the site is attributed to the rapid accumulation of well-drained calcareous soils. Since its discovery, Broken Mammoth has been well documented as one of the three earliest dated sites in Alaska (Holmes

1996, 2001; Yesner 1996; Yesner et al. 1992; Yesner and Stone 2001).

The Middle Paleosol Complex contains CZ 3, an assemblage dated between 9,300 and 10,300 ^{14}C yrs BP. The CZ 3 assemblage includes microblades, bifacial knives, flake cores, choppers, hammerstones, anvilstones, and a cache of mammoth ivory tools. Multiple hearth features as well as abundant and diverse faunal material have also been recovered. One hearth, dated to 10,300 ^{14}C yrs BP, was associated with an eyed bone needle (Holmes 1996; Yesner 1996).

The oldest cultural material occurs in CZ 4 within the Lower Paleosol Complex dated between 11,040 and 11,770 ^{14}C yrs BP. The assemblage contains evidence for bifacial and unifacial lithic reduction strategies as well as plano-convex scrapers, large quartz choppers, hammerstones,

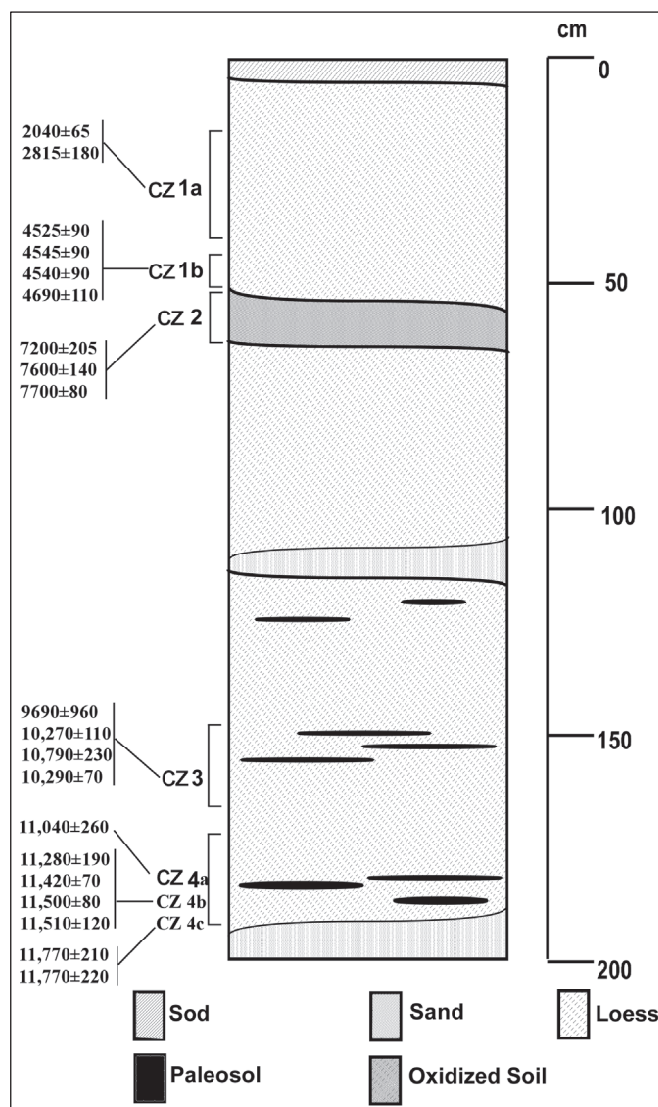


Figure 2. Broken Mammoth site stratigraphic profile.

and anvilstones. Numerous avian and mammalian remains and numerous hearths and hearth smears were also present (Holmes 1996; Yesner 1994, 1996, 2001; Yesner et al. 1992, 2000; Yesner and Stone 2001).

THE USE OF SPACE: IMPLICATIONS FOR SITE STRUCTURE

Hunter-gatherers conduct activities and use space in predictable ways. Behavioral models based on ethnographic and ethnoarchaeological studies have demonstrated that material discard, abandonment, and natural taphonomic processes affect where materials are distributed around a camp (Murray 1980; Schiffer 1972). Attempts to understand these processes and decipher meaning from the archaeological record based on ethnographic analogy have

been extensive (Binford 1978a, 1980, 1983, 1987, 1991; Carr 1991; Enloe et al. 1994; Jochim 1976; Kent 1984, 1987; Simek 1989; Stevenson 1985, 1991; Whitelaw 1991; Yellen 1977). In particular, Binford's (1983) ethnoarchaeological study of mobile hunter-gatherer and pastoralist cultures led to a universal description for individuals working around hearths. According to his model, individuals sit obliquely from hearths as they perform activities including meal preparation and tool manufacture. During these activities, they drop small objects such as bone fragments and other debris into the "drop zone" beside the hearth, while larger objects are tossed forward or backward into "toss areas" (Binford 1983). Few items fall into the hearths themselves and a doughnut-shaped distribution of waste material forms around the feature (Fig. 3).

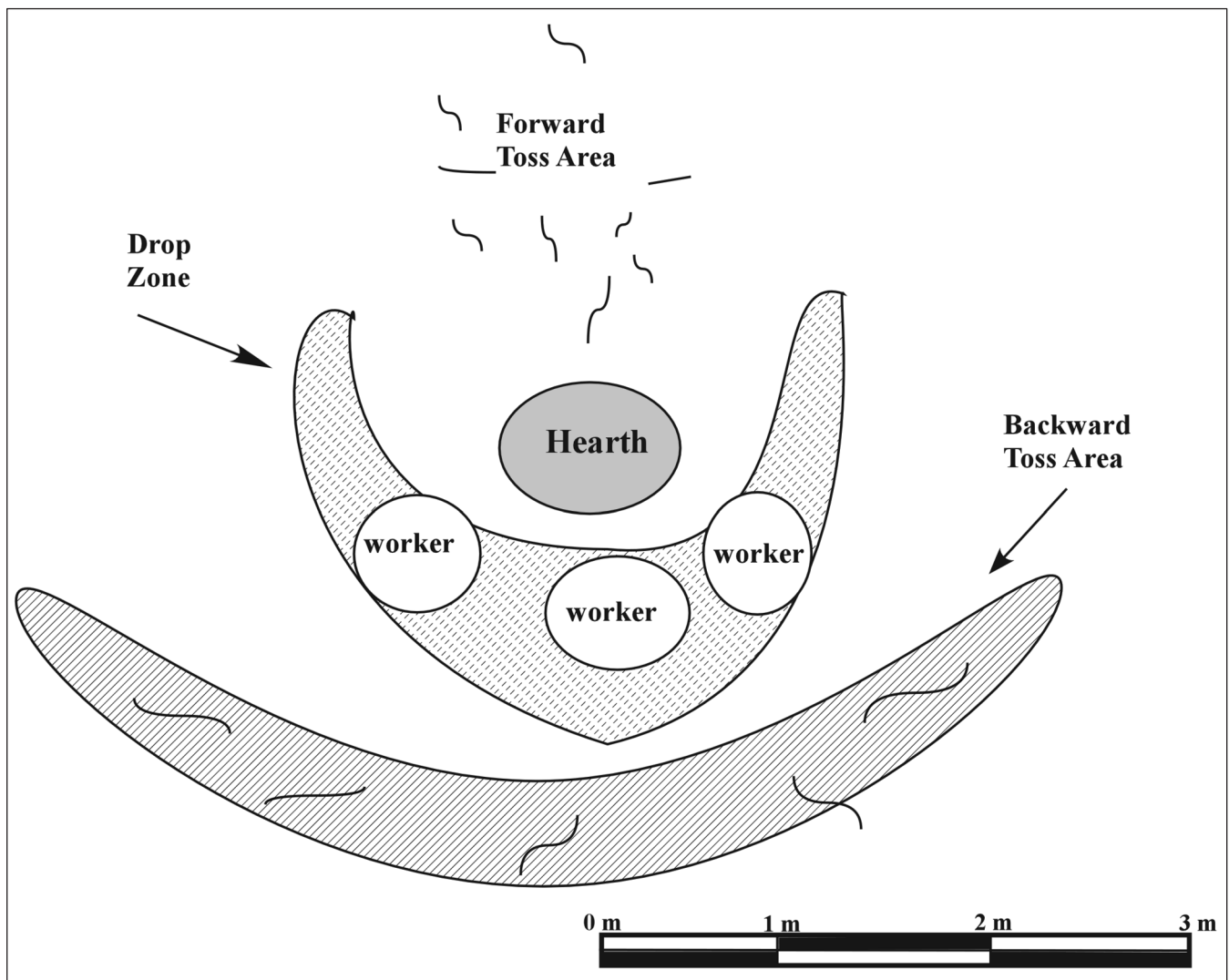


Figure 3. Binford's "Working Around a Hearth" model. Modified from Binford 1983:153.

This phenomenon has been observed in numerous ethnographic cases among the !Kung Bushmen, Nunamiut Eskimos, and Navajo (Binford 1983), and documented archaeologically in Upper Paleolithic sites (Cahen et al. 1979; Carr 1991; Simek 1987; Simek and Larick 1983; Whallon 1973). Applying this model to a prehistoric site in northwest Alaska, Anderson (1988) demonstrated that activity-specific debris was concentrated within distinct areas 2 m in diameter at Onion Portage. He argued that as more individuals sat around a single hearth, this diameter would gradually increase, and thus give a relative indication of group size.

Further archaeological distinctions can be made between *inside hearths* and *outside hearths* in that the former tend to be better contained and discrete as a function of increased maintenance inside the structure (Binford 1983; O'Connell et al. 1991). As hearths are cleaned, detritus is scattered or pitched away from hearths. Linear distributions or diffuse cultural material may be an indication of hearth clearing. Material discarded around *inside hearths* may even form rings or arcs of material as it tends to migrate to the edges of tents over time. Outside hearths do not usually receive as much attention. As a result of hearth maintenance, refuse areas or dump zones are produced through an accumulation of objects, circular and dispersed in nature. Foot traffic or shuffling creates further horizontal spreading of the material, which may become size-sorted over time (Binford 1983; Stevenson 1991).

Intensive activities like tool manufacture typically occur while seated near a hearth and conform to Binford's (1983) drop and toss zones model, with distributions that do not usually exceed Anderson's (1988) 2 m diameter observations. During extensive activities (e.g., butchering) material distributions deviate from those produced by intensive activities (e.g., tool manufacture). In the former, not only does the worker constantly shift positions around the work area but these activities also do not typically occur around hearths. Thus, discarded material spans larger areas and is less densely clustered than material deposited during intensive activities. Binford's (1978a, 1978b) ethnographic accounts noted that numerous factors influence human behavior around hearths—including wind direction, which plays a significant role in deciding where one sits.

Hearth features commonly serve as the center of group activity (Gamble 1999), but concentrated activity is not restricted to these features. Material deposited at these locations need not be contemporaneous, and discerning how many visits were made to a specific activity area during

an occupation is not always possible. This complex variation in human behavior was demonstrated by O'Connell's (1987) research with the Alyawara, where he pointed out that different activities occur in the same location, and refuse produced by a specific activity is not always deposited at the point of production. Thus, intrasite spatial analysis should focus attention on material deposited around hearths, but it should not be limited to these features, especially if dump zones occurring away from central activity areas are suspected.

ANALYTICAL TECHNIQUES

Spatial organization must be recognized through the mathematical identification of artifact concentrations and examination of cluster maps, not solely on archaeological intuition. Through systematic correlation between clusters, site function can be inferred by assessing cluster heterogeneity and distribution across the site. The *k*-means clustering technique has been widely used to perform this analysis (Kintigh 1990; Kintigh and Ammerman 1982; Reanier 1992; Simek 1984; Simek and Larick 1983) and is appropriate here because it uses point provenience data to define clusters without reducing data to the quadrat level. It also allows the investigator to assign meaning to cluster results through the application of behavioral frameworks developed from ethnoarchaeological studies (Reanier 1992). First developed by Kintigh and Ammerman (1982), the *k*-means algorithm is a nonhierarchical divisive technique used to define clusters based on provenience data. It is nonhierarchical in that at each stage of the clustering process, one data point may be assigned to a separate cluster instead of remaining in the cluster to which it was originally assigned (Reanier 1992). The clustering criterion for *k*-means analysis, the Sum Squared Error (SSE) is defined as "the sum over all objects in the analysis of the Squared Euclidean distance from each object to the centroid of the cluster to which it was defined" (Kintigh and Ammerman 1982:39):

$$SSE = \sum_{i=1}^N [(x_i - x_{ci})^2 + (y_i - y_{ci})^2]$$

The centroid of a cluster containing point *i* is (x_{ci} , y_{ci}), and (x_i , y_i) represents the *i*th point of an *N* point data set (Kintigh and Ammerman 1982). *K*-means analysis begins with a single cluster from which subdivision into more clusters occurs at the point furthest from its assigned cluster center. Data points are then reassigned, some remaining in

the original cluster, and others in the newly formed cluster. This process continues until the specified number of clusters has been created (Kintigh and Ammerman 1982; Reanier 1992). Designed to minimize intracluster variances, it also maximizes intercluster distances (Kintigh 1990; Kintigh and Ammerman 1982).

K-means analysis is particularly flexible and diverse because it can tolerate large data sets, process any assigned number of clusters, and detect small- and large-scale degrees of patterning. When the clustering process is complete, a list of each cluster's constituents, percent of the analyzed assemblage, centroid, and radius is generated. All maps presented in this paper with *k*-means clusters depict the size and shape of these defined clusters and incorporate all assigned data points. Because the method is not intuitive, the researcher must specify how many clusters to produce. While the researcher usually has an *a priori* reason (e.g., frame of reference) to select a specific number or range of clusters, other methods can be used to determine how many clusters are appropriate. Graphical representation of the reduction of the clustering criterion known as the Sum Squared Error (SSE) can be visually inspected to identify a cluster solution by the presence of a break or shoulder (Reanier 1992). While SSE reduction plots provide a quantitative explanation for clustering decisions, this method is not without problems. The plots do not have the ability to define single cluster solutions and are dependent on grid orientation (Reanier 1992). Used in conjunction with visual expectations, Reanier (1992) developed a statistical method to assess whether clusters formed during *k*-means analysis are significantly more clustered than expected from random data using Monte Carlo methods applied to the SSE criterion. While this expectation is generally reasonable, it would prevent the formation of clusters produced from the random dispersion of material through cultural and natural taphonomic processes including trampling, shuffling, hearth cleaning, and wind movement. Since such patterns might mirror random distributions produced through Monte Carlo methods, cluster solutions with behavioral meaning are more effectively identified when sets of clusters are generated that are separated by areas devoid of lithic or faunal material. Because of the complex nature of the spatial distribution of artifacts at the Broken Mammoth site, clusters were also defined when they did not include heavy overlap and single clusters encompassing only distant outliers begin to form (Reanier 1992). When these criteria are met, clusters are then evaluated for homogeneity, location, and

size of cluster. Chi-square (χ^2) analyses were used to assess the homogeneity within and between clusters. Significant differences in cluster composition (e.g., significantly more faunal remains than débitage) may indicate the primary function of an activity area was faunal processing or meal preparation. Clusters were considered dispersed if they extended over 4 m², and diffuse if fewer than twenty data points occurred on average in a 4 m² area. Intensive and extensive work areas can be identified partly through incorporating Anderson's (1988) and Binford's (1983) expected measurements of these areas.

THE BROKEN MAMMOTH ARCHAEOLOGICAL SAMPLE

For both cultural zones 3 and 4 at the Broken Mammoth site, faunal material and débitage were subjected to *k*-means analysis to address questions about lithic manufacture, lithic maintenance, food preparation, and maintenance of hearths and other features reflecting discrete intrasite activity sets. A total of 8,675 archaeological materials were included in this analysis, deriving from excavations in cultural zones 3 and 4 at the Broken Mammoth site undertaken during the 1990–2002 field seasons (encompassing the 1990, 1991, 1992, 1998, 2000, and 2002 field seasons; only partial data were available from the 1993 field season, and material had not yet been processed from the 2005 field season at the time of this analysis). However, not all of these materials were included in the *k*-means analysis. First, formal tools, microblades, charcoal fragments, and mammoth ivory fragments were not included in this analysis because of their low frequencies in the assemblages. Instead, débitage and faunal elements, which comprised the majority of artifacts at the site (Table 1), were selected for the spatial analysis because of their high frequencies in the assemblages. These included 8,555 faunal elements and 5,264 débitage fragments (Table 1).

Furthermore, because of differential recovery of these materials, a problem with all archaeological sites, not all of

Table 1: Broken Mammoth cultural zone 3 artifact frequencies

Type	Frequencies	Number included in <i>k</i> -means analysis	% included in <i>k</i> - means analysis
Fauna	5,325	3,246	61
Flakes	3,980	1,794	45
Microblades	44	0	0
Formal Artifacts	41	0	0

the débitage or faunal elements could be included in the analysis. At the Broken Mammoth site, faunal remains in both cultural zones were overwhelmingly represented by bone fragments less than 1 cm in maximum dimension, and débitage consisted primarily of tiny pressure flakes. Many of these bone and stone fragments were recovered in 1/8 in. screens, rather than *in situ*. However, only materials recovered *in situ* were given three point proveniences. Therefore, spatial analysis was limited only to archaeological material recovered *in situ*, eliminating sieved or screened materials. The final total did include nearly five thousand faunal elements and over three thousand débitage fragments, representing ~55–60 percent of the former and just under 50 percent of the latter (Table 1). The smaller sample size, however, raised the possibility that it might provide a skewed representation of spatial patterns. To control for these discrepancies, all artifacts were initially mapped in the center of the 50 cm² area from which they were recovered, and contour maps were generated using Surfer 7 Goldenware software. In every case, clusters formed by the contour maps directly overlapped clusters of material found *in situ*. Further, no new activity areas were recognized with these added precautions. This allowed the occupational intensity of each area to be assessed more accurately.

ANALYSIS OF ARCHAEOLOGICAL MATERIAL FROM CULTURAL ZONE 3

Relationships were sought between *k*-means clusters and six substantial hearths and hearth smears from the CZ 3 assemblage. Each of the hearths was discretely defined and ranged in shape from elliptical to circular, and in size from 40 cm to over 1 m in diameter. The hearths are predominantly located in the eastern portion of the site and all but one were placed over 5 m from the bluff edge.

A *k*-means analysis of the CZ 3 faunal remains shows several types of cluster associations within the optimal eleven-cluster solution (Fig. 4). Clusters 5, 6, 7, and 9 are associated with hearths, and although large, each is particularly concentrated and likely represents drop and toss zones with the exception of cluster 5. In contrast, clusters not associated with hearths (especially 1, 4, 8, 10, and 11) are widely dispersed across the western portion of the site. Each of these clusters spans at least 6 m and likely represents secondary refuse zones.

Débitage frequencies are fewer than faunal remains in CZ 3, but nonetheless eight clusters were considered

optimal in this analysis (Fig. 5). At least one flake cluster corresponds with each hearth feature and these occur in dense concentrations, mirroring the distribution pattern of fauna. Cluster 1 represents a single isolated flake while cluster 2 is a particularly dense and well-defined concentration of flakes that occurs within a 1 m radius and is not associated with a hearth. Located 15 m from the nearest hearth, clusters 1, 5, and 6 appear to be associated with the specialized work cluster 2 and were possibly deposited through a combination of shuffling of the cluster 2 material and hearth cleaning from the eastern portion of the site. Cluster 8 encompasses three of the six hearths from this cultural zone. Surprisingly, débitage is only located directly in the space between these three hearths. This spatially restricted distribution of débitage suggests perhaps wind direction played a role in seating locations and that few people sat at the hearths simultaneously.

K-means analysis cannot take the presence or absence of hearth features into account during cluster formation, but it is not surprising that each hearth feature overlapped with at least one artifact cluster for both fauna and débitage. This supports Gamble's (1999) and Binford's (1978a, 1978b) proposal that many activities are in fact hearth-centered despite disturbances from foot shuffling. While *k*-means cluster analysis independently identified flake and faunal clusters as overlapping, their content and relative frequencies varied from cluster to cluster. For instance, fauna from cluster 3 significantly outnumbered the overlapping débitage from cluster 8 ($p=0.000$), an indication this area was used predominantly for bone processing. A similar pattern is portrayed in fauna cluster 9 and flake cluster 3 ($p=0.000$). The opposite is true for lithic cluster 2 and the overlapping fauna cluster 11 because, in this case, flakes statistically dominate fauna ($p=0.000$). Each cluster is circular, with some being more discrete than others, and the small degree of overlap supports the notion the site was frequently reoccupied (Yesner 1996, 2001). The site contains evidence for the co-occurrence at Broken Mammoth of a variety of specialized tasks that would normally be found as single events on the landscape.

The evidence from Broken Mammoth could represent either of two possible scenarios: (1) a palimpsest (conflations) of a repeated series of small-scale, task-specific activities blurred through time; or (2) a more extensive semipermanent base camp. These are not considered palimpsests, however, because radiocarbon-dated hearth samples and dispersed charcoal ranging from 10,270±110 ¹⁴C yrs BP to 10,790±230 ¹⁴C yrs BP are all contemporary

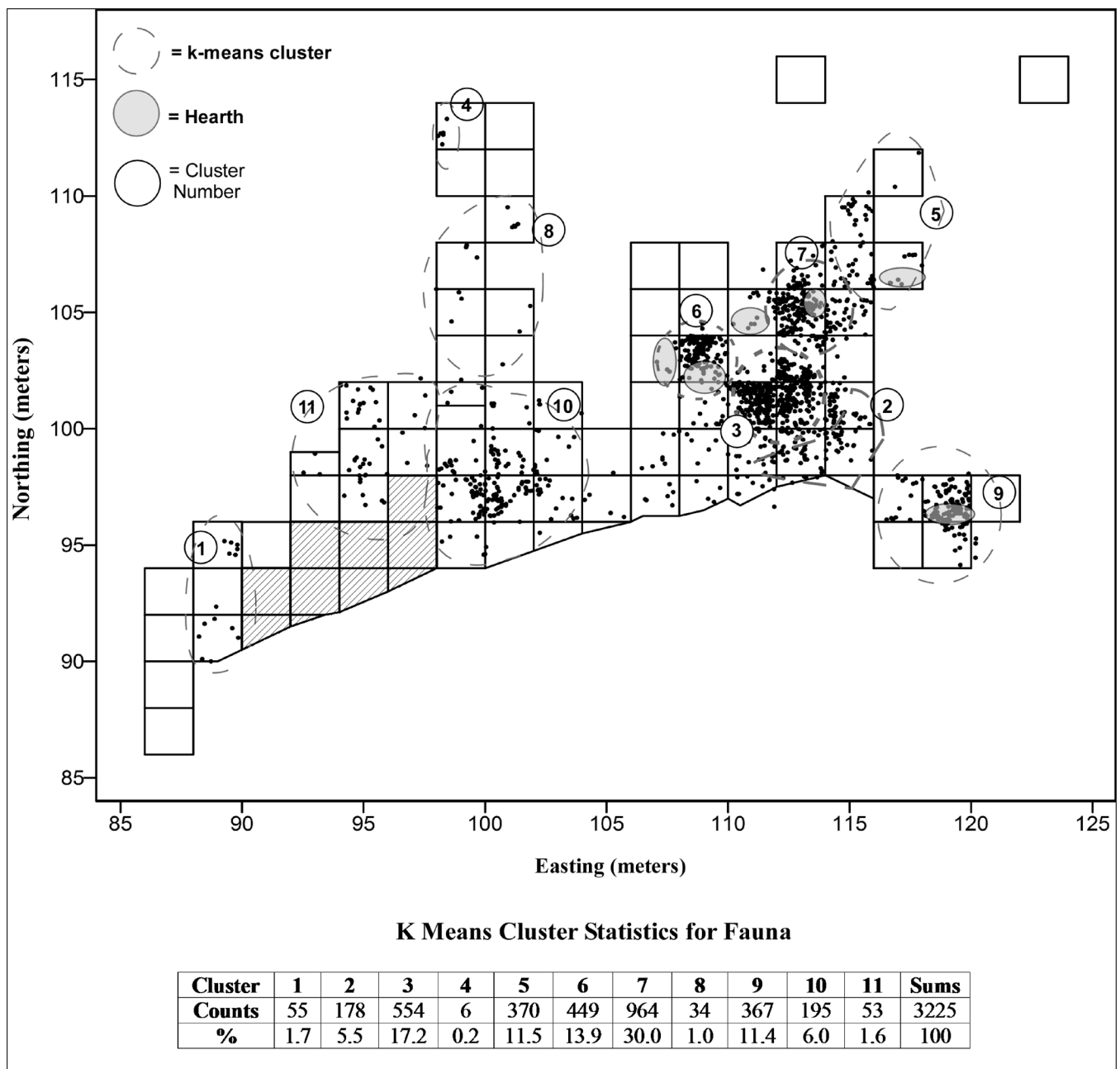


Figure 4. Broken Mammoth Site cultural zone 3 k-means clusters for fauna.

at 2σ (Hamilton and Goebel 1999; Yesner et al. 1992). Following Potter (2005, 2007), because loess accumulation occurred rapidly after the cultural zone 3 material was deposited, and because the cultural remains are clearly associated with contemporaneous hearth features, the CZ 3 material can be considered a single assemblage. Thus, although the ratio between primary and secondary reduction *débitage* has not yet been assessed for the Broken Mammoth site, because both faunal processing and lithic manufacture were common, the site does not appear to

have been the result of an accumulation of highly specialized or task-specific operations.

ANALYSIS OF ARCHAEOLOGICAL MATERIAL FROM CULTURAL ZONE 4

Most cultural features from cultural zone 4 occur along the eastern bluff edge and are characterized by eight hearths and hearth smears. Three of these hearths are approximately 50 cm in diameter, circular in nature, and are at least

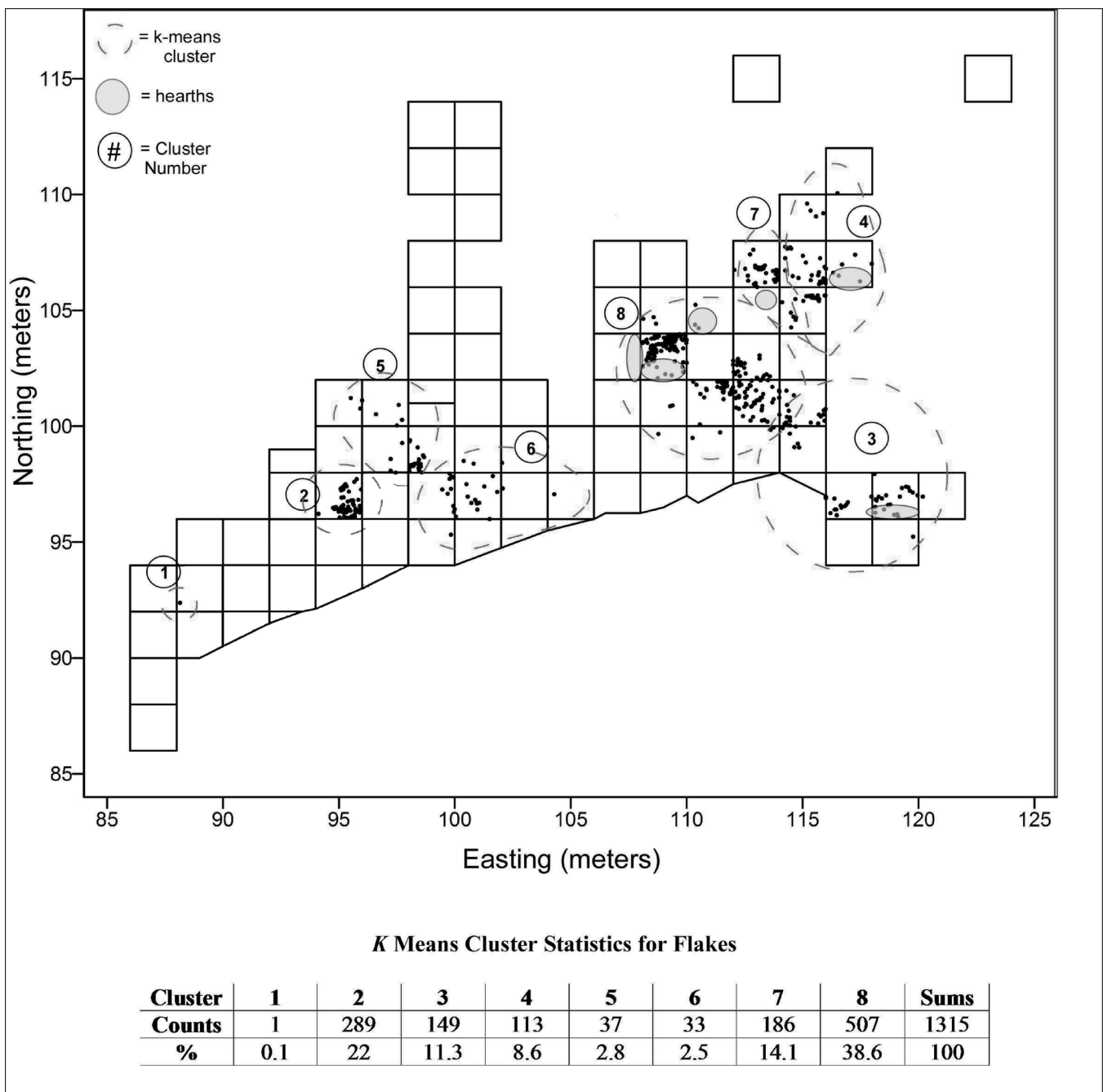


Figure 5. Broken Mammoth Site cultural zone 3 *k*-means clusters for débitage.

5 m from the bluff edge. The remains of five hearths were identified within a 4 m² area in the western-most portion of the site. These features range in shape from circular to elliptical and are 20–50 cm in diameter.

Visual inspection of the distribution of cultural material across the site clearly demonstrates the diffuse nature of the cultural zone 4 occupation. The majority of the CZ 4 finds were faunal remains, which outnumbered débitage by more than half. In applying the

k-means analysis, nine clusters were considered for the fauna data set. Faunal cluster 3 represented the densest cluster, but was not in association with a hearth. This location likely was an intensive activity area, not a refuse zone, because of its concentrated nature. Faunal distributions *not* analogous to Binford's (1978a, 1978b, 1983) "working around a hearth" model were unexpected. The dispersion of material across the site would indicate that some hearths were cleaned, the site was used

Table 2: Broken Mammoth cultural zone 4 artifact frequencies

Artifact Type	Frequencies	Number included in <i>k</i> -means analysis	% included in <i>k</i> -means analysis
Fauna	3,230	1,740	54
Flakes	1,284	602	47
Formal Artifacts	35	0	0

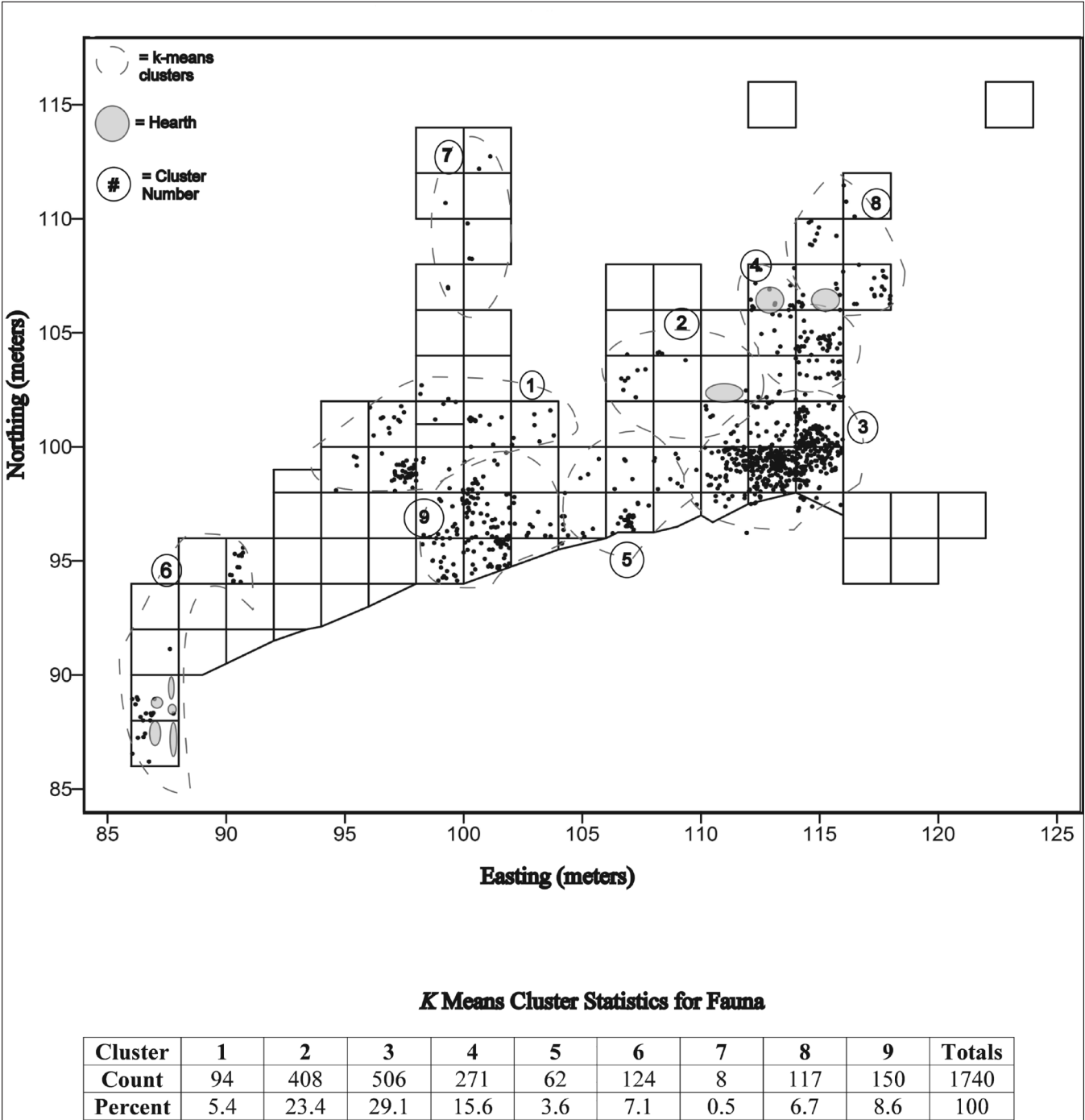
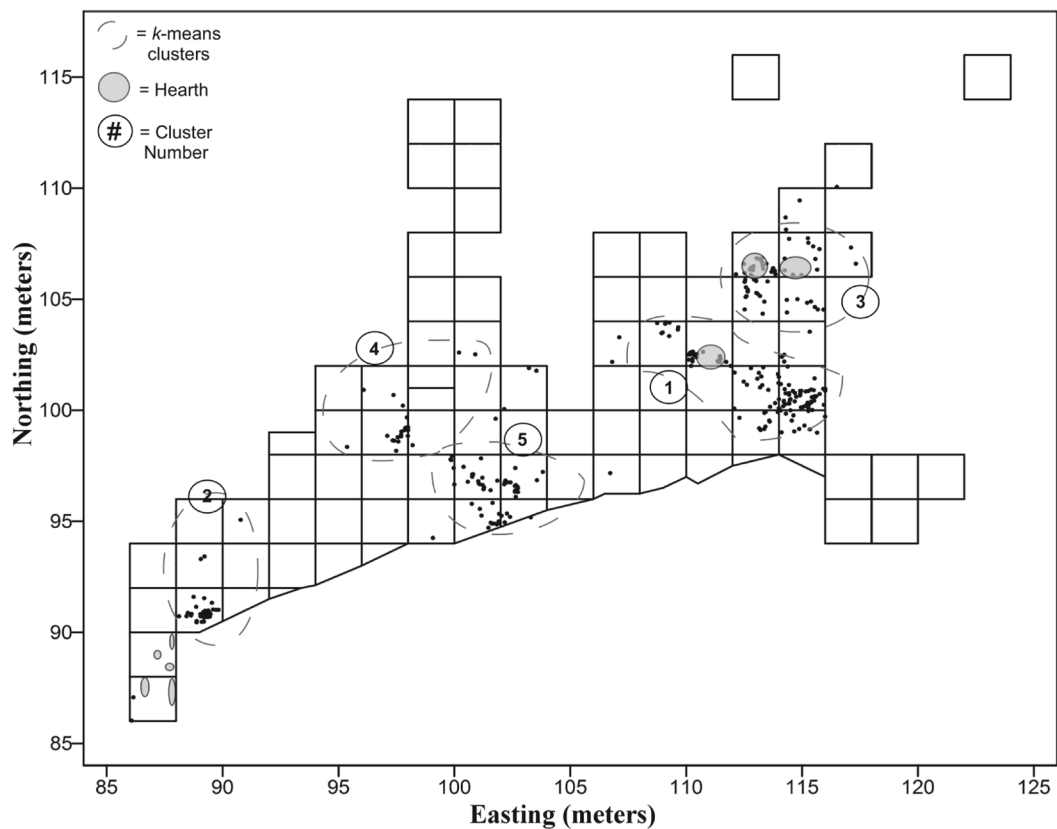


Figure 6. Broken Mammoth Site cultural zone 4 *k*-means clusters for fauna.



K Means Cluster Statistics for Flakes

Cluster	1	2	3	4	5	Totals
Count	259	143	104	28	68	602
Percent	43.0	23.8	17.3	4.6	11.3	100

Figure 7. Broken Mammoth Site cultural zone 4 k-means clusters for débitage.

infrequently, or intensive activities were not restricted to hearth areas.

Five clusters were considered optimal in the *k*-means cluster analysis for débitage from cultural zone 4. In general, débitage is not as heavily dispersed as fauna and is concentrated more heavily around hearth features (Fig. 7). There is a strong correlation between débitage, faunal remains, and features within CZ 4 with multiple activities occurring around hearths. Chi-square (χ^2) analyses were used to test whether faunal and débitage frequencies were statistically different. For instance, flake cluster 5 and faunal clusters 5 and 9 have overlapping lithic and faunal remains with frequencies that are not statistically different ($p=0.933$). However, one specialized lithic workshop was

identified in cluster 2 where the concentration is discrete and faunal remains are absent.

DISCUSSION

Activity increased in CZ 3 over CZ 4 perhaps as the result of an increase in the number of people occupying the site as evident in the relatively high number of artifacts recovered as well as the density of activity areas defined by the *k*-means technique. Moreover, faunal processing was the dominant activity during the CZ 4 occupation, while the CZ 3 occupants substantially increased lithic manufacture over earlier times, although faunal processing remained an important site function for both occupation episodes.

CZ 4 occupants used the bluff edge more intensively than in CZ 3, especially in the area of cluster 6 where a collection of small hearths occur in the western portion of the site. This area is unique because these features do not appear to be the center of identifiable activity and may be the result of low-intensity inside hearths. Moreover, their brief use may be an indication of lower population levels in the CZ 4 occupation.

Space maintenance and clearing seems to be demonstrated in at least some of the hearth features for both CZs. The restricted location of cultural material around some hearths suggests use by single individuals, and there is no indication for large, permanent, or stone-lined hearth features in either occupation. Small refuse zones are primarily located in the center of the site and are highly dispersed, suggesting this area received heavy foot traffic. Moreover, within both cultural components, intensive activities including lithic manufacture and maintenance, bone processing, and meal preparation took place around hearths but were not limited to these features. The eastern and southern sides of the site displayed the most intensive activity for both CZs 3 and 4. But hearths from CZs 3 and 4 were not superimposed, an indication of the absence of postdepositional disturbance but also for distinct occupational events.

Hunter-gatherer discard practices are partially dependent on site function and degree of mobility. Thus, one can identify site type based on discard expectations. Residential base camps would have been supported by spike or peripheral camps in areas where resources were obtained (e.g., kill sites and lithic quarries; cf. Binford 1978b; Guthrie 1983). Guthrie (1983) defines base camps as containing storage features such as caches, drying racks, tent rings, or semisubterranean features as signs of more permanent occupations. Base camps must also be located near a water source and accessible firewood. He defines spike camps as temporary seasonal hunting or processing stands where animals were processed for transport elsewhere (Guthrie 1983). Thus, one would expect groups characterized by residential mobility to discard certain materials in areas peripheral to living spaces at residential camps as they are frequently revisited, while highly mobile populations discard most material at their use locations (Murray 1980).

To date, no base camps have been found in interior Alaska as defined by Guthrie (1983), but sites possessing high feature diversity in which a wide range of generalized tasks were performed (e.g., tool and animal processing) have been documented (Potter 2005). Perhaps this is because base camps were located along river corridors and destroyed by subsequent fluvial activity (Yesner 1996). Although there is no evidence of drying racks, tent structures, or semisubterranean features at Broken Mammoth, mammoth ivory recovered from CZ 3 may represent a cache (Yesner 1996). Furthermore, the site meets other criteria for base camps, including access to substantial water sources (Shaw Creek and the Tanana River), firewood, and good protection from the elements. Perhaps more substantial facilities mentioned by Guthrie (1983) were originally positioned elsewhere at the base of the bluff along the riverbank and thus are not reflected in the excavated portion of the site. Broken Mammoth likely served as a semipermanent camp in which excavated cultural material represents a series of diverse activities.

CONCLUSIONS

This study provides the preliminary work to address the distribution of archaeological material at the Broken Mammoth site. Site activities are by no means limited solely to butchering, with a wide variety of activities including marrow processing, disposal, transport of animal remains, hearth maintenance, and tool preparation. Site function, structure, and activities did not vary much among these periods. Many of these activities were spatially segregated and restricted to small and discrete areas analogous to workshops. Faunal and lithic analyses, along with future refit studies will further illuminate details of these activities. Although settlement patterns likely did not change significantly between the late Pleistocene and early Holocene occupations, the site likely represents a semipermanent base camp and was used more intensely perhaps because of increased population densities during the later cultural zone 3 occupation. Future comparisons to other late Pleistocene and early Holocene sites in interior Alaska will better explain the nature of prehistoric hunter-gatherers during this dramatic period of climate change and faunal turnover.

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