THESIS

LINDENMEIER REDUX:

SPATIAL PATTERNS OF THE LINDENMEIER FOLSOM SITE (5LR13)

Submitted by

Jason Christopher Chambers

Department of Anthropology

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Master's Committee:

Advisor: Jason LaBelle

Robin Reich
James Zeidler

ABSTRACT

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The Lindenmeier Folsom Site (5LR13) was excavated from 1934-1940 by Frank H. H. Roberts, Jr. of the Smithsonian Institution. Over the course of six field seasons spent excavating the site, the spatial locations of approximately 6,000 items were mapped and recorded by Roberts, and later published as a series of maps in the appendices in the Concluding Report (Wilmsen and Roberts 1978). This thesis has digitally reproduced these maps using ArcGIS mapping software, preserving the spatial relationships between the artifacts mapped during the 1930's excavations, and applying sophisticated spatial analyses to the Lindenmeier dataset to detect spatial patterning.

Among other conclusions, this thesis finds that the spatial patterns exhibited at Lindenmeier vary across the site, reflecting different discard patterns enacted by the Folsom camp site occupants. Regarding hideworking and projectile manufacturing activities, the spatial patterns at Lindenmeier do not reflect the patterning at Stewart's Cattle Guard which Jodry (1999) argues as evidence for gendered segregation of space. The spatial patterns at Lindenmeier suggest an integrated suite of activities undertaken across the site with logical segmentation of space and association of tools into specific toolkits.

Examining spatial patterns within the distribution of discarded materials at the Lindenmeier Folsom site will contribute greatly to enhancing archaeologists' interpretations of Paleoindian, and specifically Folsom, lifeways on the Great Plains during the Late Pleistocene.

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CHAPTER 1 – RE-EXPLAINING THE PAST: LINDENMEIER FOLSOM REDUX

The Lindenmeier Folsom site (5LR13) is one of the largest, most well-documented, and extensively excavated Folsom sites in North America. It was discovered by the Coffin family, who collected diagnostic fluted Folsom projectile points at the site prior to the naming of the Folsom cultural complex at the Folsom type-site in New Mexico. Insistent letters to the USGS by the Coffins resulted in eventual site visits by Smithsonian Institution archaeologist Frank H.H. Roberts, Jr. Though other parties also dug the site, Roberts excavated the site from 1934-1940, eventually uncovering approximately 1800m^2. Items recovered from the excavations represented not only the first evidence for portable jewelry in the New World, in the form of intentionally-cut, discoidal bone beads, but also provided definitive evidence associating Folsom culture with now-extinct mammalian megafauna, namely *Bison antiquus* (Wilmsen and Roberts 1978: xiii).

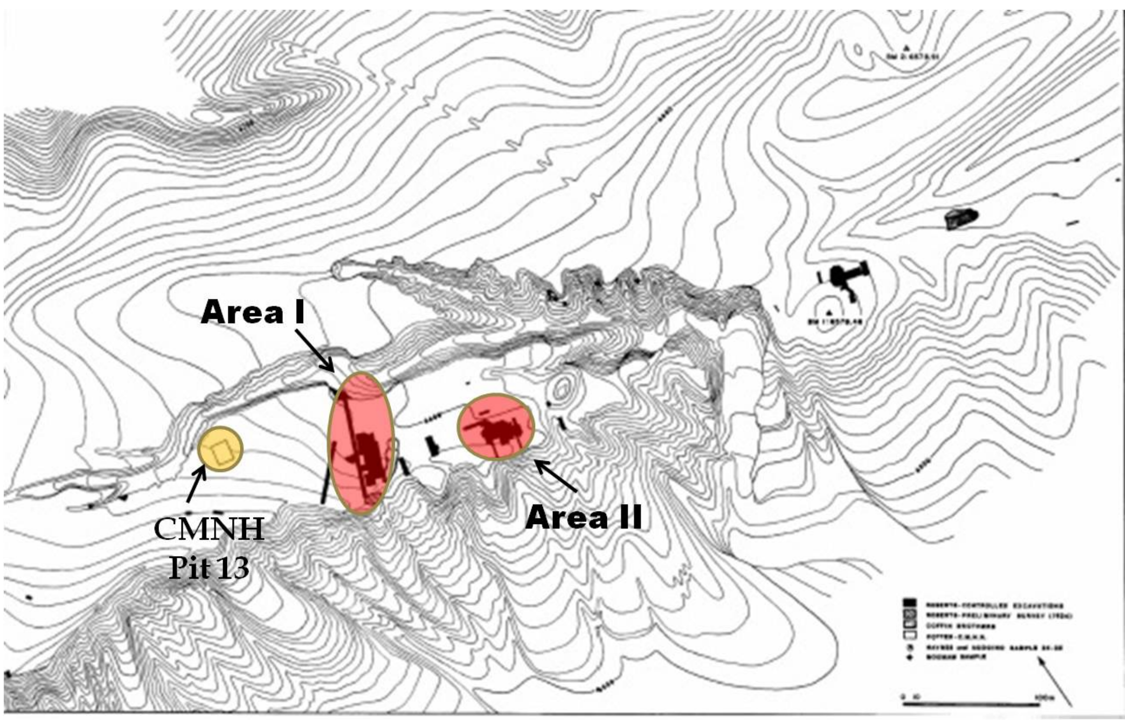

Figure 1: Lindenmeier (5LR13) Site Map (adapted from Wilmsen and Roberts 1978:2; Map 1)

Lindenmeier is a rare combination of being a large site that has been both extensively excavated and well-documented. Therefore, it represents some of the best available evidence for Folsom hunter-gatherer lifeways on the Great Plains during the close of the Late Pleistocene, ~11,000 rcybp (radiocarbon years before present). This combination of attributes is so important that it was recognized and preserved as a National Historic Landmark in 1961. Though Roberts' excavations provided a wealth of information about the Folsom complex over his six field seasons, Roberts was never able to answer several of his research questions. His excavations never revealed any human skeletal material to be used as evidence for the presence of 'Early Man' or Neanderthals in North America; nor did they reveal any identifiable residential lodge/habitation structures. Eventually, Roberts' duties with the Bureau of American Ethnology took his research elsewhere, and in 1966 he passed away without completing a final report on the site.

Following Roberts' death, Edwin Wilmsen, doctoral candidate at the University of Arizona, examined the Lindenmeier collections and Roberts' fieldnotes and published the *Concluding Report on Investigations* (Wilmsen and Roberts 1978) with the late Roberts as co-author. Wilmsen had specific research questions he sought to answer; particularly, he sought to examine differences in artifact attributes as evidence for multiple occupations, or multiple Folsom groups, inhabiting the site.

Despite the importance of the Lindenmeier site as an early, large site, aside from Wilmsen's work there has been little study of the spatial data. This thesis will investigate questions pertinent to the patterned use of space across portions of the site, as revealed by the distributions of specific artifact types. These specific questions are explicitly outlined below.

Lindenmeier Research Questions

This thesis seeks to examine three main research questions. 1) Can the null hypothesis be disproven that patterns in the spatial distribution of excavated and recorded/mapped artifacts that were excavated and recorded/mapped during the 1934-1940 Smithsonian excavations at the Lindenmeier site are the product of random chance? 2) Is spatial differentiation/segregation visible in the use of space across the site regarding discard of material items by the site occupants? 3) Are spatial patterns evident among functionally-related artifact types that are associated with specific cultural behaviors common to hunter-gatherer peoples, specifically, activities associated with projectile manufacture and hideworking/clothing manufacture.

Question 1 (Null Hypothesis) - The null hypothesis is that the distribution of artifacts within Wilmsen's Occupation Units (A, B, F, G, H) (Wilmsen 1974, Wilmsen and Roberts 1978) at the Lindenmeier site are the product of random chance. This provides a logical departure point from which to proceed with subsequent spatial patterning analyses. If the distribution of items within the Lindenmeier dataset shows to be spatially independent, or random, it raises the possibility that the Lindenmeier site represents non-culturally patterned phenomena, or a palimpsest of multiple, overlapping deposits of Folsom cultural material. Clark and Evan's Nearest Neighbor Statistic (Clark and Evans 1954) will be the quantitative, statistical method used to address the null hypothesis, and will be discussed in-depth in a following section.

Question 2 – Should the null hypothesis of spatial randomness among the distribution of discarded material items be disproven, then overall differences in the distribution of items in Area I versus Area II at the Lindenmeier Folsom site will be examined. From this, inferences can be made about Folsom spatio-cultural patterning across the approximately 87 meters (285 ft) spanning the horizontal distance between excavated portions of Areas I and II. Artifact distribution maps, Kernel Density Estimate analysis, artifact frequencies and spatial auto- and cross- correlation statistics will be used to examine the nature of the overall discard patterns across the site at multiple scales of analysis.

Question 3 - Using subsets of the larger dataset from which to conduct intracluster spatial patterning analysis, each of the Occupation Units (A, B, F, G, H) defined by Edwin Wilmsen (Wilmsen 1974, Wilmsen and Roberts 1978) will be separately examined for spatial patterning among suites of functionally-related items used in the performance of specific activities, specifically projectile point manufacture and hideworking/clothing manufacture. Both of these important behavioral/cultural adaptations for Folsom hunter-gatherer peoples will be examined separately, in order to make inferences concerning the distribution of activities within the Lindenmeier site. To assess these specific activities, thematic artifact distribution maps, artifact frequencies, spatial auto- and cross- correlations statistics (SAC/SCC) (Bonham et al. 1995), and pairwise spatial association indices will be used to assess spatial patterning among artifacts related to projectile manufacture and hideworking/clothing manufacture.

These questions are important because the Lindenmeier site is so important to Paleoindian research. Because it is so large, well-researched, and well-documented, researchers use interpretations from this almost-type site to extrapolate to other sites. Therefore, it is important that spatial patterning studies be applied to the valuable Lindenmeier dataset to provide the necessary context for extrapolating the meaning behind artifact spatial relationships to other less-thoroughly documented Folsom sites.

Dataset Strengths –This research effort derives as much information as possible from existing collections. The fact that the spatial element of the site has received little attention allows for a wealth of research questions to be addressed with the spatial dataset. The research questions selected for this thesis represent elements of the Folsom cultural complex related to use of space that are addressed in contemporary spatial analyses of other hunter-gatherer, Paleoindian (Witt 2005), and Folsom sites (Andrews 2010, Jodry 1999, Stiger 2006). As such, these other studies are directly comparable to the Lindenmeier data and allow interpretations to be made using clues present at other similar sites.

The dataset's strength is that it is a collections-based effort. No information or reference is included that is not readily available in publications. However, with the increased consideration of spatial data in recent Folsom site analyses (Jodry 1999, Arnold 2007, Andrews 2010), more evidence is now available than ever before to make meaningful interpretations concerning the use of space by Folsom peoples, and spatial patterning evident in the archaeological record as revealed at Folsom archaeological sites. Therefore, this study seeks to make as much use as possible from the extant data on the site, without the need for additional costly and destructive excavations.

Dataset Limitations – Several challenges are posed from using nearly 80-year-old data. These challenges derive mainly from limitations in the primary reference, namely Wilmsen and Roberts' (1978) *Concluding Report on Investigations*, itself a publication over 35 years old.

One limitation includes a lack of specimen-specific information for the items recorded and mapped at the site: elevation, burning, artifact size and refit status are examples of data that would aid this project in terms of providing important additional information on the spatial structure of materials recovered at the site. Elevation data, or depth, would provide evidence leading to interpretations of the occupational character at the site, and would provide evidence as to whether the Folsom component at Lindenmeier represents a single, long-term aggregation site or multiple, serially-occurring occupations (Andrews et al. 2008). Knowledge that a specific artifact or group of artifacts exhibit burning would provide evidence as to the presence/location of thermal hearth features or heat-treating of material. Simple artifact size data could inform whether the distribution of artifacts represent clean-up and site maintenance activities performed by the site occupants or taphonomic size sorting after the cultural deposits were formed; these are important considerations in making interpretations of cultural behaviors enacted by the Folsom hunter-gatherer peoples 10,780 rcybp (Haynes and Agogino 1960:5). Robert's excavation fieldnotes would provide the vertical information necessary for three-dimensional spatial analysis, but they are unfortunately unavailable for this project. Use-wear analysis would provide the specimen-specific information for piece-plotted artifacts retained in the Lindenmeier collections, and adding this information would be a useful future endeavor that would greatly increase the utility of this project.

Another central limitation to this project is the method used by Edwin Wilmsen to generate the artifact distribution maps derived from Frank H.H. Roberts' detailed excavation fieldnotes. This project uses only the two-dimensional horizontal locational data presented in Wilmsen and Roberts' (1978) final publication. In effect, Wilmsen created plan maps or two-dimensional horizontal 'mashups' that do not quite accurately represent the exact distribution of items mapped. Also, by not reporting the vertical element of the artifacts depicted, the slope effect provided by the topography upon which the artifacts lay is negated, as is any piling up of artifacts. Simply put, a plan map depicting artifact distributions cannot capture artifacts' vertical spatial relationships. Thus, the actual distribution of the artifacts mapped by Roberts in the horizontal and vertical dimensions and recorded in his fieldnotes during the 1934-1940 excavations may be somewhat different from that presented by Wilmsen in the 1978 publication. However, as Roberts' fieldnotes are unavailable for use in this thesis, Wilmsen's distribution maps must suffice to provide the dataset from which the spatial analysis of the Lindenmeier site will proceed.

In an attempt to compensate for the dataset limitations outlined above, multiple scales of analysis will be employed in examining spatial patterning. First, the Lindenmeier spatial dataset artifacts are coded using precise X,Y geographic coordinates that are associated with 5,535 artifacts piece-plotted during excavation, and digitized as part of this thesis. Many more artifacts were recorded by 'presence/absence' per 5'x 5' (and 10'x10') excavation square. Artifacts with precise X, Y coordinates were likewise extracted per excavation square and added to the frequency counts of artifacts that were recorded per excavation square. Piece-plotted artifacts with X, Y data will provide fine-scale data leading to specific artifact spatial co-associations, and the frequency counts per excavation square provide complementary spatial information at a coarser scale. These multiple, complementary scales of analysis will therefore allow general, as well as specific, spatial patterns to be identified within the distribution of items at the Lindenmeier site.

Site Structure Analyses, Overview of Theory and Background

The underlying premise behind spatial patterning studies is that "everything is related to everything else, but near things are more related than distant things" (Tobler 1970: 234). This spatial tendency of nearest neighbors is revealed in ecological studies (Bonham et al 1995), as well as ethnographic accounts of hunter-gatherer cultures that document a positive relationship between increasing social and spatial distance (O'Connell 1987:86). Such spatial patterns are inherent in culturally-patterned human behaviors, and are translated into the material world through tangible artifacts themselves and their distributions in space.

The research questions this thesis seeks to address of the Lindenmeier Site are interesting for several reasons. First, they represent important initial assessments regarding Folsom use of space at a large residential campsite, which are rarely represented in the archaeological record (Andrews et al. 2008). Many of the modern approaches to hunter-gatherer, Paleoindian, and specifically Folsom site structure (Andrews 2010, Jodry 1999, Stiger 2006, Surovell and Waugespack 2007), contain a strong spatial component and offer useful interpretations of the use space at such sites, examining questions of gender segregation (Jodry 1999) and interior versus exterior use of space (Andrews 2010, Surovell and Waugespack 2007). However, until now, no such approach has been attempted at the Lindenmeier Folsom site. This thesis represents an initial effort to make interpretations of the cultural processes enacted at the site based upon the distribution of artifacts recorded and mapped during excavations. These excavation maps were subsequently digitally reproduced using mapping software, thereby creating an attribute-based dataset of thousands of artifacts, with multiple scales of associated spatial information.

Spatial patterning studies do not have a universally accepted method. Jodry (1999) and Andrews (2010) used k-means density analysis to examine horizontal clustering of artifacts to determine activity areas at the Stewart's Cattle Guard and Mountaineer Folsom sites in Colorado, respectively. In a slightly different application of k-means density analysis, Anderson and Burke (2008) examined the definition of vertical cultural levels at Karabi Tamchin, a stratified Neanderthal rockshelter site in the Crimea, Ukraine. Witt (2005) used traditional, non-spatial statistics (specifically Pearson's r) to examine the statistical relationships between bi-facially and uni-facially reduced flakes at the Aubrey Clovis site in Texas. Interestingly, Witt's study does not focus on distinct activity areas, but rather examines the pairwise statistical relationships between functionally related items. Arnold (2007) used kernel density estimates to examine spatial patterning among the stone and bone artifacts recovered from the 10,500 rcybp Hanson Folsom site in Wyoming. For the Barger Gulch Folsom site in Colorado, Surovell and Waugespack (2007) have employed a variety of techniques including factor analysis to derive possible hearth locations. Combined with artifact distribution gradients and size sorting, as well as artifact long-axis directionality and micro-topography, they were able to determine the presence and location of residential lodge structures.

While the specific method of analyses has varied, typically, the majority of spatial patterning studies in archaeology employ a combination of visual inspection as well as some sort of quantitative method to assess intra-site spatial structure. Many might argue that visual inspection, usually derived from artifact dot distribution and density maps, is too subjective to provide definitive statements about spatial patterning. Thus, quantitative methods are used to (ideally) provide objective statements about observed spatial patterning, and/or to bolster visual interpretations. The net result of the myriad approaches have had varying levels of success in presenting valid assessments about the differential use of space by the occupants of an archaeological site. With this in mind, the following intra-site spatial patterning analysis of the Lindenmeier Folsom site is offered to illustrate general patterns observable, both visually and statistically, in the distribution of archaeological materials across previously excavated portions of the site, specifically Areas I and II (Figure 1).

Chapter Overview – This thesis is composed of seven chapters. Chapter 1 provides background information on the Lindenmeier Folsom site (5LR13), describes the history of research associated with the site, outlines the research questions addressed in the thesis, and describes the dataset. A brief overview of site structure approaches used in hunter-gatherer, as well as Paleoindian site studies is also presented.

Chapter 2 describes the specific methods used in the data collection process, as well as justification for the analyses employed to examine spatial patterning within the derived Lindenmeier spatial dataset.

Chapter 3 examines the first of three research questions, whether the spatial distribution of artifacts excavated within Areas I and II are randomly distributed. The null hypothesis is examined as an initial step in conducting spatial patterning analysis with the Lindenmeier spatial dataset. This chapter will continue with a description of the methods used to address this question, namely Clark and Evan's (1954) Nearest Neighbor statistic.

Chapter 4 addresses the second research question, whether spatial patterns across the site indicate differential use of space or repetition of spatial patterns from Occupation Unit to Occupation Unit. Descriptions of the overall visual spatial patterns, distribution of artifact frequencies, statistical spatial associations and auto and cross- correlation tests (Moran 1948, Bonham et al. 1995) are presented.

Chapter 5 addresses the third and final research question, whether spatial patterns are evident among functionally related artifact types associated with specific behaviors within each Occupation Unit. Specifically, this chapter will discuss the distribution of artifact types functionally related to projectile manufacture and hideworking activities. Data subsets of selected artifact types are examined to detect spatial patterns with respect to the overall distribution of items per Occupation Unit.

Chapter 6 presents a discussion of the various results of the analyses conducted on the Lindenmeier spatial dataset in reference to some of the issues pertinent to site structure/spatial patterning studies, and makes comparisons between the Lindenmeier data, ethnographic analogy, and known archaeological Folsom sites.

Chapter 7 presents a summary of conclusions reached from the previous chapters, and attempts to place these conclusions into appropriate context to relate to the larger questions of Paleoindian, and specifically Folsom site structure.

CHAPTER 2 - A METHOD TO THE MADNESS: LINDENMEIER SPATIAL ANALYSIS APPROACHES

This thesis was able to benefit from advances in digital mapping software that previous researchers did not have access to at the time. Though the field work/data collection was conducted over 80 years ago, Roberts' close attention to detail preserved the spatial relationship between excavated artifacts in the form of hand-drawn paper maps. These detailed maps have allowed this contemporary researcher the opportunity to create a digital mosaic of Roberts' maps in an attempt to make sense of the complicated archaeological signature at the Lindenmeier site. An explanation of the methods used to create the derived data set and the subsequent spatial analyses is offered herein.

Data Collection – In order to generate the dataset used to examine spatial patterning at the Lindenmeier Folsom site, the distribution maps in the appendices of Wilmsen and Roberts' (1978) *Concluding Report on Investigations* were digitally reproduced. First, all of the maps depicting artifact distributions at the excavation scale were extracted as high-resolution .jpg (Joint Photgraphic Experts Group) files from a .pdf copy of the 1978 document. The distribution maps were then imported into ArcGIS 9.3, rescaled to a common scale, stitched together using link tables in the Georeferencing tool, and rectified into actual coordinate space.

These rectified images were then digitized, or digitally traced, creating polygons for Area and excavation unit boundaries and point shapefiles representing the specific horizontal location of individual specimens. Collectively, these polygons and points are symbols representing the spatial relationships between and among items. As each item was digitized, attribute table information was concurrently updated, coding the artifact type associated with each specimen.

Once all individual artifacts were digitized, geographic coordinates were calculated for all piece-plotted items, as well as the excavation square associated with each specimen.

In addition, the polygon shapefiles created for each excavation unit also contained frequency of occurrence information for each of the artifact types present within the boundaries of each excavation square. Artifacts with specific X,Y coordinate information were extracted into counts per excavation square using the Selection by Location tool. Artifacts presented as presence/absence within excavation squares, but not provided any specific locational information (hematite, grinding stones, etc.) in the 1978 text, were added to the attribute tables for each excavation square. A field was created (precision) in the attribute table for each individual artifact to record the associated scale of spatial data.

Wilmsen presented his Occupation Units as groups of excavation squares; this Occupation Square information was also coded for each excavation square. Coding the Lindenmeier spatial dataset at these multiple scales (individual artifact, excavation square, Area I versus II) allows for different subsamples to be extracted from the dataset and analyzed separately.

Data Analyses - A blend of qualitative and quantitative methods was used in the analysis of spatial patterning presented below. The subjective nature of qualitative assessments is complemented with objective assessments of spatial patterning provided by spatial statistics. Tables 1 through 3 present the logic behind the methods used to answer the associated research questions.

Table 1: Method Justification for Research Question 1

Research Question	Significance	Data Scale	Method	Justification
Question 1 - “Is the spatial distribution of artifacts excavated within Areas I and II of the Lindenmeier Folsom occupation randomly distributed?”	Null hypothesis determines whether further spatial patterning analyses are warranted, or if palimpsest deposits are indicated.	Piece-plotted data (items with X,Y coordinates)	Clark & Evan's Test for Spatial Randomness	Quantitative method to examine spatial patterning using individual X,Y coordinates.
		Presence/absence within excavation squares.	Spatial Auto-correlation	Quantitative method to reveal spatial patterning at the excavation square (5'x5') scale.
			Spatial Cross-correlation	

Clark and Evan’s Test for Spatial Randomness – To reject the null hypothesis that the distribution of items recovered at Lindenmeier are a product of random chance, all items within each of Wilmsen’s defined occupation units were statistically treated using Clark & Evan’s (1954) Test for Spatial Randomness. The results of these tests are presented in Table 4.

Spatial Auto-& Cross- correlation – Spatial auto-correlation (SAC) and spatial cross-correlation (SCC) statistics in the R spatial statistical environment utilize the Moran and bi-Moran statistic to examine spatial relationships among, as well as between, artifact types. These statistics effectively demonstrate whether statistically significant spatial relationships exist at the 5’x 5’ excavation square scale. The results for each calculation includes a p-value statistic that indicates, similar to Clark and Evan’s test, a confidence interval indicating whether the artifacts exhibit statistically significant relationships, as well as the character (positive or negative) of any detected relationship.

Table 2: Method Justification for Research Question 2

Research Question	Significance	Data Scale	Method	Justification
Question 2 - Is spatial patterning present in the distribution of artifacts recovered from the site, indicating differential use of space across the site? Or, are the same patterns repeated from Occupation Unit to Occupation Unit?	Examines if spatial differentiation exists in the distribution of items across the site from Unit to Unit.	Piece-plotted data (items with X,Y coordinates)	Artifact Distribution Maps	Visual representation of the use of space from the distribution of individual artifacts.
			Spatial Association	Quantitative evaluation of spatial patterning at the scale of the individual artifact.
			Kernel Density Estimates	Visual and quantitative indication of areal clustering of items at the scale of the individual artifact.
		Presence or absence within excavation squares	Artifact frequencies	Quantitative evaluation of the distribution of items within each Occupation Unit.
			Refits	Indicates spatial and/or temporal connectedness among and within areas of the site.
			Spatial Auto-correlation	Quantitative evaluation of the spatial relationship among artifacts of the same type at the excavation square (5'x5') scale.
			Spatial Cross-correlation	Quantitative evaluation of spatial relationships between artifact types at the excavation square (5'x5') scale.

Visual Interpretation - Visual interpretation of spatial patterning is used as an initial step in determining differential use of space within an archaeological site. This method is subjective in that it does not provide definitive results, but is useful to guide quantitative statistical hypothesis testing. For this study, visual interpretation of the artifact distributions for the Lindenmeier assemblage is accomplished via comparing multiple layers of GIS-derived data of overall tool and bone distributions occurring within Areas I and II, as well as between artifact types per Occupation Unit.

Flake count maps digitized from the 1978 *Concluding Report* were coded using a color gradient, (ROYGBIV) to represent the range of flake debitage values present within each excavation square. With cool colors representing low values, and warm colors representing high frequencies, these maps provide a useful visual depiction of where lithic reduction (if primary deposition), or hotspots representing where site cleanup activities (dumping, piling) were practiced (Schiffer 1978).

Artifact distributions are presented in the form of dot distribution maps, in which each dot represents the precise two-dimensional location of an individual artifact specimen. The ability to selectively display subsets of data in ArcGIS (by desired location, artifact type, etc.) allows thematic maps to be made to examine spatial patterns in the distribution of specific individual artifacts in space.

Another useful visual indication of the distribution of bone and lithic tool specimens within each excavation square per Occupation Unit is the proportional symbol map. Using different symbols to represent bone and lithic tool categories, proportionally-sized symbols are displayed depicting the relative relationship between these two gross categories of artifacts per excavation square. These maps are a graphical representation of the method used by Witt (2005) to demonstrate differences in bone and lithic frequencies at the excavation square scale for the Aubrey Clovis site.

Table 3: Method Justification for Research Question 3

Research Question	Significance	Data Scale	Method	Justification
Question 3 - Are spatial patterns evident among functionally-related artifact types associated with specific behaviors (projectile manufacture, hideworking)?	Are spatially distinct activity areas present, indicating segregation of space (by task, gender, etc.)?	Piece-plot data (items with X,Y info)	Artifact distribution maps	Visual representation of the use of space from the distribution of individual artifacts functionally related to hideworking or projectile manufacture activities.
			Spatial Association	Quantitative evaluation of spatial relationships between and among artifact types functionally related to hideworking or projectile manufacture activities at the scale of the individual artifact.
		Presence or absence within 5'x5' excavation squares	Artifact frequencies	Quantitative evaluation of distribution of artifact types functionally related to hideworking or projectile manufacture per Occupation Unit.
			Spatial Auto-correlation	Quantitative evaluation of spatial relationship among artifact types functionally related to hideworking or projectile manufacture activities.
			Spatial Cross-correlation	Quantitative evaluation of spatial relationships between artifact types functionally related to hideworking or projectile manufacture activities.

Spatial Association – Using a special case of Clark and Evan's (1954) Nearest Neighbor indices, straight-line distances are calculated between piece-plotted items to determine the nearest neighbor of a specimen using it's precise X,Y coordinates. For each individual specimen within a category of artifact (i.e. each mapped biface, bone needle, etc), the distance between that item and its nearest neighbor is calculated, stored, and compared against all other iterations of other specimens of that item type and their nearest neighbor. The net result is a table generated using the R statistical environment depicting the pair-wise spatial relationships of each artifact type associated with a particular activity (hideworking, projectile manufacture) and its co-occurring nearest neighbor. To aid the reader, these results have been grouped by activity and presented within their respective sections.

The spatial association of artifacts provides a way to examine the spatial relationships between individual specimens of all artifact types mapped with precise X,Y coordinates. This helps to examine what artifact types are likely to be found in proximity to each other. This method of examining the pair-wise spatial relationships treats the dataset at a much finer scale than the spatial auto and cross-correlation (SAC/SCC) statistic, and is a useful predictor of frequently co-occurring artifact types (Schiffer 1983).

Artifact frequencies – The frequency, and percentage, of occurrence of artifact by type is a useful way to examine the distribution of items across Areas I and II, as well as within each Occupation Unit. Knowing the function behind the artifact types in the hunter-gatherer toolkit provides clues to the activities enacted with those tools at the site. Thus, higher frequencies of items indicate higher intensity of discarded items, hence activity areas (if manufacture) or site maintenance (if preferential discard) associated with the artifact type. In addition, the frequency of occurrence, calculated for each artifact type from the total number of items, as well as total tools, per Occupation Unit was recorded. This allows for examining the distribution of functionally related artifact types associated with specific activities common to hunter-gatherer peoples in a quantitative way.

Spatial Auto-& Cross-correlation – Spatial auto-correlation and cross-correlation statistics were employed to examine the spatial relationships present among and between the 23 artifact types recorded within each 5’x5’ excavation square at the Lindenmeier Folsom site. Moran’s I (Moran 1948, Czaplewski and Reich 1993) was used to test for spatial auto-correlation for each tool type, and bi-Moran’s I was used to test for spatial cross-correlation (Bonham et al. 1995) between differing tool types present within each excavation square. With these statistics, it is possible to calculate how two variables, Yi and Zi, are correlated in space. Moran's I can be thought of as being a special case of the cross-correlation statistic:

$$I_{YZ} = \frac{1}{W} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(z_j - \bar{z})}{\sqrt{Var(y)Var(z)}}$$

Equation 1: Moran's I

where Wij is a scalar that quantifies the degree of spatial association or proximity between locations i and j, or a 0-1 variable indicating that locations i and j are within some distance range of each other, W is the sum of all n^2 values of Wij, Var(y) is the sample variance of Yi, and Var(z) is the sample variance of Zi. The cross-correlation statistic simultaneously tests the following hypotheses:

a) Is variable Y spatially correlated?
b) Is variable Z spatially correlated?
c) Are variables y and z spatially cross-correlated?

If Yi = Zi, then the cross-correlation statistic is equivalent to Moran's I (Czaplewski and Reich 1993).

Stated another way, these statistics, calculated using the R spatial statistical environment (Reich 2008), test the strength and direction of relationships between artifact types, indicating: 1) whether there are statistically significant spatial relationships (aggregated/clustered or dispersed) between pairwise items, 2) whether the relationship represents a positive or negative/inverse relationship, and 3) confidence with which these interpretations may be considered valid.

Every 5'x5' excavation square within each of Wilmsen's Occupation Units was coded according to the frequency of occurrence of artifacts, for each of the 23 different artifact types reported from the site excavations, using the location selection feature within ArcGIS. These data were then exported via database (.dbf) files into an Excel worksheet compatible with the R statistical software package. Spatial weight matrices were constructed within the R program using the ‘queens move’ strategy, with the underlying assumption that contiguous neighbors exert equal influence regardless of direction, in contrast to ‘bishop’ or ‘rook’ moves in chess. A total of 276 auto- and cross-correlation statistics were calculated using the R statistical software environment (2011) for each of the artifact types observed within the Occupation Units (A, B, F,G,H) defined by Wilmsen (Wilmsen and Roberts 1978). The full results of these spatial auto- and cross-correlation analyses are presented in Appendices A-E., with subsets of these data presented for functionally-related artifact types associated with specific activities (hideworking, projectile manufacture) in their respective sections.

The spatial correlation (SAC/SCC) statistics suggests gross spatial patterns at the scale of the 5’x5’ excavation unit, in contrast to the local specimen-scale patterns between individual artifacts. Therefore, there should not necessarily be any agreement between documented nearest neighbors in the spatial associations described above and those patterns revealed in the SAC/SCC analyses. These statistics reveal whether observed spatial patterning is present between artifacts of the same type (SAC) and between artifacts of different types (SCC). They are used to document statistically significant positive, spatial relationships within or between artifact types. Alternatively, an inverse relationship may be observed between artifact types, indicating segregation of space in the performance of separate activities involving these tool types. This is visible in Jodry’s (1999) study of the Stewart’s Cattle Guard Folsom site, in which she demonstrates that the distribution of refuse associated with projectile manufacture (associated with males) is spatially segregated from Folsom ultrathins (associated with females), arguing for the segregation of space based on gender.

The full results of the spatial auto and cross-correlation statistics for each of Wilmsen's five Occupation Units (A, B, F, G and H) are presented in Appendices A-E. To interpret these tables, the Moran's I value is a positive or negative number indicating the strength and direction of the spatial auto- or cross- correlation relationship between pairwise artifact types. Positive values indicate positive relationships (+) between artifact types, with negative values indicating a negative, or inverse, relationship (-). The p-value is a confidence measure, indicating the Moran's I statistic's reliability measured by how many errors are likely per 100 iterations.

For this study, p-values of <.01 indicate a greater than 99% probability that the relationship is accurately depicted, regardless of how many iterations of Moran's I are conducted. P-values between 0.11 and .05 are reliable at the 95% confidence level, p-values between .051 and .10 are reliable at the 90% level, and p-values between .101 and .15 are reliable at the 85% confidence level. For the purposes of this study, p-values exceeding .15 are considered not significant (NS), or random/spatially independent. This threshold is flexible however, and may be adjusted, which can alter interpretations; therefore, explicit definitions of these interpretational categories are presented above. To aid the reader, four (4) categories of statistical relationship are highlighted using color, with the highest confidence results (p<.01) highlighted in red, and decreasing with yellow (p<.05), green (p<.10), and finally to the lowest confidence results considered included in this analysis highlighted in blue (p<.15).

This chapter presented the methods by which the derived Lindenmeier spatial dataset is to be analyzed. Multiple analyses will be employed in examining the Lindenmeier spatial dataset, with both visual and quantitative/statistical analyses employed using multiple scales, and units, of analysis. Finally, this chapter concluded with a description of the statistical thresholds used in the statistical analyses used to determine significance of any revealed spatial patterns in the dataset.

Chapter 3- WHAT ARE THE ODDS?: ASSESSING THE LINDENMEIER DATASET FOR SPATIAL RANDOMNESS

To examine spatial patterning in the Lindenmeier spatial dataset, the null hypothesis, that the distribution of artifacts recovered from the Lindenmeier site excavations are a product of random chance, was considered. Similarly, random distributions of artifacts could represent palimpsest deposits of overlapping but unassociated materials. Therefore the dataset was first statistically treated using a Clark & Evans (1954) Test for Spatial Randomness to determine the appropriate analyses to be applied to the data set.

Clark and Evan's Test for Spatial Randomness - This test measures the observed versus expected straight-line, Euclidean, distance measurements between randomly selected points (50 per unit in this thesis) and calculates the distances between their nearest neighbors. A confidence threshold (p-value) of .05, indicating a 95% level of confidence in the result of the statistic, was used as evidence to disprove the null hypothesis. These tests for randomness were calculated for the overall distribution of piece-plotted items, the combined bone and lithic specimens with X, Y coordinates, within each of Wilmsen's Occupation Units for Areas I and II (see Table 1 below). Bone and lithic specimens were combined for these tests as they are hypothesized to be functionally integrated components of the site; this idea is supported by numerous excavation accounts of modified bone, as well as from the undeniable association of the Folsom projectile point imbedded in the *Bison antiquus* vertebra. These statistics provide an estimate of the aggregation or dispersion of objects, given an observed versus random density, and indicates whether items exhibit a random, non-random or regular pattern.

Table 4: Lindenmeier Area I & II Clark and Evan's Test for Randomness Results

	Area I		Area II		
	Unit A	Unit B	Unit F	Unit G	Unit H
Density (items/m^2)	4.22	5.56	9.72	6.53	7.23
Expected mean distance under Complete Spatial Randomness (m)	0.24	0.21	0.16	0.20	0.19
Average distance to nearest neighbor (m)	0.16	0.17	0.12	0.14	0.15
Clark & Evan's Nearest Neighbor Index	0.64	0.80	0.72	0.73	0.82
P-value	2.00E-06	0.007822	1.96E-39	0	4.81E-04
Results:	Artifacts are clustered	Artifacts are clustered	Artifacts are clustered	Artifacts are clustered	Artifacts are clustered

Density values for each Occupation Unit indicate that the highest density of overall piece-plotted items are observed in unit F (9.72 items/m^2), with Unit A exhibiting the lowest density (4.22 items/m^2), less than half that of Unit F. In summary, Units A and B in Area I exhibit lower densities than those Units in Area II (F, G, H).

Another useful spatial indicator presented in Table 1 is the average distance to nearest neighbor per Occupation Unit. Slight variation is observed among the distances between nearest neighbors for items between Units in Area I, while slightly greater variation is observed among the distances between nearest neighbors within Area II. Overall, however the items within Units A and B in Area I are only slightly further apart than those items within Units F, G, and H in Area II. Items within Unit F, G, and H in Area II are an average of .12, .14 and .15m apart, respectively, while within Units A and B in Area I nearest neighbors are further apart, .16 and .17m, respectively. Given the unit density and average distance to nearest neighbor, generally speaking, there are more items in closer proximity in the Units in Area II than those in Area I, suggesting somewhat differing patterns of discard between these two areas. If size class information were available for these items then more specific patterns of preferential size sorting in the overall discard pattern would be evident for each Unit

The Clark & Evan's Nearest Neighbor Index value is a special case of Moran's I; values less than 1 indicate aggregation, while values greater than 1 indicate dispersion. Taken as a relative measure of aggregation, Table 1 indicates that items within Unit A are more aggregated than Units F and G, which in turn are more aggregated than Units B and H.

In every case presented in Table 4, the p-values for each of the Units in both Areas I and II are well within the threshold outlined above ($p<.05$) to test for spatial randomness, indicating the items within each of the Units are distributed non-randomly.

"***For all we know, the archaeological record is just one big palimpsest, incompletely effaced***"

(Anonymous archaeologist, 1981; borrowed from Steiner et al. 1996:279)

Palimpsest deposits - Another way that random distributions of items are manifest in the archaeological record is as palimpsest deposits. Spatial palimpsests refer to large-scale distributions, and describe "a mixture of episodes that are spatially segregated but whose temporal relationships have become blurred and difficult to disentangle" (Bailey 2007:207). Bailey (2007) describes four different types of archaeological palimpsests: 1) true palimpsests, 2) cumulative palimpsests, 3) spatial palimpsests, and 4) temporal palimpsests. True palimpsests are defined as "a sequence of depositional episodes in which successive layers of activity are superimposed on preceding ones in such a way as to remove all or most of the evidence of the preceding activity"(Bailey 2007:204), with only the most recent trace being intact. Cumulative palimpsests are “successive episodes of deposition, or layers of activity, that remain superimposed one upon the other without loss of evidence, but are so re-worked and mixed together that it is difficult or impossible to separate them out into their original constituents” (Bailey 2007:204). Cumulative palimpsests represent the concept of the palimpsest as it is most commonly used in archaeology, in which multiple (perhaps individually patterned) archaeological deposits deriving from culturally patterned behaviors become co-mingled in space, thus obscuring patterns in the overall spatial organization. Spatial palimpsests refer to large-scale distributions, and describe “a mixture of episodes that are spatially segregated but whose temporal relationships have become blurred and difficult to disentangle” (Bailey 2007:207). Finally, temporal palimpsests are “an assemblage of materials and objects that form part of the same deposit but are of different ages and ‘life’ spans” (Bailey 2007:207). This likely implicates recycling of previous cultures’ archaeological materials at a site “where all the materials are found together because they are constituents of the same episode of activity or deposition” (Bailey 2007:207), though they may have originally derived from different contexts.

Palimpsest deposits may or may not necessarily be randomly distributed items, but their presence tends to mar the spatial patterns between previously associated items. Like adding a pile of yesterday’s puzzle pieces to today’s puzzle, confusion results as to what pieces fit to which puzzle. Thus while the presence of palimpsest deposits do not necessarily preclude further spatial patterning analyses, their detection does condition what valid interpretations may be made from the spatial distributions of items. However, as highly statistically significant, non-random spatial patterns were indicated by the Clark and Evan’s test, further spatial patterning analyses are warranted.

Discussion of Significance – An important initial step in conducting spatial analysis is to determine if the distribution of items within a spatial dataset are the product of random chance, or spatial independence, prior to examining the dataset for specific spatial patterns. One way to quantitatively test for spatial randomness is through spatial statistics, in this case with Clark and Evan's (1954) Nearest Neighbor Test for Spatial Randomness. None of the distributions of items within any of the Occupation Units defined by Wilmsen (Wilmsen and Roberts 1978) exhibit spatial randomness, given the extremely low p-values presented in Table 4. This information indicates the data are not spatially random. Likewise the items within Wilmsen's Occupation Units (A, B, F, G, and H) do not indicate that palimpsest deposits are present to complicate the interpretation of the distributions. Therefore, the odds are good that the distributions of excavated artifacts are not a product of random chance, but rather are the product of culturally patterned discard behaviors warranting further spatial analyses.

Chapter 4 – LOST (AND FOUND) IN SPACE: EXAMINING SPATIAL PATTERNS IN A CONSTELLATION OF FOLSOM ARTIFACTS

Chapter 3 established that discernible spatial patterns are present across the Lindenmeier site, and are not best explained as the result of randomness or palimpsest deposits, Chapter 4 seeks to examine the nature of these patterns in greater detail. Specifically, this chapter seeks to address whether spatial patterns across the site indicate differential use of space or a repetition of spatial patterns from Occupation Unit to Occupation Unit within the site. Empirical descriptions of the overall visual spatial patterns evident, artifact distribution frequencies, and refit characteristics, as well as the results of statistical spatial associations and auto-and cross-correlation tests, and Kernel Density Estimates within both excavation Areas are offered to shed light on how the Folsom site inhabitants patterned their use of the available space at Lindenmeier.

Lindenmeier Site Structure - Visual Interpretation

Area I Flake Counts **–** Flake count, or debitage, concentrations are apparent in Area I. High concentrations are visible in the northern portion (Occupation A), with smaller discrete concentrations in the eastern and southern portions of Area I. A large ‘void’ or area of low flake counts is visible in the center of Area I, measuring approximately 25’ East to West x 45’ North to South. Flake counts within Trench A (10’x10’ units) appear to be low for the majority of the trench, except within those units adjacent to the high flake counts found in the northern portion of Occupation Unit A.

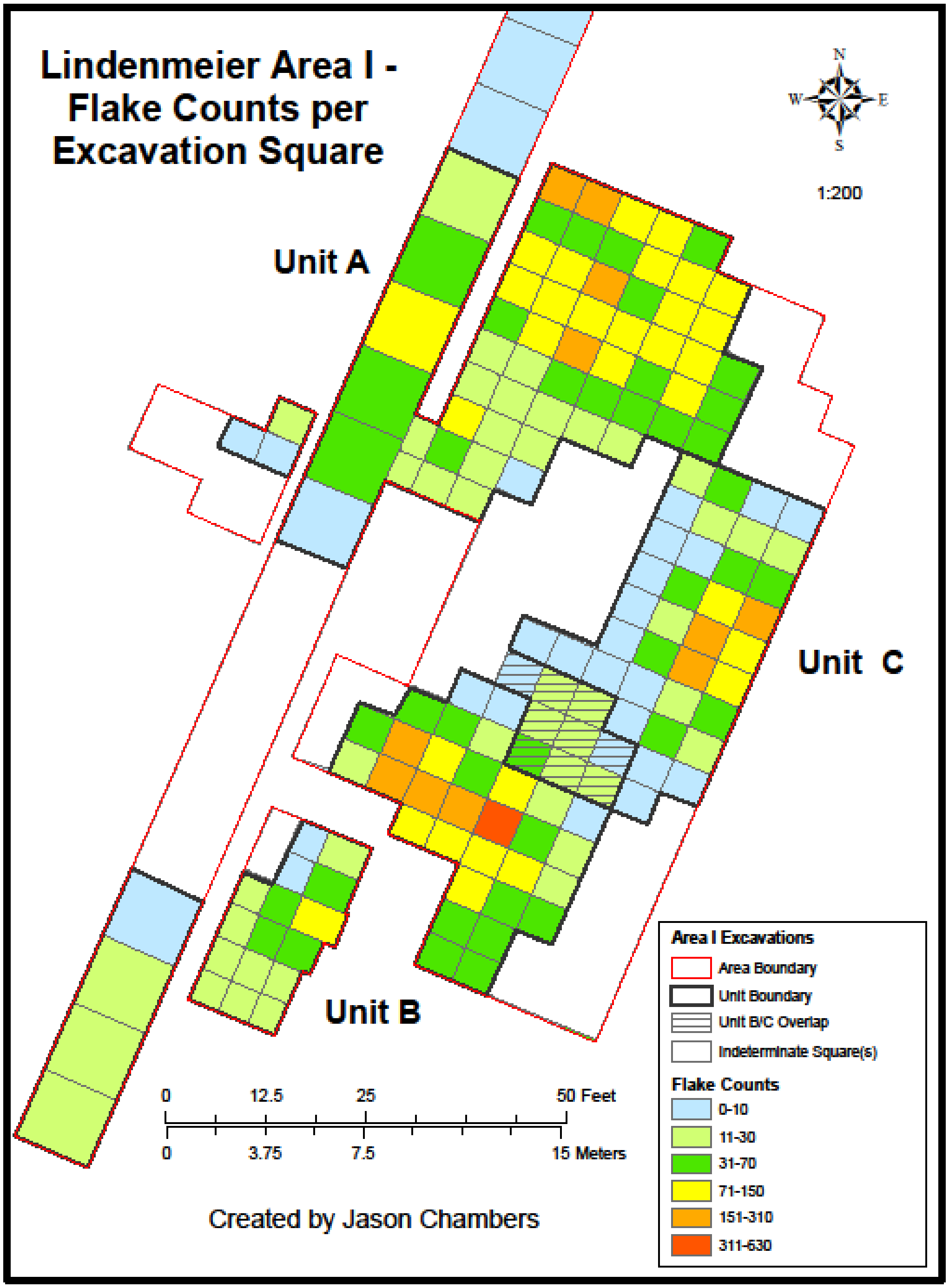

Figure 2: Flake Counts per Excavation Square, Lindenmeier Area I

Unit A Flake Counts - Of the 64 excavation squares that comprise Wilmsen's Occupation Unit A (Wilmsen and Roberts 1978:54), four squares (6.3%) exhibit the highest flake density observed for Area I (151-310 flakes/square). Excavation squares with the highest flake counts at the site, (ranging from 631-1230) are present within Area II but not observed in Area I. Twenty squares (31.3%) contain between 71 and 150 flakes, with the majority of these squares located in the northern portion of Unit A. Eighteen squares (28.1%) contain between 31 and 70 flakes per square. Sixteen squares (25%) contain between 11 and 30 flakes, with the majority of these being located in the southern portion of Occupation Unit A. Six squares (9.4%) contain between 0 and 10 flakes per square, the lowest flake counts observed, with the majority of these squares located in the southwest portion of Unit A.

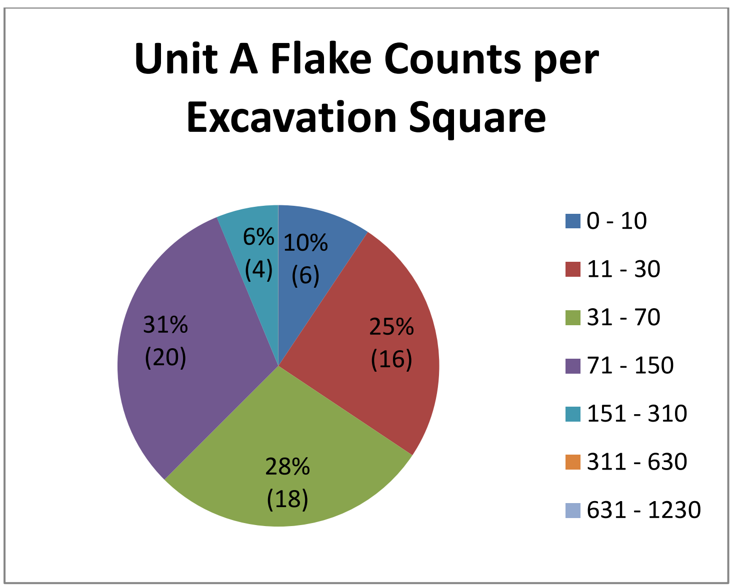

Figure 3: Flake Counts per Excavation Square, Lindenmeier Area I Unit A

Unit B Flake Counts– Fifty-three excavation squares comprise Wilmsen's Occupation Unit B (Wilmsen and Roberts 1978:54) in the southern portion of Area I. Of these, only one square (1.9%) exhibits a flake count of between 311 and 630, and it is located in the center of a high flake concentration. Four squares (7.5%) contain between 151 and 310 flakes, forming an "L" shape oriented East-West, located immediately west of that square containing the highest concentration of flakes. Eight squares (15.1%) contain between 71 and 150 flakes, with the majority of these located immediately south of square 1E, with an East-West orientation. Fifteen squares (28.3%) contain between 31 and 70 flakes, with these located to the northwest and southeast of square 1E. Seventeen squares (32.1%) contain between 11 and 30 flakes; the majority of these squares are to the southeast of square 1E in Area 3 (area between Trench A and the contiguous block excavations) and in the southern end of Trench A. Eight squares (15.1%) contain between 0 and 10 flakes, the lowest flake counts recorded, with the majority clustered in the northeast portion of Area 3.

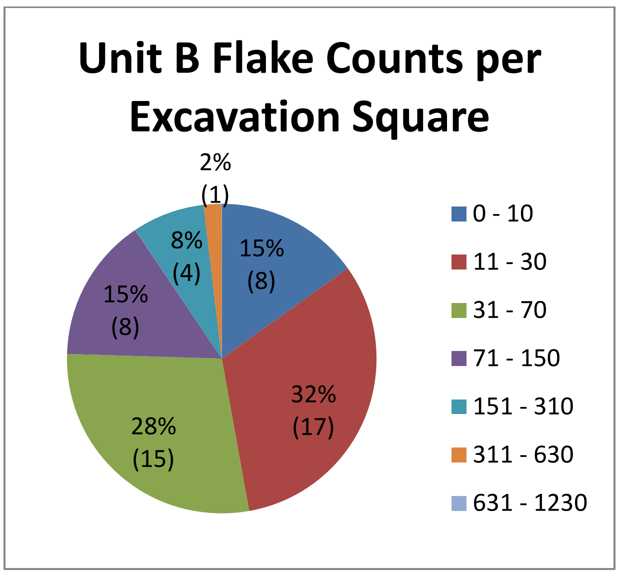

Figure 4: Flake Counts per Excavation Square, Lindenmeier Area I Unit B

Unit B/C Overlap Flake Counts – Wilmsen and Roberts (1978:54) indicate an area of overlap between Occupation Units B and C, comprised of nine excavation squares. Of these nine, one square (11.1%) contains between 31 and 70 flakes, six squares (66.7%) contain between 11 and 30 flakes, and two squares (22.2%) contain between 0 and 10 flakes.

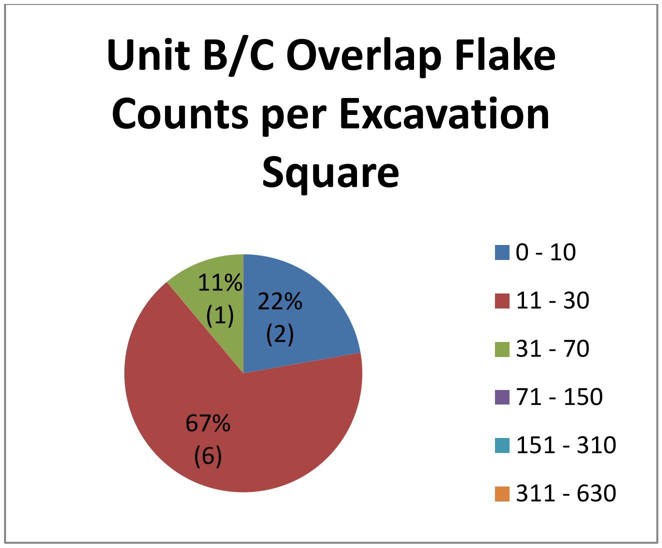

Figure 5: Flake Counts per Excavation Square, Lindenmeier Area I, Unit B/C overlap area

Unit C Flake Counts – Thirty-six excavation squares comprise Wilmsen and Roberts (1978:54) Occupation Unit C in the eastern portion of Area I. Of these, three squares (8.3%) contain between 151 and 310 flakes, and are located in a cluster in the central-eastern portion of Occupation Unit C. Adjacent to these, three squares (8.3%) contain between 71 and 150 flakes per excavation square. Taken together, these six squares form a cluster of the highest flake counts observed in Occupation Unit C, measuring approximately 15' North-South x 10' East-West, and are ringed by squares with lower total flake counts. Seven squares (19.5%) contain between 31 and 70 flakes, with the majority of these surrounding the squares with higher flake counts mentioned previously. Seven squares (19.5%) contain between 11 and 30 flakes per excavation square, and are also observed surrounding the previously mentioned squares with higher flake counts in Occupation Unit C. Sixteen squares (44.4%) contain between 0 and 10 flakes per excavation square, roughly completing the ring around the high flake count concentration and forming a boundary between Occupation Unit C and Occupations A and B.

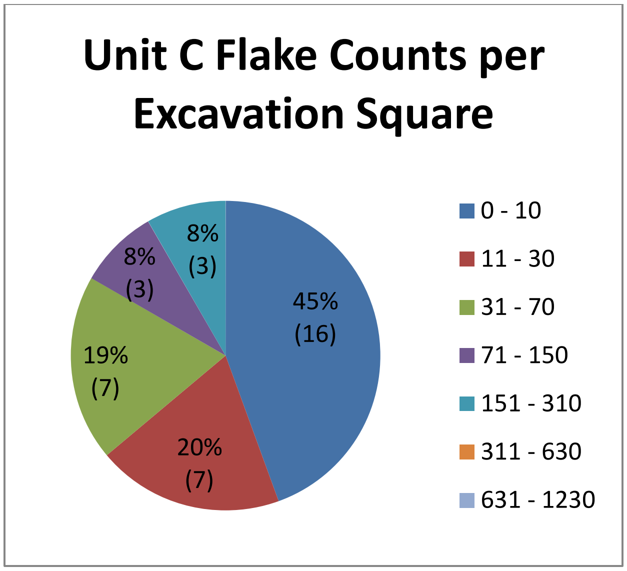

Figure 6: Flake Counts per Excavation Square, Lindenmeier Area I Unit C

Area II Overall Flake Counts – Within Lindenmeier Area II, the most conspicuous feature among flake counts is the visible clustering of excavation squares exhibiting high flake count values that occur in what Wilmsen defined as Unit Y (Wilmsen and Roberts 1978:58), or the indeterminate squares that occur between Units G and H. The highest-value category (631-1270 flakes per square) occurs as a bank of refuse exhibiting an east-west orientation, surrounded by a gradient of lower-value squares in a radial pattern in all directions from this cluster. A relatively precipitous decrease in flake count values is observed to the north (Unit H), east (trench), and south (Unit G) of this cluster, while to the west this decrease is more gradual approaching Unit F.

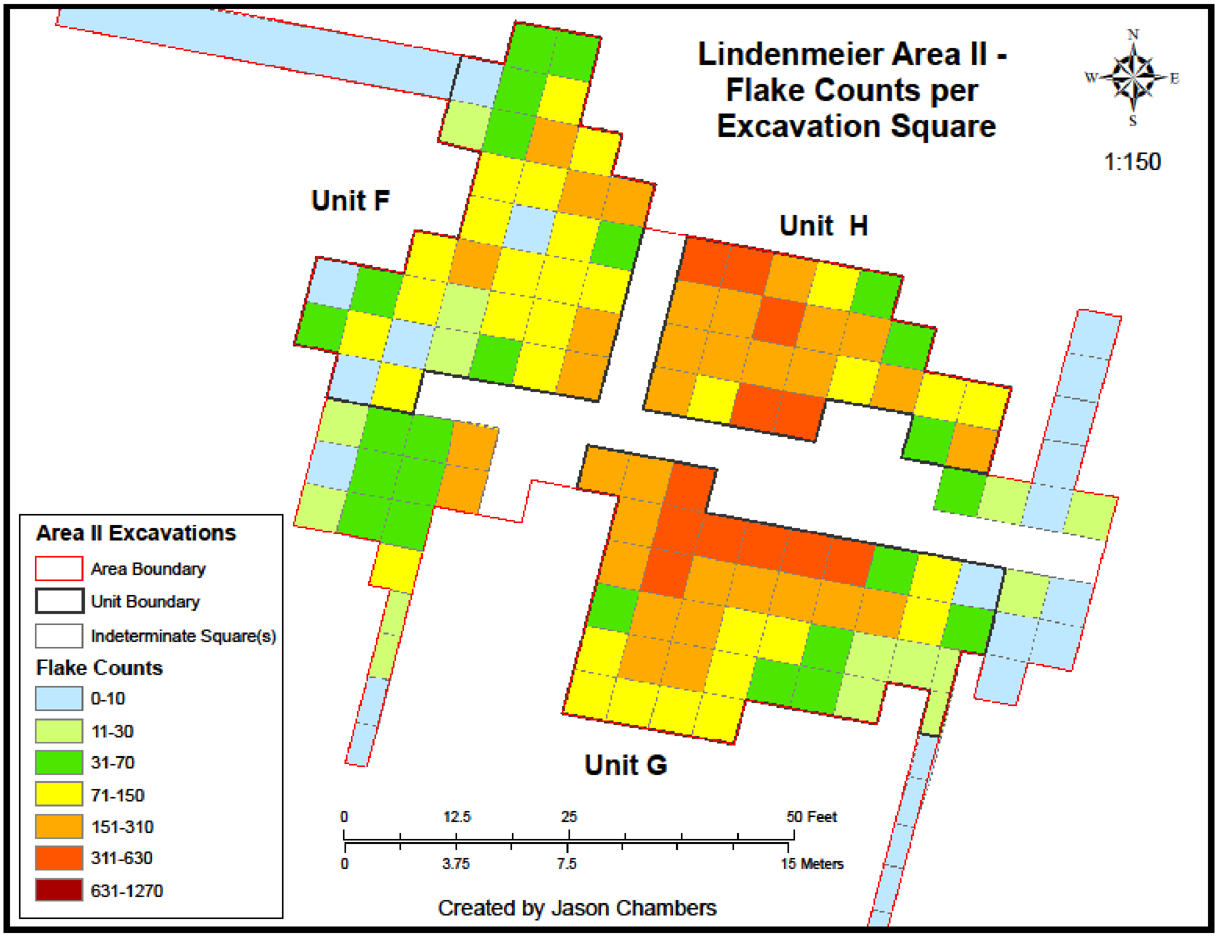

Figure 7: Flake Counts per Excavation Square, Lindenmeier Area II

Unit F Flake Counts- Thirty-eight excavation squares comprise Unit F; of these, five (13.2%) contain 0-10 flakes, three (7.9%) contain 11-30 flakes, eight (21.1%) contain 31-70 flakes, sixteen (42.1%) contain 71-150 flakes, and six (15.8%) contain 151-310 flakes; none of the excavation squares comprising Unit F contain the highest categories of flake counts (311-630 and 631-1230 flakes).

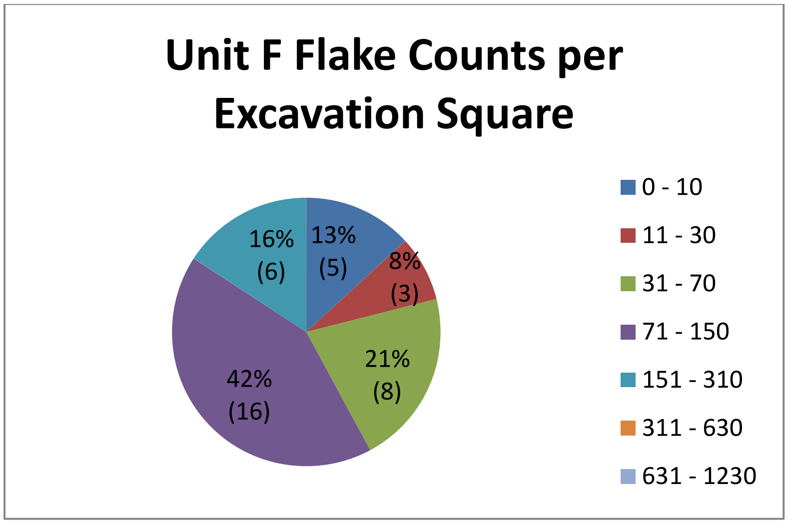

Figure 8: Flake Counts per Excavation Square, Lindenmeier Area II Unit F

Unit G Flake Counts – Forty-two excavation squares comprise Unit G; of these, one (2%) contains 0-10 flakes, five (12%) contain 11-30 flakes, six (14%) contain 31-70 flakes, 10 (24%) contain 71-150 flakes, 13 (31%) contain 151-310 flakes, seven (17%) contain 311-630 flakes. No excavation squares in Unit G contain the highest category, 631-1,230 flakes, observed at the Lindenmeier site.

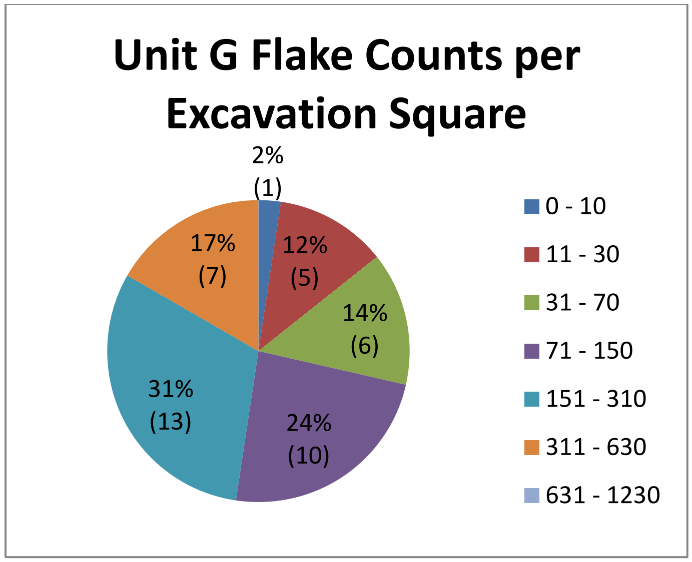

Figure 9: Flake Counts per Excavation Square, Lindenmeier Area II Unit G

Unit H Flake Counts – Twenty-five excavation squares comprise Unit F in Area II of the Lindenmeier site. Of these, no excavation squares exhibit flake counts from 0-10 or 11-30, three (12%) contain 31-70 flakes, five (20%) contain 71-150 flakes, twelve (48%) contain 151-310 flakes, and five (20%) contain 311-630 flakes per excavation square.

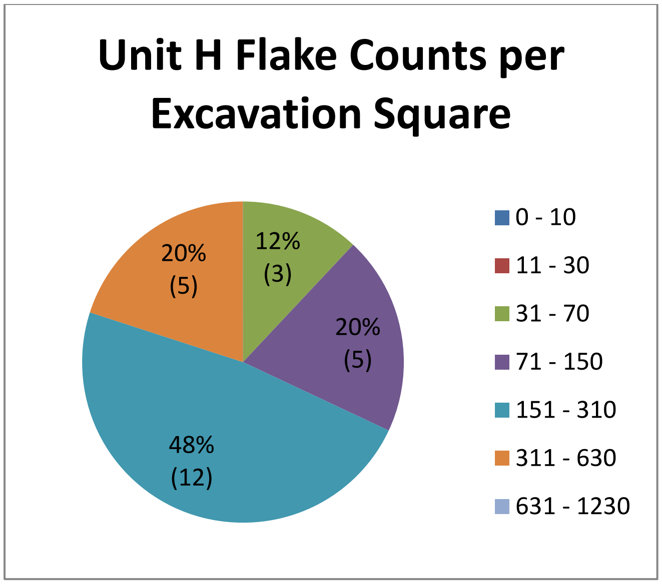

Figure 10: Lindenmeier Area II Unit H Flake Counts per Excavation Square

***Flake count observation summary* -** In summary, higher overall flake counts are present in Area II than in Area I. Within Area I, different frequencies of flake counts per excavation square are observed in Units A, B, and C. Excavation squares with higher frequencies of flake counts tend to be clustered within each Unit, with diminishing counts observed towards the margins of these clusters and between Units. Within Area II, flake counts per excavation square likewise differ in terms of frequency between Units F, G, and H indicating nuances in differential discard preferences. Like Area I, excavation squares with high frequencies of flake counts in Area II tend to be clustered, with the same observable diminishing of frequencies towards the margins between Units, except where Units G and H overlap within the area deemed as indeterminate squares.

Area I Plotted Bone Distributions – Within Area I (Figure 12), 41 of 239 (17.2%) total excavation units contain 1,084 pieces of plotted bone. Of this total, 19 (46.3%) of the excavation squares containing bone are located in Occupation Unit A, and 22 (53.7%) are located in

Occupation Unit B, with no plotted bones located within either the area of Occupation B/C overlap or within Occupation Unit C.

Within the 63 excavation squares that comprise Occupation Unit A, 19 (30.2%) contain plotted bone. The distribution of plotted bone within Occupation Unit A appears in a general northeast-southwest trending line that runs intermittently in a diagonal through the occupation unit.

Within the 53 excavation squares that make up Occupation Unit B, 22 (41.5%) contain plotted bone. The distribution of bones within Occupation B are separated into two distinct clusters, with one oriented in a northeast-southwest direction through Area 3 (the group of 18 excavation squares immediately east of Trench A, and southwest of the contiguous block excavation area), and oriented northwest-southeast within the block excavation area.

The absence of plotted bones observed in Occupation Unit C suggests that the high concentrations of flake debris located there are unrelated to bone processing activities, or that the Unit was incompletely excavated or recorded (Wilmsen and Roberts 1978). Alternatively, taphonomic preservation issues may be responsible for the absence of plotted bone in Unit C.

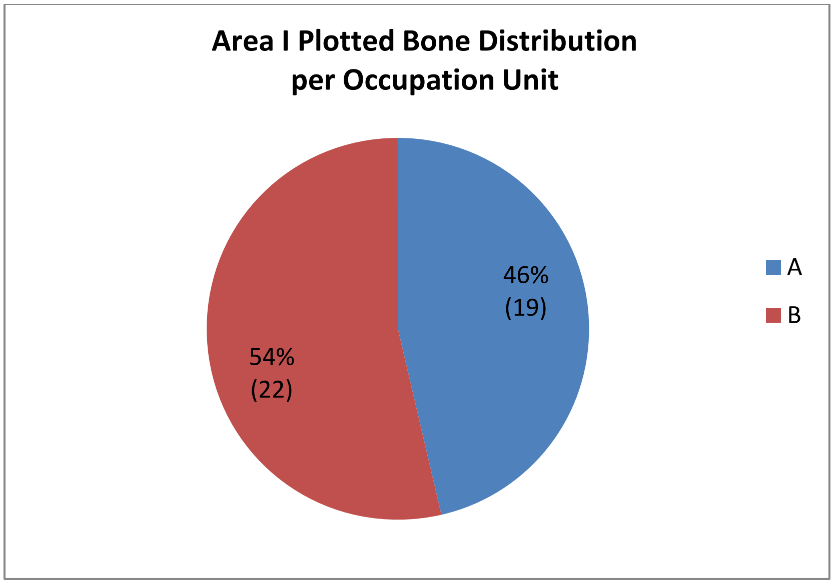

Figure 11: Bone Distribution per Occupation Unit, Lindenmeier Area I, Units A & B

The discrete clustering of plotted bone fragments in Area I visually suggests some spatial patterns. The bone clusters likely represent the remnants of, presumably, bison carcasses given their majority among the site's vertebrate faunal assemblage. An alternative interpretation is that the bone clusters represent bone refuse piled by the site occupants. Given that Roberts reported the presence of articulated bison skeletal elements in Area I within his yearly fieldwork summaries (Roberts 1935:41) this lends credence to the proposed interpretation of Area I bone distributions representing the remains of a multiple bison kill location, or a secondary processing area nearby the kill location. Roberts does not mention articulation of intact skeletal elements for Area II. Further, it seems reasonable to interpret this articulation, long after the connective tissue decayed, as evidence that taphonomic processes such as bioturbation likely played a small part in the final distribution of artifacts, at least within Area I.

Occam's razor suggests that, all things being equal, the simplest explanation is the most likely. In this case, given the large amount of unconstrained space within the valley, site cleanup/maintenance activities are unlikely responsible for such clustering of cultural materials.

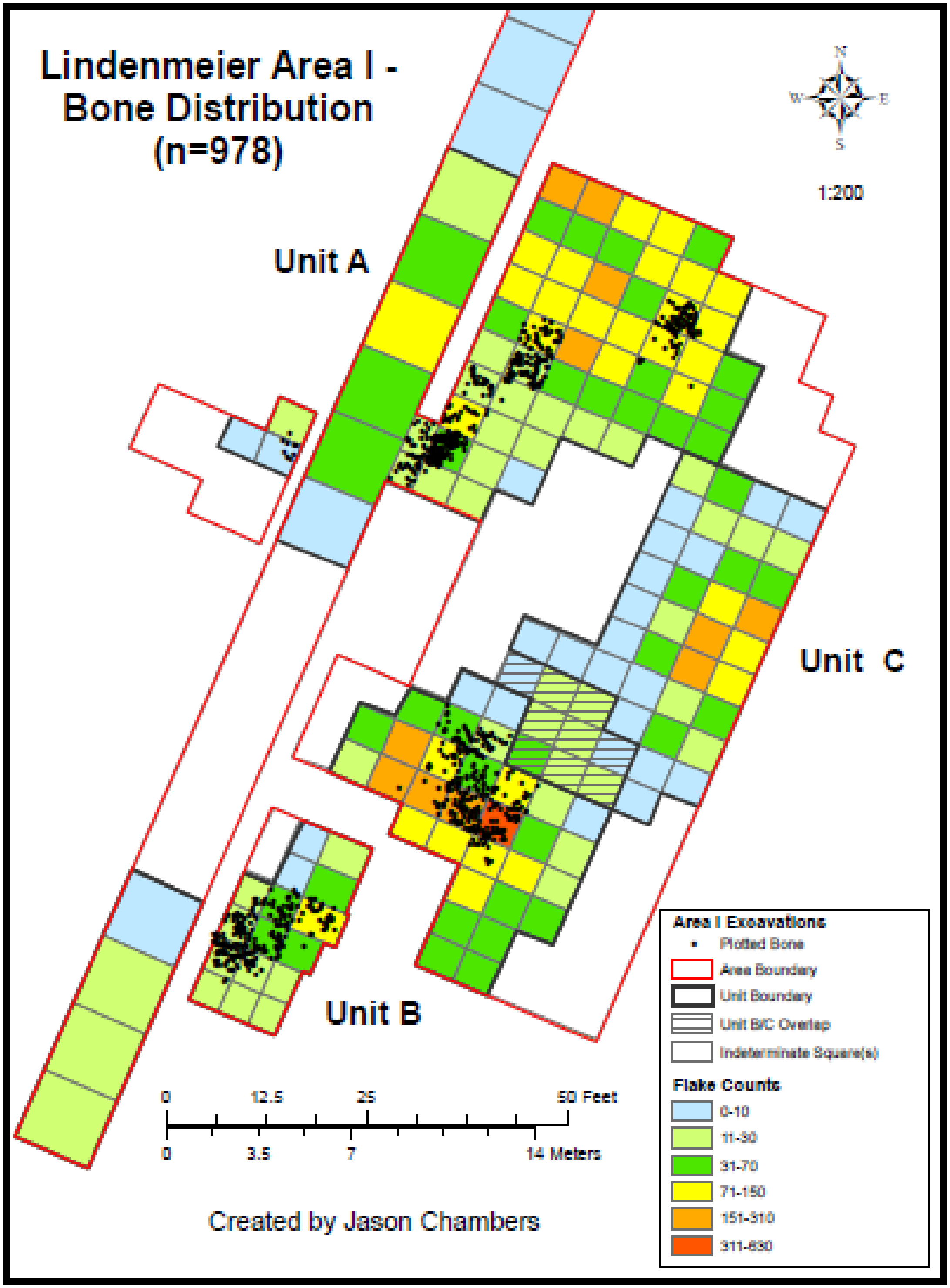

Figure 12: Bone Distributions, Lindenmeier Area I

Area II Bone Distributions - Within Area II, 86 of 172 (50%) total excavation units contain 1,208 pieces of plotted bone. Of this total, 32 (37.2%) of the excavation squares containing bone occur in Occupation Unit F, 33 (38.4%) occur in Unit G, and 21 (24.4%) occur in Unit H.

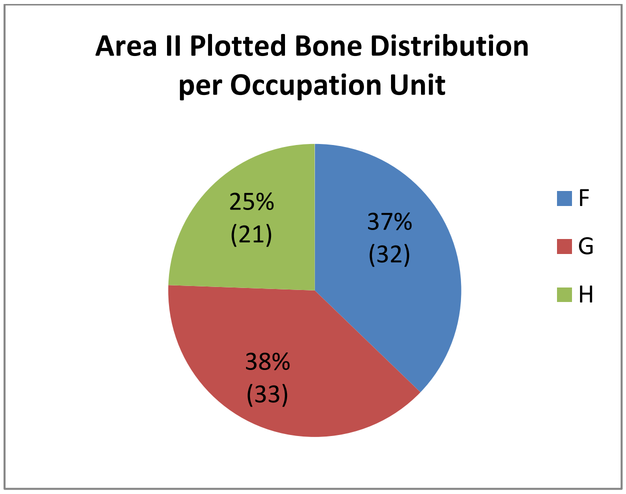

Figure 13: Plotted Bone Frequency Distribution, Lindenmeier Area II

Of the 38 excavation squares comprising Occupation Unit F, 32 (84.2%) contain plotted bone. The distribution of plotted bones within Unit F are dispersed, unlike the clustering seen in Area I Units, and roughly form an inverted 'T' shape, suggesting a somewhat perpendicular linear distribution pattern.

Within the 43 excavation squares comprising Unit G, 33 (76.7%) contain plotted bone. While the plotted bone within Unit G are also dispersed throughout the Unit, the majority of the specimens appear to be located in proximity to the south of the bank with the highest recorded flake counts, with the bone frequencies appearing to drop off in the east, west, and south directions.

Of the 25 excavation squares that make up Occupation Unit H, 21 (84%) contain plotted bone. While the distribution of bones within Unit H are also dispersed throughout the Unit, the distributional pattern appears somewhat different from that seen in Units F and G, seemingly displaying small clusters interspersed with linear distributions. Like Unit G, the plotted bone frequencies within Unit H seem to drop off toward the east, west and south.

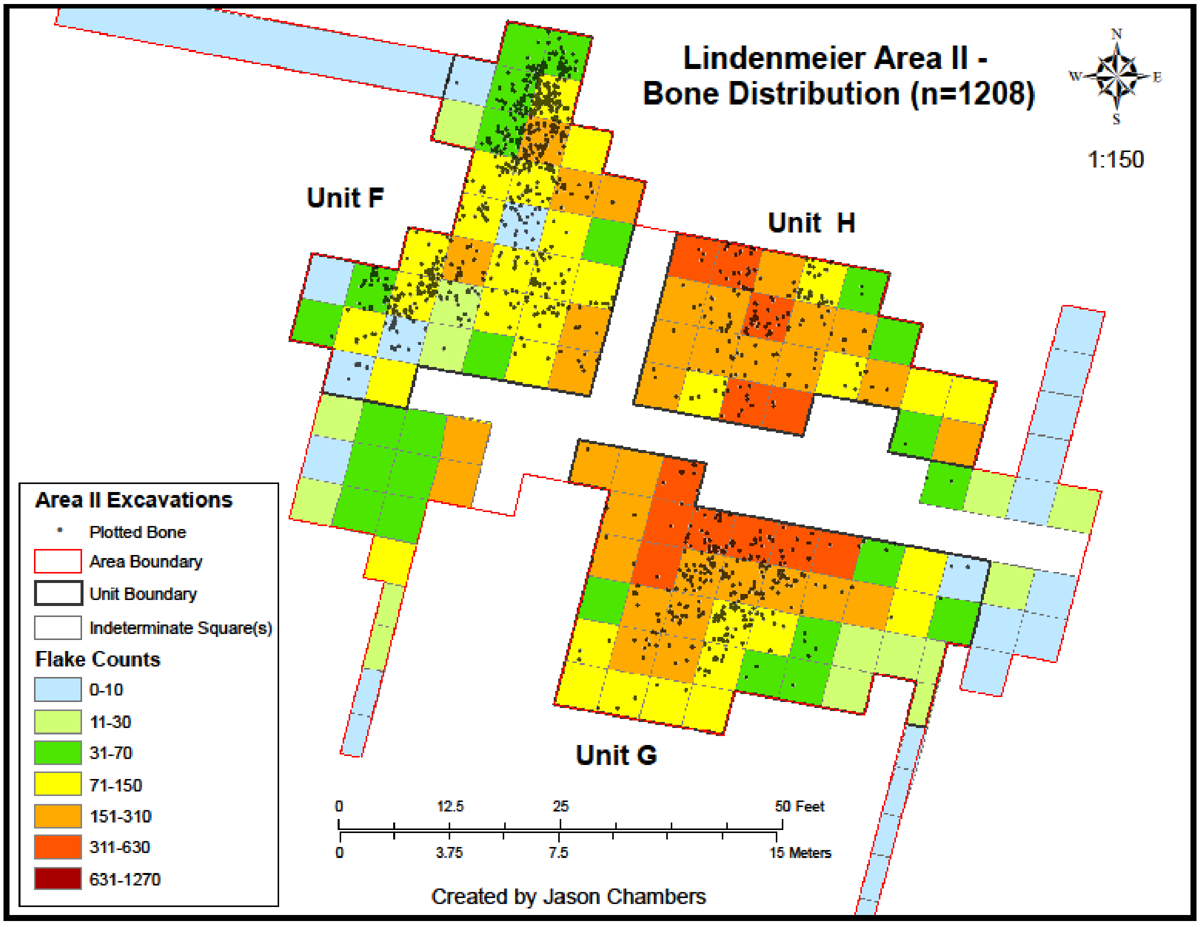

Figure 14: Bone Distribution, Lindenmeier Area II

The distribution of plotted bones within Area II appears different from that observed in Area I, with dispersion characterizing Area II as opposed to the discrete clustering observed in Area I. If the interpretation of the bone clusters in Area I representing the remnants of bison carcasses is correct, then it may be argued that Area II represents a secondary processing area in which disarticulated skeletal elements were processed and discarded as refuse. Areas I and II are separated by approximately 85 meters, which fits with the idea that the proposed secondary processing in Area II was likely conditioned by the desire of the site occupants to segregate their camp in space upwind from the presumably noxious, odoriferous remains of a bison kill.

The remains of typical non-prey species (wolf, fox, etc) present within the Lindenmeier vertebrate faunal assemblage is further evidence that the proposed bison kill attracted scavengers. This might suggest another reason the site occupants would separate their activities in space as a security measure, not just to shield the site occupants from foul odors, but also as a security measure to protect children and elderly social members, and hard-earned resources, from scavengers.

Area I Lithic Tool Distributions – Within Area I, 119 of the 239 (49.8%) total excavation units contain 1,135 pieces of plotted lithic tools. Of this total, 53 (44.5%) of these excavation units are located in Occupation Unit A, 47 (39.5%) are located in Occupation Unit B, 9 (7.6%) are located in the area of Occupation Unit B/C overlap, and 10 (8.4%) are located in Occupation Unit C.

Of the 63 excavation squares that comprise Occupation Unit A, 53 (84.1%) squares contain the plotted lithics located in this occupation unit. The 566 lithics located within Occupation Unit A make up 49.9% of the total lithics plotted in Area I.

Of the 53 excavation squares that comprise Occupation Unit B, 47 (88.7%) contain the plotted lithics located in this occupation unit. The 492 lithics located within Occupation Unit B make up 43.3% of the total lithics plotted in Area I.

Of the nine excavation squares that make up the Occupation Unit B/C area of overlap, all nine (100%) contain the plotted lithics located in this area of Occupation B/C overlap. The 59 lithics located in the area of Occupation Unit B/C overlap make up 5.2% of all lithics plotted within Area I.

Of the 36 excavation squares that make up Occupation Unit C, 10 (27.8%) contain the plotted lithics located within this occupation unit. The 18 lithics located within Occupation Unit C comprise 1.6% of all lithics plotted within Area I.

Within Area I, the lithic artifacts exhibit a very different distributional signature than the bone items presented above. Where the bone items were tightly clustered in space, the lithic artifacts are distributed much more evenly throughout the excavation squares comprising Units A and B. This suggests linearity in the northern portion of Area I (Unit A), as two tails appear to extend to the southeast and southwest, creating a wishbone shape overall.

The dearth of lithic tools in the eastern portion of Area I, labeled Unit C by Wilmsen and Roberts (1978), may reflect incomplete excavation of this area and is not further considered in this thesis. The blank areas indicate what Wilmsen called 'Indeterminate squares', and similarly are not included in the following analyses.

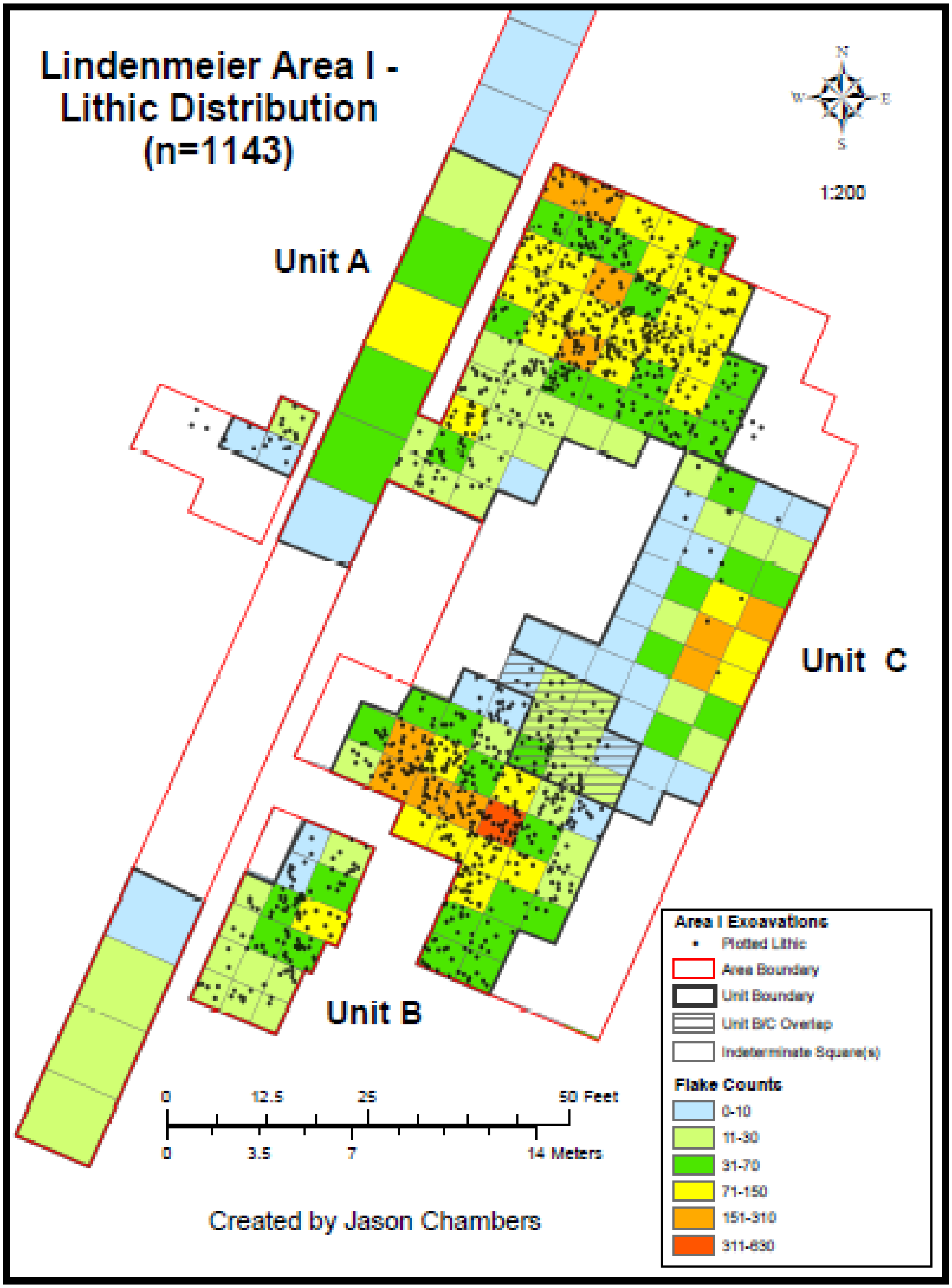

Figure 15: Lithic Tool Distribution Map, Lindenmeier Area I

In the southern portion of Area I, items appear roughly evenly distributed among excavation squares, though seemingly to cluster around the excavation square exhibiting the highest flake counts.

Area II Lithic Tool Distributions

The distribution of lithic artifacts in Area II differs from Area I; where the lithic artifacts in Area I were evenly distributed throughout the Occupation Units, the lithic artifacts in Area II appear to be clustered within each Occupation Unit. Within Unit F, lithic artifacts appear evenly distributed throughout, a cluster is seen in the southeast, as well as several ovoid, linear, and arcing directional distributions are observed in the southwest of the Unit.

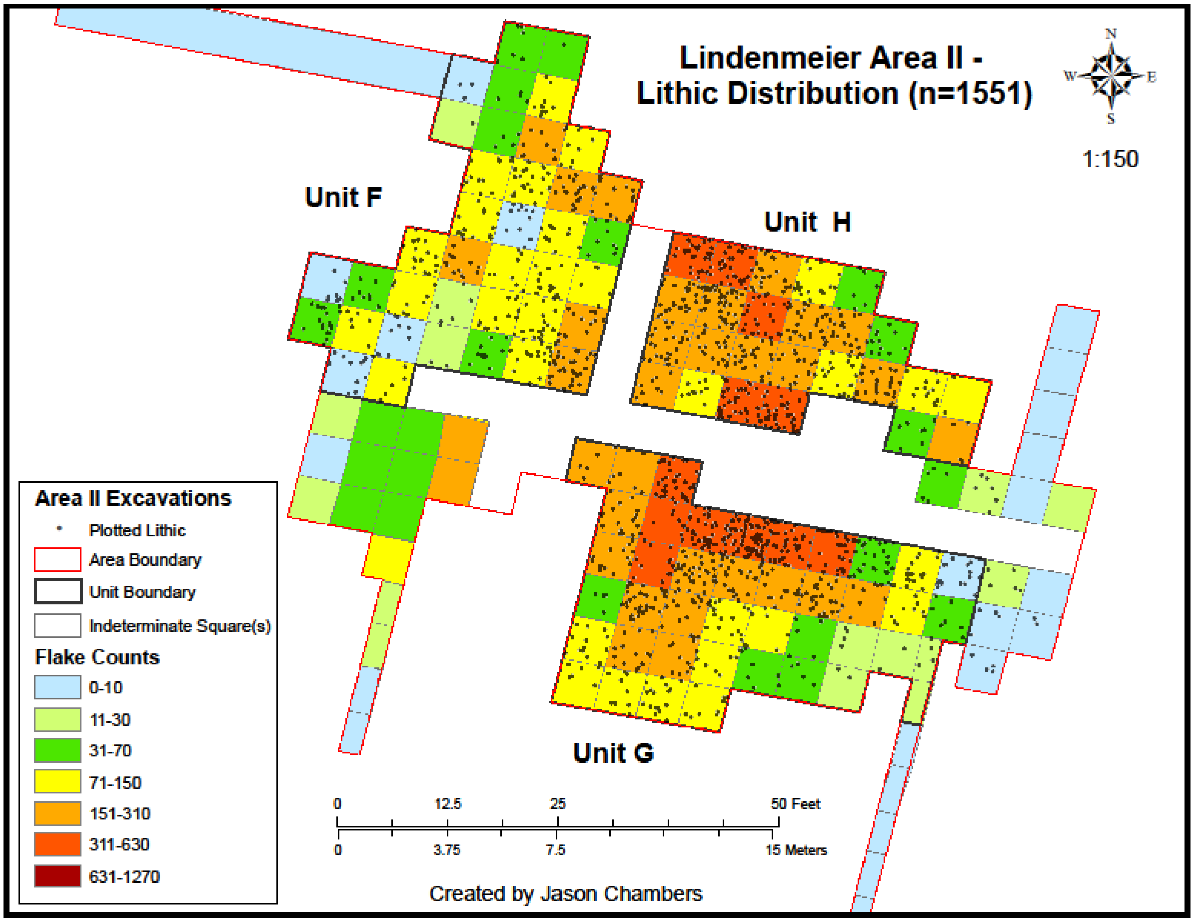

Figure 16: Lithic Tool Distribution Map, Lindenmeier Area II

Within Units G and H, variation from the lithic distribution pattern visible in Unit F is observed. Lithic artifacts in Units G and H appear clustered, with artifact frequencies decreasing towards the borders of each Unit. In Unit G, the clustering of lithic artifacts appears to overlap with the excavation squares exhibiting the highest flake counts. Interestingly, these two data types at different scales (individual artifact versus excavation square scale), mutually suggest high rates of discard of lithic items and debitage in this area. A similar distribution of lithic artifacts is observed to the north within Unit H, where lithic artifacts appear to cluster around excavation squares with the relatively highest flake counts.

Proportional Symbol Map - The proportions of tools versus bone counts per excavation area differ across both Areas I and II in each of Wilmsen's occupation units. Figure 17 presents a visual representation of the bone versus tool proportions for Lindenmeier Area II, adapted from Witt (2005) for the Aubrey Clovis Site, in which he numerically distinguished bone versus tool proportions of artifact frequency per excavation unit.

In Area I, a somewhat similar distributional pattern is seen. From Unit to Unit, more excavation squares contain lithic artifacts than contain bone artifacts, reflecting the distributional patterns seen within the individual bone and lithic artifact distributions.

Within Unit A, a relatively small number of lithic artifacts per excavation square interspersed with moderate numbers of bone characterize the proportional distribution of bone versus lithic artifacts. This is directly related to the clustering of bone artifacts demonstrated in Figure 12. There is a slight suggestion of a perpendicular relationship between the distributions of excavation squares containing predominantly bone versus those containing predominantly lithic artifacts. Within Unit B, however, the majority of excavation squares exhibit greater proportions of bone to lithic artifacts.

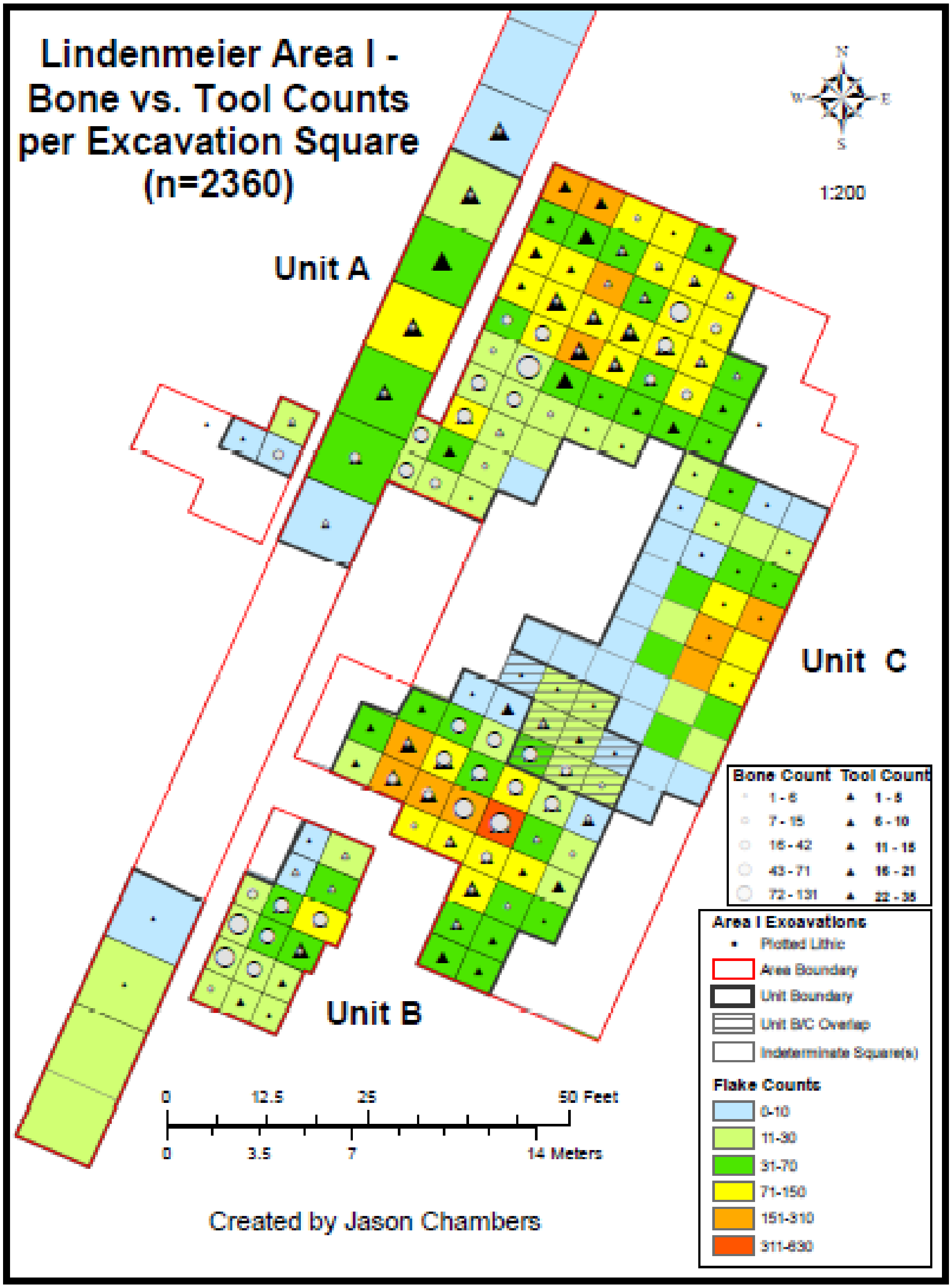

Figure 17: Bone versus Tool Proportional Symbol Map, Lindenmeier Area I

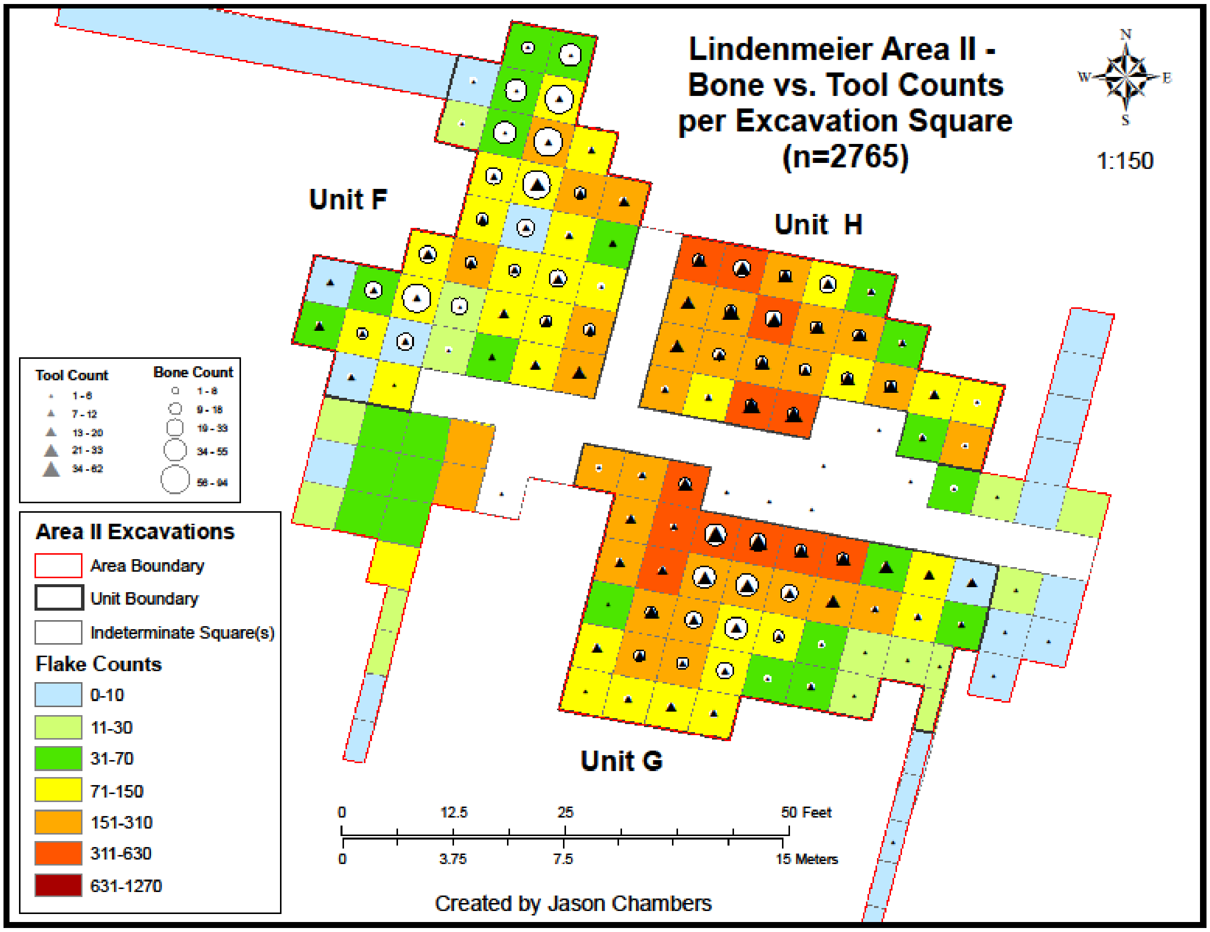

Figure 18: Bone versus Tool Proportional Symbol Map, Lindenmeier Area II

Within Area II (Figure 18), variation is observed in the proportional distributions of bone and lithic artifacts. Within Unit F, the majority of excavation squares exhibit higher proportions of bone to lithic artifacts. Within Unit G, more even proportions of bone and lithic artifacts are seen, with relatively even bone and lithic artifact proportions, surrounded by excavation squares containing little or no bone and relatively even, low lithic proportions that taper off toward the boundaries of the Unit. Within Unit H, similar proportions of bone and lithic artifacts are observed for some excavation squares, though tending generally toward higher lithic artifact proportions, and likewise tapering off toward the Unit's eastern and northern boundaries.

Artifact Frequencies - The frequency occurrence of different artifact types is useful in making distinctions among the distribution of discarded items within Wilmsen's Occupation Units. Table 5 documents the frequency, and percentage, of item occurrence recorded within each of Wilmsen's defined Occupation Units for Areas I and II.

Variation is seen within the overall distribution of tools versus bones per Unit in Areas I and II. Within Area I, Units A and B contain roughly equal amounts of items (1,178 versus 1,283), however, differences among the proportional distribution of these items is seen. Unit A exhibits roughly equal proportions of tools versus bones, 50.8% and 49.2% respectively, while within Unit B, the makeup is 61.3% bones and 38.7% tools.

Within Area II, a pattern of roughly 2-to-1 bone versus tool (or vice versa) is seen, similar to that of Area I Unit B. Unit F contains nearly twice as many bones as tools (65.8% versus 34.2%). While this pattern is similar but reversed in Units G (60.3% tools versus 39.7% bones) and H (64.6% tools versus 35.4% bones). It is interesting that Areas I and II are represented by similar numbers of excavation squares (107 versus 106), as well as similar total items (2,461 versus 3,074), yet each of the Units in Area II are smaller than those in Area I.

Table 5 depicts the frequency and proportion distribution of items per Unit for each of the artifact types mapped during excavations and included in this dataset. Yellow-colored rows highlight frequency distributions of artifact types of possible interest to the reader. While an in-depth look at the distribution of each of the artifact types is depicted in the table, it is beyond the scope of this thesis to address the significance of each and every artifact type in relation to each other. Instead, artifact types functionally related to important hunter-gatherer activities, specifically projectile manufacture and hideworking are discussed in Chapter 5.

Table 5: Lindenmeier Artifact Frequencies per Area and Unit

	Area I				Area II						
Occupation Unit	A		B		F		G		H		**Total**
Number of 5x5 Units	57		50		38		43		25		**213**
	#	%	#	%	#	%	#	%	#	%	#
Total Items	**1178**	**-**	**1283**	**-**	**1214**	**-**	**1060**	**-**	**800**	**-**	**5535**
Total Tools	598	50.8%	497	38.7%	415	34.2%	639	60.3%	517	64.6%	2666
Total Bone	580	49.2%	786	61.3%	799	65.8%	421	39.7%	283	35.4%	2869
Biface	40	3.4%	19	1.5%	23	1.9%	36	3.4%	24	3.0%	142
Bone Needle	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**5**	**0.5%**	**11**	**1.4%**	**16**
Channel Flake	39	3.3%	40	3.1%	79	6.5%	246	23.2%	144	18.0%	548
Decorated Bone	9	0.8%	1	0.1%	2	0.2%	2	0.2%	2	0.3%	16
Double Edge Tool	46	3.9%	33	2.6%	14	1.2%	26	2.5%	25	3.1%	144
Endscraper	37	3.1%	16	1.2%	31	2.6%	24	2.3%	36	4.5%	144
Fluted Point	27	2.3%	8	0.6%	11	0.9%	16	1.5%	20	2.5%	82
Grinding Stone	5	0.4%	1	0.1%	2	0.2%	0	0.0%	1	0.1%	9
Hematite	6	0.5%	4	0.3%	6	0.5%	4	0.4%	8	1.0%	28
Indeterm. Point	0	0.0%	2	0.2%	2	0.2%	36	3.4%	1	0.1%	41
Notch	0	0.0%	0	0.0%	3	0.2%	2	0.2%	5	0.6%	10
Ochre	2	0.2%	1	0.1%	0	0.0%	0	0.0%	1	0.1%	4
Plotted Bone	452	38.4%	522	40.7%	727	59.9%	307	29.0%	172	21.5%	2180
Preform	14	1.2%	22	1.7%	16	1.3%	62	5.8%	38	4.8%	152
Recorded Bone	128	10.9%	264	20.6%	72	5.9%	114	10.8%	111	13.9%	689
Single Edge Tool	60	5.1%	44	3.4%	41	3.4%	42	4.0%	42	5.3%	229
Tip/Graver	12	1.0%	8	0.6%	11	0.9%	13	1.2%	18	2.3%	62
Unfluted Point	0	0.0%	1	0.1%	6	0.5%	4	0.4%	4	0.5%	15
Unmodified Flake	42	3.6%	105	8.2%	9	0.7%	54	5.1%	77	9.6%	287
Unspecified Flake/Tool	200	17.0%	120	9.4%	102	8.4%	17	1.6%	4	0.5%	443
Utilized Flake	48	4.1%	70	5.5%	59	4.9%	47	4.4%	55	6.9%	279
Worked Bone	12	1.0%	1	0.1%	1	0.1%	1	0.1%	1	0.1%	16

Spatial Association –The results of the spatial association tests are presented in tables within each respective section that depict the frequency of occurrence, per artifact type, that each artifact type occurs as its own nearest neighbor; calculated using straight-line, Euclidean distance between individual artifacts. Additionally, percentages of occurrence are likewise presented for each Unit, in order to get a sense of the co-association (Schiffer 1987) of artifact types.

Area I – While all of the nearest neighbor occurrences among all combinations of the 14 artifact types present in the X,Y dataset for Area I were calculated, description of all of these neighborhood associations would be unduly cumbersome to describe in depth. The following will highlight some of the more noteworthy spatial associations based on frequency and percentage of occurrence. The specific spatial associations for particular artifact types functionally related to selected activities pertinent to understanding hunter-gatherer, and Folsom, lifeways, namely hideworking and projectile manufacture, will be discussed in Chapter 6.

Area I - Unit A – Within Unit A, there are 1,018 nearest neighbor occurrences among the 14 artifact types present. In terms of frequency, the majority of these neighbor occurrences is composed of unspecified flakes and plotted bone. Of the 452 occurrences of plotted bone, it is its own nearest neighbor 385 times, or in 85.2% of the cases; unspecified flakes are their own nearest neighbor 88 times, or 44% of the cases. Given their high frequency of occurrence within Unit A, plotted bone and unspecified flakes overwhelmingly represent the majority of neighbors in most cases for each of the other artifact types present in Unit A, including 41.7% of occurrences with tips/gravers, 35.9% of occurrences with channel flakes, and 25.0% of occurrences with preforms. The frequent tendency for unspecified flake/tools to be located immediately adjacent to so many tool types in Unit A suggests a measure of on-site, in-situ tool replenishment or manufacture being undertaken likely concurrently alongside other tasks relating to the bone clusters found elsewhere in Area I, and a flexibility of tool-kit in the presence of flake-based tools generated at-need that Wilmsen and Roberts were unable or unwilling to characterize more specifically within his discerning tool typology.

In terms of both frequency and percentages in the other cases, most other spatial associations are composed of single digit frequency and percentage of occurrences. In 33.3% of nine occurrences where fluted Folsom projectile points were found, most commonly they occurred alongside bone specimens; 27.1% of the occurrences of double edge tools co-occur alongside plotted bone.

Also interesting is what tool types do not occur as their own nearest neighbors and what pairs of tools do not co-occur. Neither preforms nor bifaces occur as their own nearest neighbors in Unit A. Preforms and fluted Folsom points never occur alongside each other in Unit A, indicating these were not discarded en masse via site maintenance, but rather discarded individually as they wore out during use or after following failed replenishment attempts. Endscrapers and channel flakes do not occur alongside each other in Unit A, with each tool type suggestive of hideworking and projectile manufacture activities, respectively, this may indicate a degree of spatial dispersion/segregation in the related activities. Tips never occur alongside themselves, fluted Folsom points, preforms, channel flakes, bifaces, unmodified flakes, or plotted bone in Unit A. If tips are suggestive of decorative item manufacture, the negative spatial association between tips and these items may suggest spatial segregation of decorative item creation and activities relating to projectile manufacture.

Aside from bone and unspecified flake artifact types, other noteworthy spatial associations indicate clustering of single-edge tools in 20% of occurrences, between single-edge tools and endscrapers in 16.2% of cases, and between single and double-edge tools in 14.5% of cases. This consistency within the observed clustering in the discard of similar implements suggests task-oriented organization of space within Unit A, indicating an area where a specific, recurrent tool-kit was repeatedly employed, and discarded, by like-minded individuals employing these combinations of tools with a similar intent.

Unit B – There are 1,014 nearest neighbor occurrences among the 14 artifact types located within Unit B. As was seen in the description of spatial associations for Unit A, the vast majority of neighborhood occurrences in terms of frequency and percentage are between combinations of other artifact types and unspecified flakes and plotted bone specimens. In 78.2% of occurrences, plotted bone is its own nearest neighbor; in 53.3% of occurrences, unspecified flake/tools are their own nearest neighbor. Plotted bone occurs rather evenly in co-association among the majority of tool types in Unit B.

Though far fewer fluted Folsom points occur in Unit B than in Unit A, they most often co-occur with plotted bone in 50% of occurrences; this is interesting given that fluted Folsom points do not occur alongside many tool types in Unit B, whereas they are more-or-less evenly distributed alongside the tool types in Unit A, suggesting differences in discard patterns of fluted Folsom points between Units A and B in Area I. Similar frequencies of channel flakes are present, and co-occur in similar frequencies alongside similar tool types in both Units A and B. Bifaces occur as their own nearest neighbor, as well as alongside utilized flakes in 21.1% of occurrences.

The frequent co-occurrence of utilized, unmodified and unspecified flake/tool among many tool types suggests that tool refurbishment was a regular, integral part of the cultural patterning conditioning the use of space in Unit B just as in Unit A.

Tool types that do not occur as their own nearest neighbors in Unit B include fluted Folsom points, Indeterminate points, preforms, endscrapers, single-edge tools, and tips. Many more pairs of tools do not co-occur in Unit B than was seen in Unit A, generally suggestive of differing patterns of preferential discard among tool types within each Unit.

Area II – Unit F – One thousand and thirty-one (1,131) nearest neighbor cases were observed for the 15 types of artifacts in Unit F. Similar to Unit A and B in Area I, Unit F also exhibits high frequencies and percentages of occurrence among the various artifacts and plotted bone specimens. Unspecified flakes are also prevalent neighbors to the various artifact types, though much less common than is seen in Units A and B in Area I. Plotted bone specimens co-occur as neighbors as much as 100% of occurrences with indeterminate points, and 50% or greater of occurrences with fluted points (54.5%), endscrapers (51.6%), unfluted points (50.0%), and preforms (50.0%). Unspecified flakes occur as nearest neighbors to unfluted points and notches 33.3%, and as their own nearest neighbors in 30.7% of occurrences.

Other noteworthy spatial associations among the remaining artifact types in Unit F include double edge tools and channel flakes (35.7%), notches and bifaces (33.3%) and bifaces and channel flakes (21.7%).

Area II Unit G – Nine hundred and thirty-four (934) nearest neighbor cases are observed for the 15 types of artifacts with X, Y coordinate information for each individual artifact in Unit G. While plotted bone still often occurs as nearest neighbor to the various artifact types, it does so in greatly reduced frequencies and percentages from those seen in Units A and B in Area I as well as Unit F in Area II. The overall frequency of plotted bone is reduced in Unit G, and occurs as its own neighbor as a high of 52.1% of those cases, indicating that bone objects discarded in this area have likely been disarticulated. This negative association indicates that the manipulation of bone items was undertaken in Unit G with different aims than in other Units ; clearly, other cultural depositional processes are conditioning the discard pattern of bone objects in Unit G. Unspecified flake/tools are likewise noticeably reduced in frequency as well as percentage of occurrence in Unit G from previously described Units, occurring as its own neighbor a high of 17.6% of occurrences.

More common spatial associations are observed among and between the remaining artifact types in Unit G than previously described Units. These associations are present in percentages of occurrence as high as 50.0% among unfluted points, between notches and preforms, and between notches and channel flakes. Channel flakes occur in high frequencies and percentages as neighbors to several artifact types; endscrapers and channel flakes occur as nearest neighbors in 37.5% of cases, unmodified flakes and channel flakes 31.5% of cases, tips and channel flakes 30.8% of cases, preforms and channel flakes 30.6% of cases, and 25% or greater with indeterminate points (25.0%) and double- edge tools (26.9%).

Unit H – Six hundred and sixty-five (665) nearest neighbor cases were observed for the 15 artifact types Unit H. Plotted bone and channel flakes are the most frequently occurring artifact type within Unit H. However, plotted bone is reduced in frequency and percentage of occurrence as nearest neighbor between the artifact types present, occurring as high as 50.0% of cases with unfluted points, as its own neighbor 39.5% of occurrences, and as neighbor to single-edge tools (31.0%), unmodified flakes (27.3%), and fluted Folsom points 25.0% of occurrences.

Of the remaining artifact types, spatial association is observed between indeterminate points and channel flakes (100.0%), notches and utilized flakes (60.0%), tips and unmodified flakes (27.8%), unspecified flake/tools and fluted points (25.0%), unfluted points and channel flakes (25.0%), unfluted points and utilized flakes (25.0%), bifaces and unmodified flakes (25.0%) and fluted Folsom points and single-edge tools (25.0%).

Discussion of Significance – Spatial association is a quantitative measure of the nearest neighbor relationships calculated from straight-line, Euclidean, distance between individual artifacts with associated X, Y coordinate information. The relationships among artifacts of the same type, as well as between artifacts of different types, reveal local neighborhood patterns among artifacts at the scale of the individual artifact. Similarities are observed among and between unspecified flake/tools and plotted bone associations with other artifact types in Units A and B in Area I, and interestingly in Unit F, but not the other two Units, in Area II. Given the different distributional patterns observed in the plotted bone found in Area I versus II, it is surprising that similar patterns in the spatial associations exist between these Units. This data suggests that within Unit F, bone specimens were a conditioning factor in the distribution of lithic items. Additionally, given the dispersed nature of bone specimens in Unit F, coupled with Robert's refit evidence linking Area I and II (Roberts 1941:79), it suggests this area was a bone processing area, likely related to secondary butchery practices (disarticulation, marrow extraction, etc.).

Units G and H in Area II exhibit different spatial association patterns than those in Units A and B in Area I, as well as Unit F in Area II. Considering differences in the frequencies of items present in different Units, there generally are more occurrences of positive spatial association in Units G and H than in Units A, B, and F. These increased numbers of associations indicate more complex spatial relationships among the tools classes represented, and hence, greater spatial connectedness between multiple, different activities performed in Units G and H than in Units A, B and F.

Spatial Auto- & Cross- Correlation Statistics – Area I tool, bone and flake counts

In order to interpret the results of the spatial auto- and cross- correlations statistics presented in the following tables for Area I, the Moran's I value is a positive or negative number indicating the strength and direction of the spatial auto- or cross- correlation relationship between pairwise artifact types. Positive values indicate positive relationships (+) between artifact types, with negative values indicating a negative, or inverse, relationship (-). The p-value is a confidence measure, indicating the Moran's I statistic's reliability measured by how many errors are likely per 100 iterations.

For this study, p-values of <.01 indicate a greater than 99% probability that the relationship is accurately depicted, regardless of how many iterations of Moran's I are conducted. P-values between 0.11 and .05 are reliable at the 95% confidence level, p-values between .051 and .10 are reliable at the 90% level, and p-values between .101 and .15 are reliable at the 85% confidence level. For the purposes of this study, p-values exceeding .15 are considered not significant (NS), or random/spatially independent. This threshold is flexible however, and may be adjusted, which can alter interpretations; therefore, explicit definitions of these interpretational categories are presented above. To aid the reader, four (4) categories of statistical relationship are highlighted using color, with the highest confidence results (p<.01) highlighted in red, and decreasing with yellow (p<.05), green (p<.10), and finally to the lowest confidence results considered included in this analysis highlighted in blue (p<.15).

Occupation Unit A– Within Occupation Unit A, statistically significant positive spatial auto-correlation (SAC) is found within the overall distribution of tools (p=.001), bones (p=.071) and flake counts (p=0) at the 5'x5' excavation square scale. These statistics, presented in Table 6, indicate that clustering is present in the distributions of these items in relation to themselves. In other words, tools are found with other tools, bones are found with other bones, and similar flake counts cluster together.

Statistically significant positive spatial cross-correlation (SCC) is observed within the co-distributions of tools and flake counts (p=.001) suggesting that within Occupation Unit A, tools and flake counts are positively related. Stated another way, the presence of high flake counts are a good predictor of tools, and vice versa. However, statistically significant negative spatial cross-correlation (SCC) was observed within the co-distributions of bones and flake counts (p=.072). This indicates that where high flake counts are observed, bones tend to be lacking, and vice versa. No statistically significant pattern was observed between tools and bone, suggesting that tools are not a good predictor of bones, and vice versa, for Occupation Unit A.

Table 6 : Overall Spatial Auto- & Cross- Correlation Statistics, Lindenmeier Area I Unit A

	Overall			
	Tools	Bones	Flake Count	
Bimoran I	0.222	-0.008	0.191	Tools
Significance	++++	NS	++++	
P-value	0.001	0.937	0.001	
		0.094	-0.098	Bones
		++	--	
		0.071	0.072	
			0.257	Flake Counts
			++++	
			0	

Occupation Unit B– Within Occupation Unit B, statistically significant positive spatial auto-correlation (SAC) was observed within the overall distribution of tools (p=.001), bones (p=.137) and flake counts (p=.025). These results are presented in Table 7. Though still statistically significant, the p-values associated with the SAC statistics for the individual distributions of bones and flake counts were somewhat weaker than those observed for Occupation Unit A.

Statistically significant positive spatial cross-correlation (SCC) was observed within the co-distributions of tools and bones (p=.04), tools and flake counts (p=0), and bones and flake counts (p=.055) in Unit B. In contrast to Occupation Unit A, no negative relationships were observed in Occupation Unit B. Instead, bones and high flake counts exhibited a positive relationship, suggesting a somewhat different pattern present in the distribution of these items in relation to one another, and likewise suggesting that different (presumably cultural) spatial patterning practices are responsible for the slightly differing use of space from Occupation Unit A to Unit B. This suggests the possibility that the production of flake debitage is related not only to tool refurbishment or manufacture, but also to the processing of bone items in Unit B.

Table 7: Overall Spatial Auto- & Cross- Correlation Statistics, Lindenmeier Area I Unit B

	Overall			
	Tools	Bones	Flake Counts	
Bimoran's I	0.25	0.123	0.25	Tools
Significance	++++	+++	++++	
P-value	0.001	0.04	0	
		0.102	0.115	Bones
		+	++	
		0.137	0.055	
			0.166	Flake Counts
			+++	
			0.025	

Area II - Spatial Auto- & Cross- Correlation Statistics

Occupation Unit F **–** Within Occupation Unit F, and presented in Table 8, statistically significant positive spatial auto-correlation (SAC) was found within the overall distribution of tools (p=.004) and flake counts (p=.004). No statistically significant auto-correlation (SAC) is observed in the distribution of bones (p=.195) based on the interpretive rubric outlined previously. Therefore, within Occupation Unit F, the presence of tools is a good predictor of other tools, high flake counts tend to occur together, and bones are neither positively or negatively associated with either tools or flake counts.

Statistically significant positive spatial cross-correlation (SCC) is observed within the co-distributions of tools and flake counts (p=.028), which mirrors the SAC statistics describing high flake counts as a good predictor of the presence of tools. No statistically significant relationship was observed, however, within the co-distributions of tools and bones (p=.8) or bones and flake counts (p=.447). This suggests that within Occupation Unit F, the distribution of bones are spatially independent of tools and high flake counts.

Table 8: Overall Spatial Auto- & Cross- Correlation Statistics, Lindenmeier Area II Unit F

	Overall			
	Tools	Bones	Flake Counts	
Bimoran's I	0.221	-0.015	0.148	Tools
Significance	++++	NS	+++	
P-value	0.004	0.8	0.028	
		0.086	0.047	Bones
		NS	NS	
		0.195	0.447	
			0.229	Flake Counts
			++++	
			0.004	

Occupation Unit G **–** Within Occupation Unit G, and presented in Table 9, statistically significant positive spatial auto-correlation (SAC) was observed within the overall distribution of tools (p=0), bones (p=0) and flake counts (p=0). Thus, in Occupation Unit G, tools, bones and flakes are useful predictors of other items of the same type.

Statistically significant spatial cross-correlation (SCC) was observed within the co-distributions of tools and bones (p=0), tools and flake counts (p=0), and bones and flake counts (p=0). Therefore, the presence of tools, bones and flake counts are useful predictors of other items of dissimilar type as well.

Statistically significant SAC was observed for tools, bones and flakes, and SCC was observed for all the various combinations therein. Given that Clark and Evan's Nearest Neighbor statistic did not suggest random distributions, it follows that functional integration of the items in Occupation Unit G took place among the overall bone, tool and flake debitage distributions. This also suggests that a variety of related processes are responsible for the spatial patterns in the discard of items in this Occupation Unit.

Table 9: Overall Spatial Auto- & Cross- Correlation Statistics, Lindenmeier Area II Unit G

	Overall			
	Tools	Bones	Flake Counts	
Bimoran I	0.426	0.424	0.429	Tools
Significance	++++	++++	++++	
P-value	0	0	0	
		0.547	0.361	Bones
		++++	++++	
		0	0	
			0.566	Flake Counts
			++++	
			0	

Occupation Unit H **–** Within Occupation Unit H, and presented in Table 10, statistically significant positive spatial auto-correlation (SAC) was observed within the overall distribution of tools (p=.136). Also, statistically significant negative spatial auto-correlation (SAC) was observed within the overall distribution of bones (p=.138). No spatial auto-correlation (SAC) was observed within the distribution of flake counts (p=.546) for Occupation Unit H. Therefore, within Occupation Unit H, tools tend to occur together in space, while bones are spatially dispersed.

No statistically significant cross-correlation (SCC) was observed within the co-distributions of overall items in Occupation Unit H. A lack of statistically significant results observed among the various combinations of tools, bones and flake counts suggests that the spatial patterns responsible for the distributions of items in Occupation Unit H are somewhat different from those responsible for producing Occupation Unit F, and drastically different from those responsible for producing Occupation Unit G.

Table 10: Overall Auto- & Cross- Correlation Statistics, Lindenmeier Area II Unit H

	Overall			
	Tools	Bones	Flake Counts	
Bimoran's I	0.126	-0.065	0.074	Tools
Significance	+	NS	NS	
P-value	0.136	0.659	0.295	
		-0.206	-0.065	Bones
		-	NS	
		0.138	0.641	
			0.026	Flake Counts
			NS	
			0.546	

Kernel Density Estimates **-** Kernel Density Estimates (K.D.E.) were calculated for piece-plotted items in Areas I and II using ArcGIS 9.3 software to visually examine artifact clustering. Three iterations were calculated separately for each Area I and II data subsets with X,Y coordinates: all piece-plotted items, bones and lithics. For each of these data subsets per Area, Kernel Density Estimates were calculated using a .5 meter search radius, and symbolized with an Equal Interval classification scheme using five classes. Data values of 0 were excluded, and a light-to-bright red color gradient was used to visually simplify the graphically displayed results. The Kernel Density Estimate result layers are displayed using a 20% transparency overlaying the flake counts so that the visual KDE results would not be influenced by the background flake count values, while still providing some measure of relationships between KDE results and flake debris counts.

Figure 19 presents the KDE values for all piece-plotted specimens located within Area I. Within Unit A, five non-contiguous clusters of items are observed, separated by background density values. From North to South these clusters are separated by 4.9, 1.7, 2.0 and 2.8m distances, respectively. Within Unit B, two main non-contiguous clusters are observed. In the northern section of Unit B, a multi-part cluster composed of four hotspots are surrounded by background values; the cluster in the southern section of Unit B similarly is composed of three non-contiguous hotspots surrounded by background values.

Figure 20 presents the KDE for plotted bone specimens within Area I. The KDE for plotted bone bolsters the previously described clustering of bone in Area I by providing visual, graphically-displayed quantitatively-derived results that show discrete clusters of bone containing hotspots surrounded by background values, and separated by 5.0, 1.7, 2.0, 2.8m respectively from North to South.

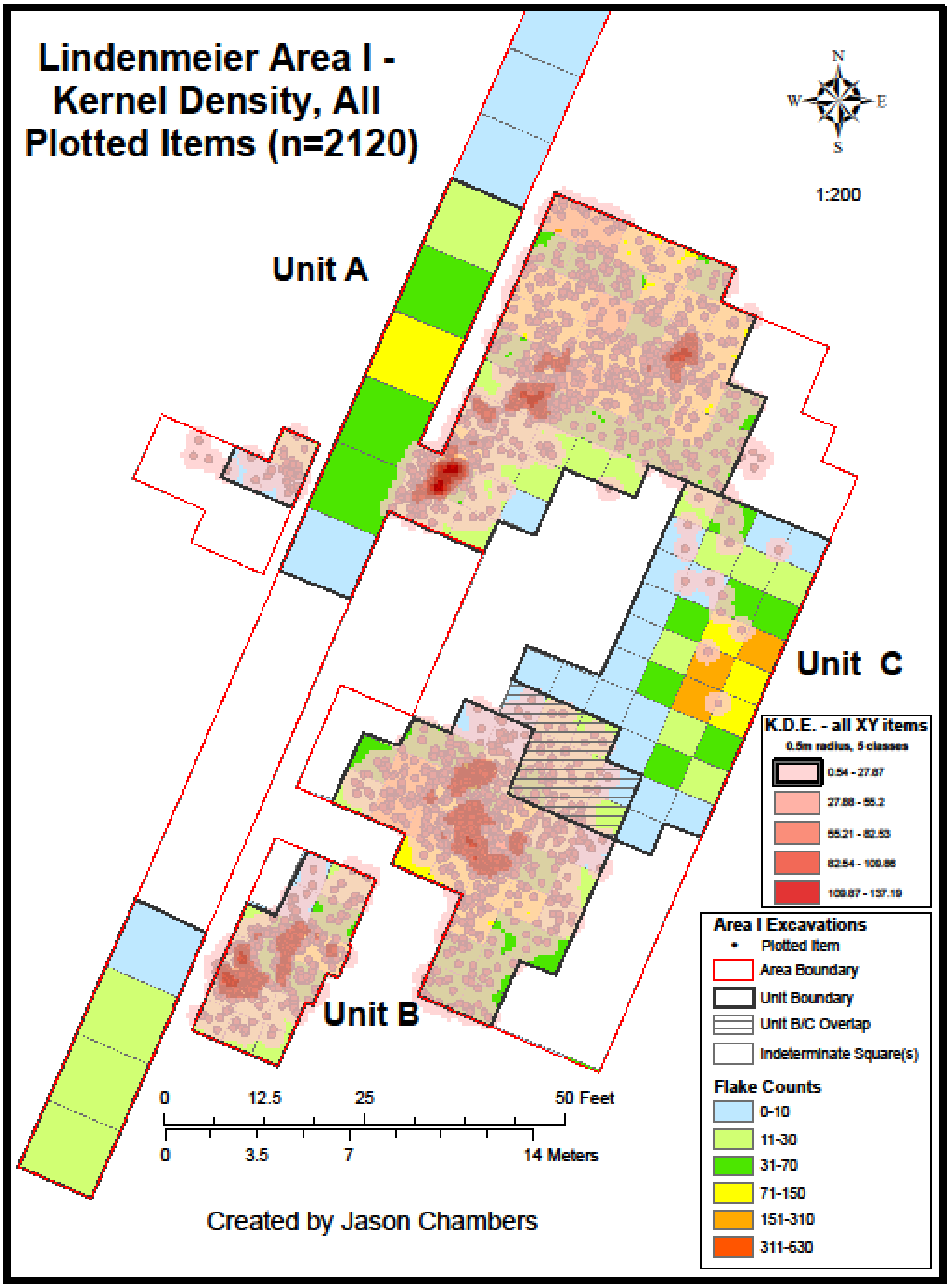

Figure 19: Kernel Density Estimates (.5m) for All Plotted Items, Lindenmeier Area I

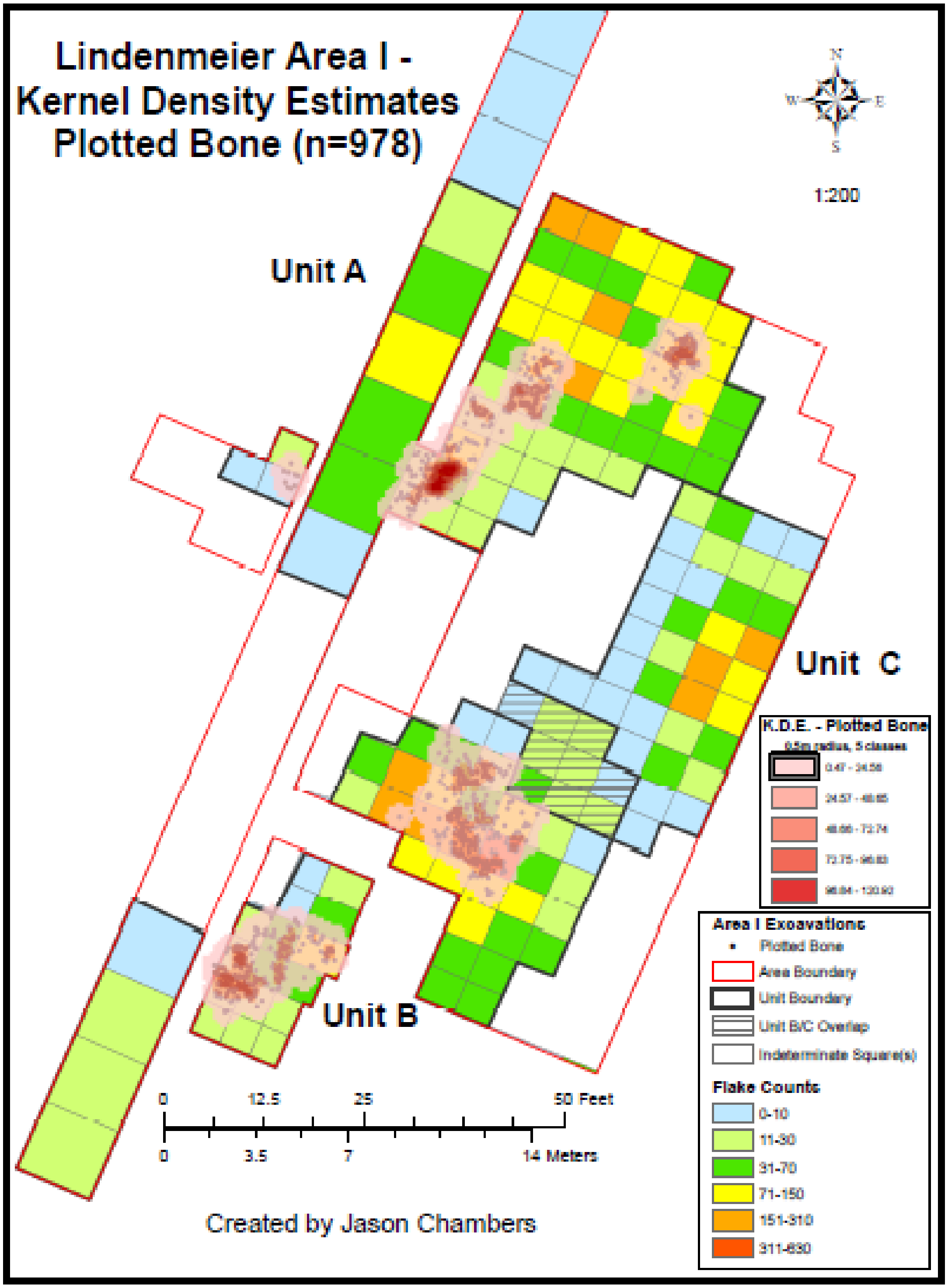

Figure 20: Kernel Density Estimates (.5m) for Plotted Bone Map, Lindenmeier Area I

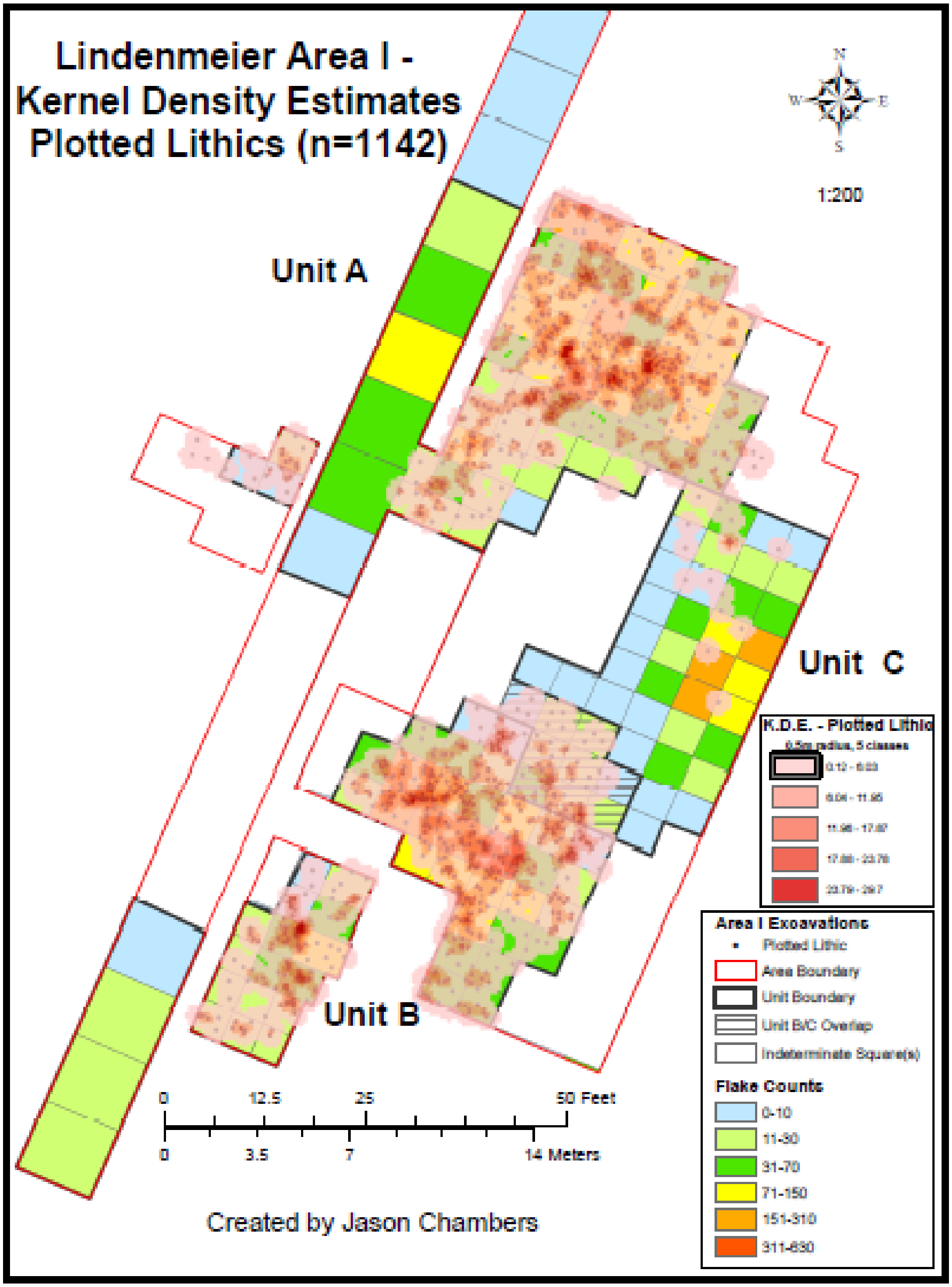

Figure 21: Kernel Density Estimates (.5m) for Plotted Lithics, Lindenmeier Area I

Figure 21 presents the KDE values for the plotted lithic specimens within Area I. Within both Units A and B, the distribution of lithics is definitively different from that of bone, with lithics occurring in less-discrete and non-contiguous clusters. Within both Units A and B, linearity is suggested from the banks of lithic distributions, in contrast to the more ovoid bone clusters.

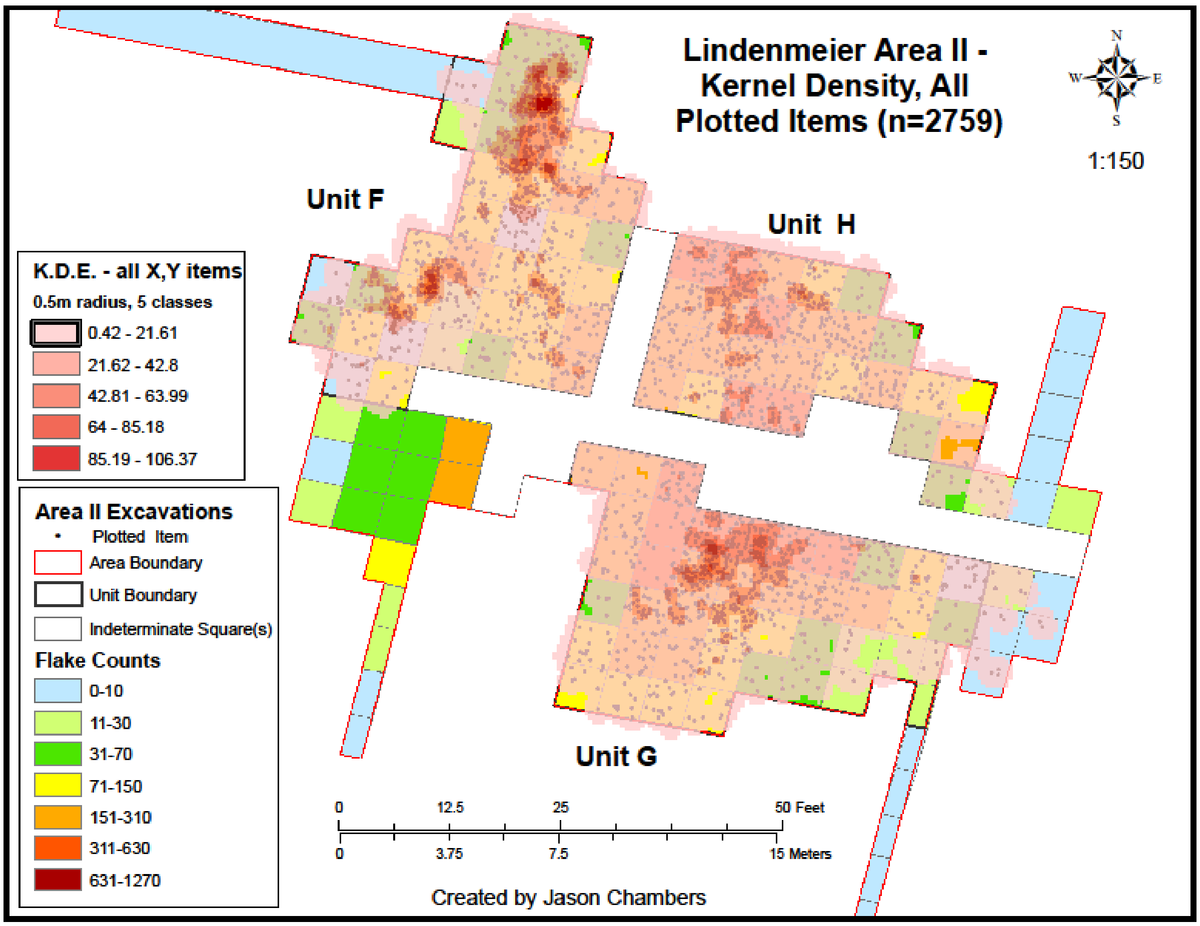

Figure 22: Kernel Density Estimates (.5m) for All Plotted Specimens, Lindenmeier Area II

Figure 22 presents the KDE results for all piece-plotted specimens in Lindenmeier Area II overlaid upon the flake debris counts. This figure shows increased overall clustering of specimens in Unit F versus Units G and H. Within Unit F, three main groupings or clusters (or more accurately, clusters of clusters) are observed from the background density values. A contiguous cluster covering 9.54m^2 north-to-south with five hot spots, or peaks in artifact frequency per 0.5m^2 of area (or density), is located in the northern part of the Unit, with two 'wings' or banks of debris extending linearly in arcs to the south and southeast for 1.5 and 1.8m, respectively. Located 6.46m to the south-southwest, still within Unit F, is a horseshoe-shaped cluster covering 1.95m^2 with a centrally-located hot spot on the western arm. Slightly (1.5m) to the southwest, is an amorphous cluster, covering an area of 7.9m^2, also with two refuse banks, both extending 0.75m to the west and northwest. Still within Unit F, located 4m to the east are additional clusters reminiscent of an archipelago extending to the southeast; another cluster is kidney-shaped and covers 1.05m^2 and is surrounded by three small clusters covering .08, 0.8 and 0.11m^2 respectively. Further to the southeast are three additional clusters, collectively termed #F3, slightly elliptical in shape and of uniform density covering .11, .33, and .13m^2 respectively, that extend linearly towards the Indeterminate Squares between Units F, G and H.

Within Unit G, KDE values indicate one main cluster. This cluster of debris exhibits an amorphous shape covering 9.4 m^2, and dominates the Unit. The cluster contains three hotspots as well as several centrally located 'blank' areas or valleys in artifact frequency, each measuring approximately 0.5 m^2. Two areas of low and uniform density are observed distributed to the south and southwest of this cluster, ranging between 0.1-.4m^2.

Unit H exhibits patterns in KDE values that differ from both Units F and G. Within Unit H, several smaller non-contiguous clusters of roughly uniform density dominate. These combine to cover approximately 5.6m^2, ranging from 0.1-3.5m^2.

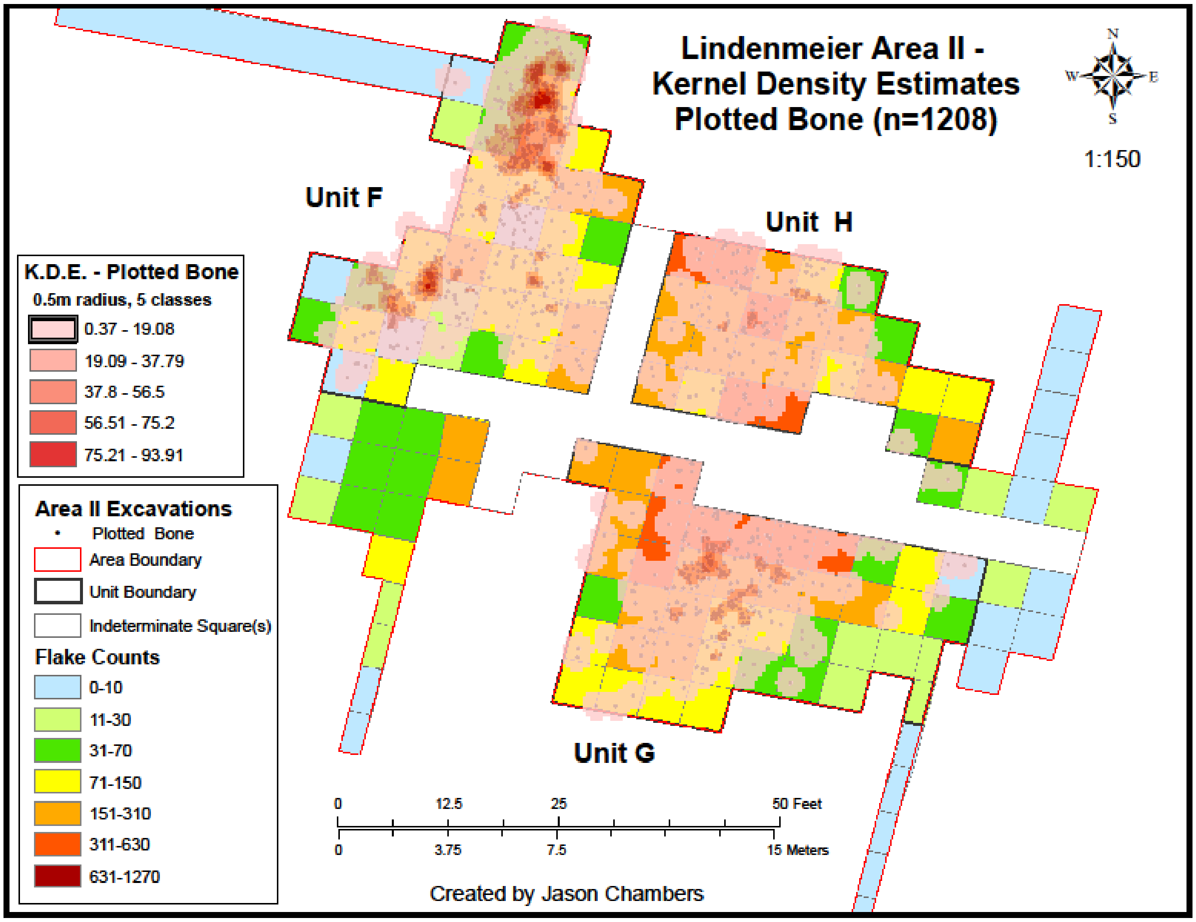

Figure 23: Kernel Density Estimates (.5m) for Plotted Bone, Lindenmeier Area II

Figure 23 presents the KDE for the plotted bone specimens within Area II. As with the overall distribution of items discussed above, variation is seen in the distribution of bones between Units. Within Unit F, the pattern roughly follows that described for the overall distribution of items. However, for Units G and H, differing patterns in the clustering of bone items is observed from that of the overall distribution of items per Unit. Within Unit G, bone is generally evenly distributed throughout the Unit, with small clusters of bone occurring immediately south of the bank of excavation squares containing the highest flake counts. Unit H likewise presents a pattern of uniform distribution of bones, with three small clusters located in the center of the Unit, surrounding an isolated square of high flake counts.

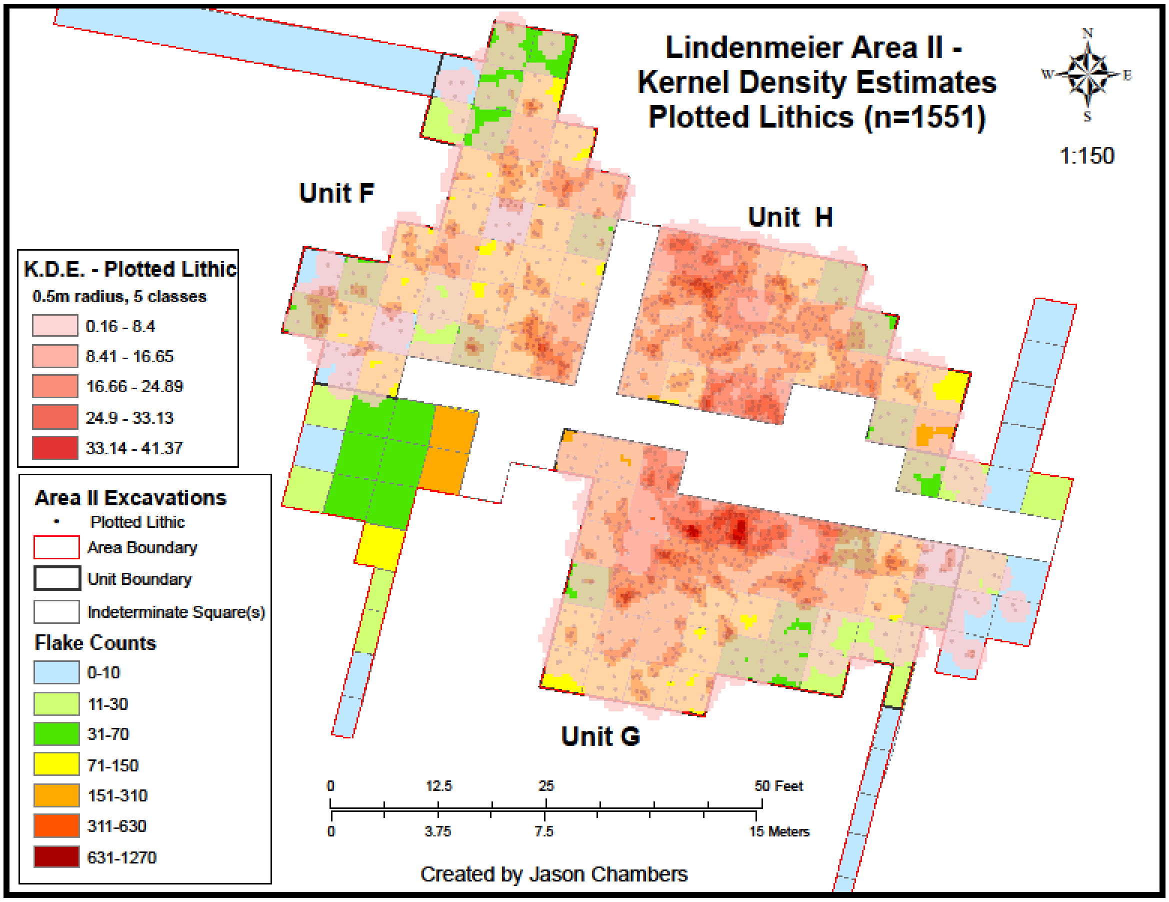

Figure 24: Kernel Density Estimates (.5m) for Plotted Lithics, Lindenmeier Area II

KDE values for the piece-plotted lithic specimens (Figure 24) suggest different distribution patterns from Unit to Unit within Area II. Within Unit F, small, discrete lithic clusters of uniform density distributed across the Unit dominate, while within Unit G more contiguous lithic clustering is observed, while within Unit H denser concentrations of lithics are observed more uniformly across the Unit.

Discussion of Significance - While KDE provides visual estimates of the clustering present among piece-plotted artifacts with X, Y coordinates, it is a subjective method. As such, the cluster designations should not be taken as definitive units for purposes of quantitative analysis, but rather as an indication of the intensity of the differential distribution of artifacts, and hence, use of space, across the site and per Unit. These areas of highest density represent local landmarks within the site, or refuse piles generated from site maintenance, around and within which site occupants likely navigated with pathways between the various parts of the site.

Refits - Wilmsen reported 58 refits comprising 111 fragments, and argued that these refits suggest 'autonomous episodes of occupation" (Wilmsen and Roberts 1978:59), or multiple occupations. Unfortunately, no specimen-specific information is presented for these fitted fragments, limiting the development of appropriate interpretations of the social implications for intra-site structural patterns. Should this information at some time in the future become available, appropriate interpretations of resource sharing, projectile rehafting, etc. will become available. Specific use-wear information would be of great use in eliciting social patterns, but simply knowing the artifact type comprising the fitted fragments would help flesh out patterns of social relationships within the occupation units outlined by Wilmsen.

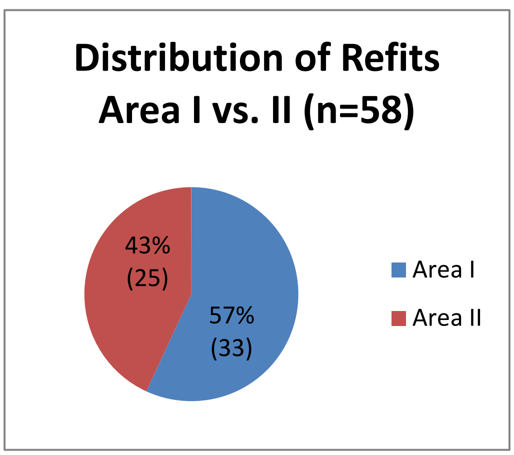

Figure 25: Distribution of Refits between Lindenmeier Areas I & II

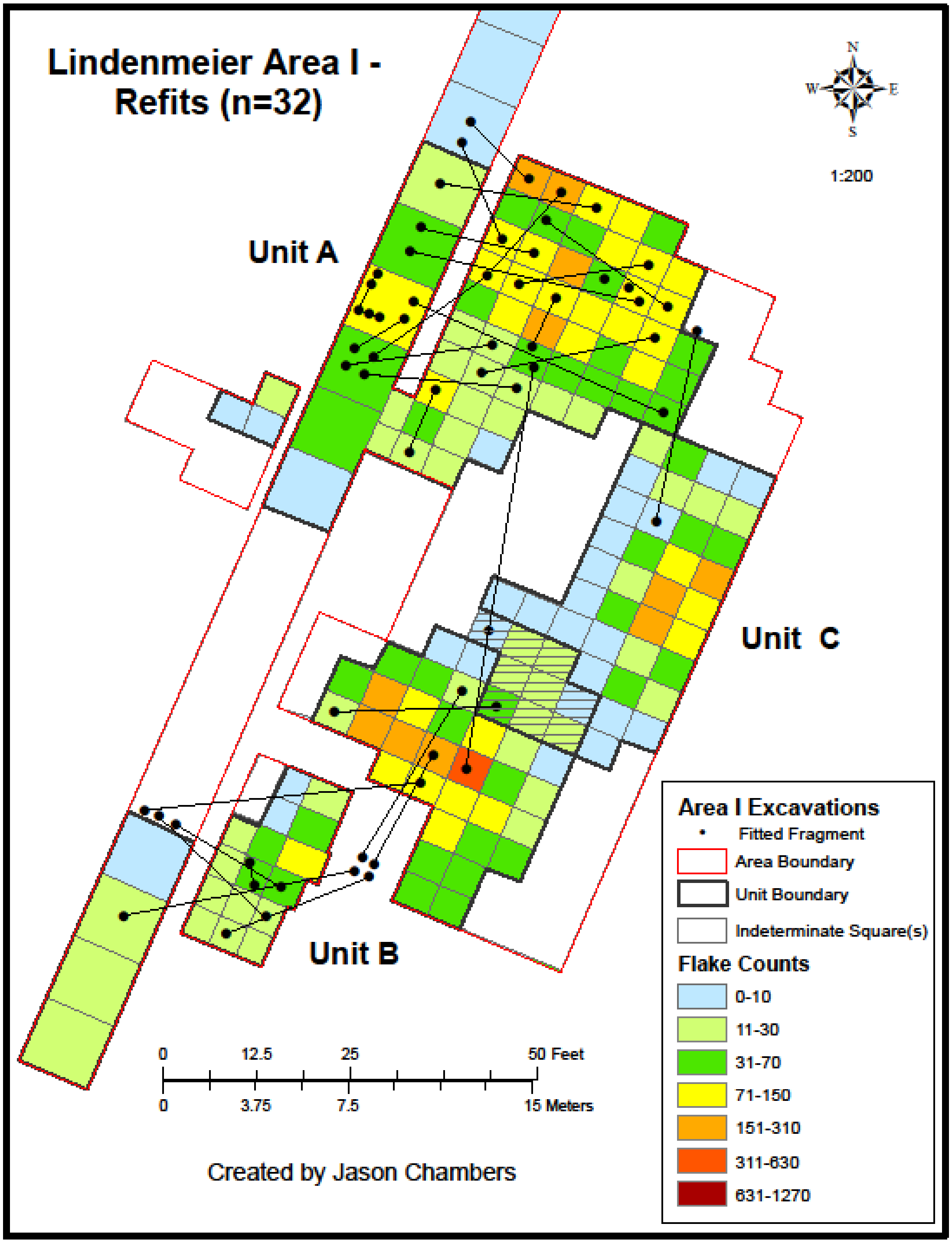

Figure 26: Lindenmeier Area I Refits/Fitted Fragments (Reproduced from Wilmsen & Roberts 1978:62)

Area I –Of the 58 refits within the Folsom occupation in Area I, 33 (56.9%) of these refits occur within Area I, with the remainder located within Area II. Roberts (1941:79) does mention, however, another pair of refits linking Unit B in Area I and Unit G in Area II, a distance of some 137m (450 ft) (Wilmsen and Roberts 1978:60), providing a link between these two portions of the site.

Occupation Unit A-Of the 33 refits within Area I, 21 (63.6%) occur within Unit A, the highest frequency of refits within (or between) any occupation unit, representing 36.2% of the 58 total refits within combined Areas I and II. The mean distance between refits within Unit A is 4.4m.

Occupation Unit B- Of 33 refits within Area I, 10 (30.3%) are located within Unit B, with a single refit (3%) linking Unit A to the two fitted fragments reported by Roberts (1941:79) in Unit B, and mentioned above. The mean distance between refits within Unit B is 6.5m.

Occupation Unit C – a single refit (3%) is present within Unit C linking to an indeterminate square at the eastern margin of Unit A, 7.92m away. The refit profile for Unit C is clearly different from those of A and B, indicating these areas were utilized differently by the Folsom site occupants.

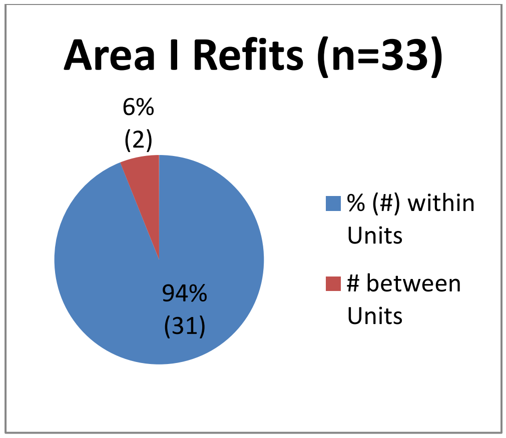

Figure 27: Refit Distribution, Lindenmeier Area I

Within Area I, 31 of 33 (93.9%) refitted fragments occur entirely within Occupation Units A and B. One (3%) refit occurs between Unit A and Unit B, and one (3%) occurs between Unit B and an indeterminate square on the eastern margin of Unit A. This suggests that interactions in Unit A were not only more frequent, but cover shorter distances than those in Unit B, indicating greater connectivity among site occupants and/or activities undertaken within Unit A than Unit B. Use-wear analysis, or even knowledge of what tool types the refits comprise would lend greater insight to the interpretation of patterns of resource-sharing, and other social distance indicators; even without this information, patterns of spatial connectivity at the site evident from the distribution of refits within and between Units.

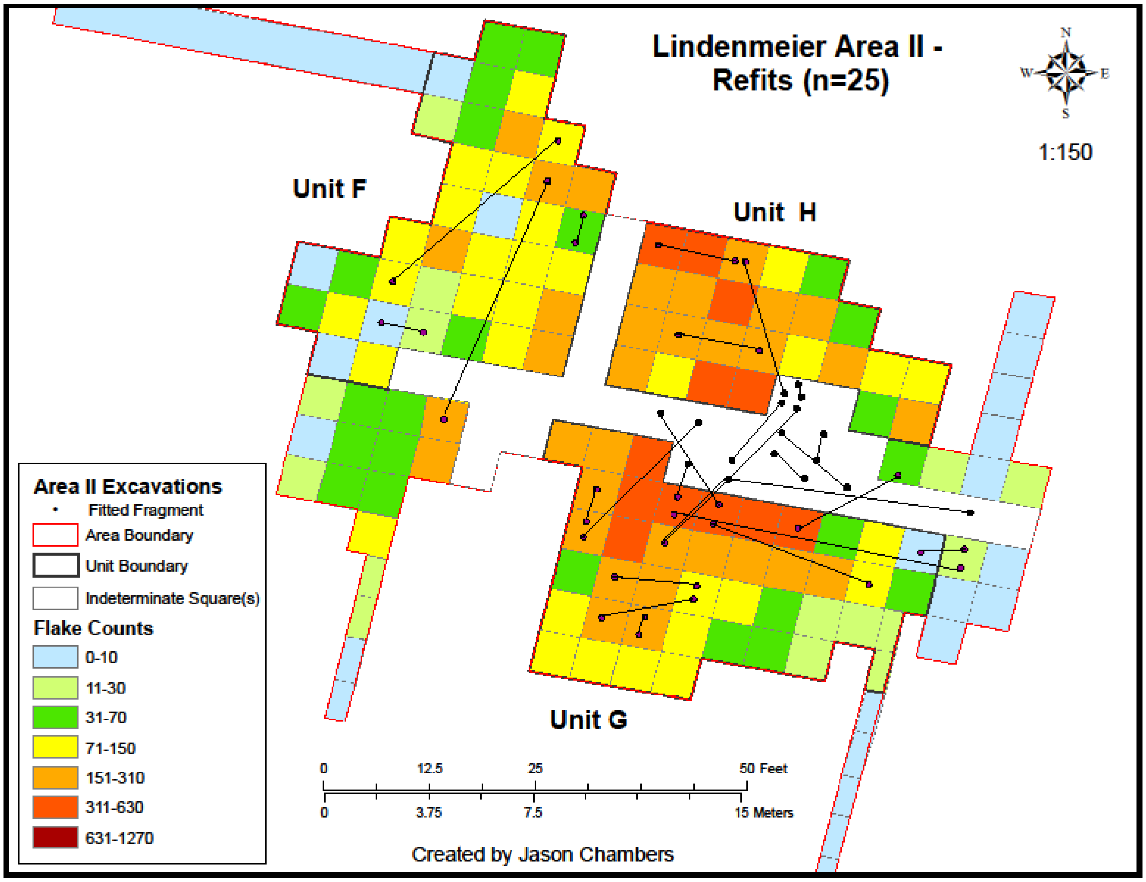

Figure 28: Lindenmeier Area II Refits/Fitted Fragments (Reproduced from Wilmsen & Roberts 1978:63)

Area II – Of the 58 of fitted fragments at the Lindenmeier Folsom site, 25 (43.1%) occur within Area II, and are distributed between Units F, G, H and Y (indeterminate squares between Units G & H). Wilmsen explicitly mentions that "linked pairs in Units G and H sometimes extend into Unit Y but never into the opposite unit" (Wilmsen and Roberts 1978:59), suggesting this as evidence for his 'autonomous episodes of occupation' (Wilmsen and Roberts 1978:59). This observation, however, provides no clues to the relationship of Units G and H to Unit F. It is noteworthy, that the greatest numbers of refits seem to co-occur with the highest flake counts recorded for the site (Unit Y). If Wilmsen's assessment of Units G and H representing individual occupations is correct, then a possible explanation for the patterns of fitted fragments may be related to resource recycling. This could mean the area of high flake counts in Unit Y represents a lithic material resource/refuse pile generated by the initial site occupants and later utilized during reoccupation of the same site area.

Occupation Unit F- Of 25 refits in Area II, 3 (12%) are located entirely within Unit F, with an additional refit (4%) occurring between Unit F and an indeterminate square to the south in Unit Y. The mean distance between refits within Unit F is 3.44m.

Occupation Unit G- Within Unit G seven refits (28%) are occur entirely within the Unit, with an additional five (20%) refits between Unit G and numerous indeterminate squares in Unit Y to the north. The mean distance between refits within Unit G is 3.77.

Occupation Unit H-Within Unit H two (8%) refits are located entirely within the Unit, with an additional refit (4%) occurring between Unit H and an indeterminate square to the south in Unit Y. The mean distance between refits within Unit H is 2.90m.

Occupation Unit Y – Within Unit Y six (24%) refits are entirely within the Unit , with an additional five (20%) refits linking Units Y and G, one linking Units Y and H, and one refit linking Units Y and F.

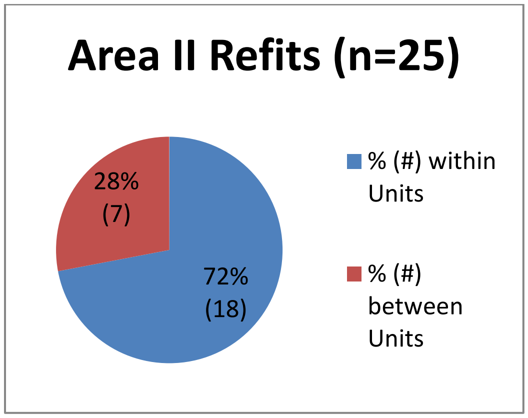

Figure 29: Lindenmeier Area II Refit Distribution

Within Area II, 18 of 25 (72%) refitted fragments occur entirely within Occupation Units F, G, and H, while seven (28%) refits occur between occupation units (Units F and Y = 4%, Units G and Y = 20%, and Units H and Y = 4%).

Discussion of Significance **–** Refits are a useful clue to examine site structure, and may indicate temporal and spatial relationships between fitted fragments found within a site. Villa (1982) argued that post-depositional displacement/mixing of archaeological materials within and across originally separate stratigraphic units may generate a palimpsest assemblage, and used refits as an index for this displacement so that appropriate interpretations could be made concerning an archaeological site's stratigraphic integrity. She argued that refits may reveal the presence of post-depositional or taphonomic mixing, which may be invisible in visually determined stratigraphic breaks during excavation. This could lead to false interpretations of a site as exhibiting a single occupation, and also suggests that soil layers should be considered as plastic medium through which artifacts may float upwards or downwards (Villa 1982:287). Given the questions surrounding the stratigraphic relationship of all Folsom cultural materials at the Lindenmeier site, the refit data described above may help resolve questions of the occupational character at Lindenmeier.

Specimen-specific information highlighting the type of tools comprising the refits may influence interpretations of the activities undertaken at the Lindenmeier site. For example, Stiger (2006) observed refitted projectile point distal sections and bases at the Mountaineer Folsom site, leading to an interpretation of off-site use of projectiles resulting directly in on-site preferential discard of discarded point bases. Interpretations such as these, as well as intra-site resource sharing may also be indicated through refitting studies.

Chapter Summary

Chapter 4 examined general patterns structuring the use of space in the Folsom occupation at the Lindenmeier site. Patterns visible among and between Areas I and II were discerned using visual interpretation of numerous site maps generated via the dataset. Site maps depicting flake counts, artifact distributions, proportional symbols, and Kernel Density Estimate values serve to provide baseline assessments of the visible spatial patterns present across the Lindenmeier site. The patterns garnered from visual interpretation of the various maps were accompanied by quantification of those patterns derived from statistical analyses of significance among artifact frequencies, spatial associations, spatial auto- and cross-correlations, kernel density estimates and refits.

Differences are seen within overall flake counts between Area I and Area II, with higher overall flake counts present in Area II than in Area I. Variation in the frequencies of flake counts per excavation square in Area I is observed in Units A, B, and C, with high-frequency flake counts clustered within each Unit; these frequencies diminish towards the margins of these clusters and between Units. Within Area II, flake counts per excavation square likewise differ in terms of frequency between Units F, G, and H indicating nuances in discard patterns. In both Areas, excavation squares with high flake count frequencies tend to be clustered, with the same diminishing of frequencies observable towards the margins between Units.

Similarly, differences are visible in the spatial patterns exhibited among plotted lithics and bone fragments in each Area. Bones in Area I are tightly clustered with the clusters spatially segregated, likely representing the remnants of bison carcasses given their majority among the site's vertebrate faunal assemblage. An alternative interpretation is that the bone clusters represent bone refuse piled by the site occupants. Roberts reported the presence of articulated bison skeletal elements in Area I within his yearly fieldwork summaries (Roberts 1935:41); thereby lending credence to the interpretation of Area I bone distributions representing the remains of a multiple bison kill location, or a secondary processing area nearby the kill location. The distribution pattern of bones in Area II is much more dispersed among the Units, lacking the overt clustering of Area I, suggesting that different discard patterns are at work within Areas I and II.

The proportional symbol maps presented offer a visual assessment of the relation of lithics and bone artifacts present within each excavation square. In Area I more excavation squares contain relatively more lithic artifacts than bone artifacts, reflecting the distributional patterns seen within the individual bone and lithic artifact distributions. Within Area II variation is likewise observed in the proportional distributions of bone and lithic artifacts. Within Unit F, the majority of excavation squares exhibit higher proportions of bone to lithic artifacts. Within Unit G, more even proportions of bone and lithic artifacts are seen, with relatively even bone and lithic artifact proportions, surrounded by excavation squares containing little or no bone and relatively even, low lithic proportions that taper off toward the boundaries of the Unit. Within Unit H, similar proportions of bone and lithic artifacts are observed for some excavation squares, though tending generally toward higher lithic artifact proportions, and likewise tapering off toward the Unit's margins.

The spatial associations among and between different items of each tool type distributed across the Lindenmeier site reveal some interesting patterns. Similarities are observed among and between unspecified flake/tools and plotted bone associations with other artifact types in Units A and B in Area I, and in Unit F, but not the other two Units in Area II. Given the different distributional patterns observed in the plotted bone found in Area I versus II, it is surprising that similar patterns in the spatial associations exist between these Units. This suggests that bone specimens were a conditioning factor in the distribution of lithic items within Unit F. Additionally, given the dispersed nature of bone specimens in Unit F, coupled with Robert's refit evidence linking Area I and II (Roberts 1941:79), it suggests this area was a bone processing area, likely related to secondary butchery practices (disarticulation, marrow extraction, etc.).

Units G and H in Area II exhibit different spatial association patterns than those in Units A and B in Area I, as well as Unit F in Area II. Considering differences in the frequencies of items present in different Units, there generally are more occurrences of positive spatial association in Units G and H than in Units A, B, and F. These increased numbers of associations indicate more complex spatial relationships among the tools classes represented, and hence, greater spatial connectedness between multiple, different activities performed in Units G and H than in Units A, B and F.

Spatial auto- & cross- correlation statistics also reveal some interesting spatial patterns amongst the distributions of artifacts across Areas I and II of the Lindenmeier site. Within Occupation Unit A tools are found with other tools, bones are found with other bones, and similar flake counts cluster together. Statistically significant positive spatial cross-correlation (SCC) is observed within the co-distributions of tools and flake counts (p=.001) suggesting that within Occupation Unit A, tools and flake counts are positively related. However, statistically significant negative spatial cross-correlation (SCC) was observed within the co-distributions of bones and flake counts (p=.072); indicating that where high flake counts are observed, bones tend to be lacking, and vice versa. No statistically significant pattern was observed between tools and bone, suggesting that tools are not a good predictor of bones, and vice versa, for Occupation Unit A. Within Occupation Unit B, statistically significant positive spatial auto-correlation (SAC) was observed within the overall distribution of tools (p=.001), bones (p=.137) and flake counts (p=.025). Though still statistically significant, the p-values associated with the SAC statistics for the individual distributions of bones and flake counts were somewhat weaker than those observed for Occupation Unit A.

In contrast to Occupation Unit A, the spatial auto- & cross- correlation statistics indicate no negative relationships were present in Occupation Unit B. Instead, bones and high flake counts exhibited a positive relationship, suggesting a somewhat different pattern present in the distribution of these items in relation to one another, and likewise suggesting that different spatial patterning practices are responsible for the differing use of space from Occupation Unit A to Unit B. This suggests the production of flake debitage is related not only to tool refurbishment or manufacture, but also to the processing of bone items in Unit B.

Spatial auto & cross correlation statistics also reveal interesting patterns among the artifact distributions in Areas I and II. Within Occupation Unit F, the presence of tools is a good predictor of other tools, high flake counts tend to occur together, and bones are neither positively or negatively associated with either tools or flake counts. In Occupation Unit G, tools, bones and flakes are useful predictors of other items of the same type, while within Occupation Unit H tools tend to occur together in space while bones are spatially dispersed.

The patterns observable in the frequency-of-occurrence tables, figures, and proportional symbol maps, and presented visually in the lithic and bone distribution maps, are more visually striking when combined with the various Kernel Density Estimate maps. These accentuate the differences visible in the clustering of bone, as well as lithic, material in Area I vs. II. KDE values for all piece-plotted specimens located within Area I portray five discrete, non-contiguous clusters of items within Unit A. Within Unit B, two main non-contiguous clusters are observed, a multi-part cluster composed of four hotspots and another three non-contiguous hotspots surrounded by background values. The KDE for plotted bone bolsters the previously described clustering of bone in Area I showing discrete clusters of bone surrounded by background values.

The distribution of lithics is definitively different from that of bone within both Units A and B of Area I. Lithics occur in less-discrete and non-contiguous clusters. Within both Units A and B, linearity is suggested from the banks of lithic distributions, in contrast to the more ovoid bone clusters. Within Area II, greater overall clustering of specimens is visible in Unit F versus Units G and H. Within Unit G, KDE values indicate one main cluster. Unit H exhibits patterns in KDE values that differ from both Units F and G. Within Unit H, several smaller non-contiguous clusters of roughly uniform density are present.

Variation is seen in the distribution of bones between Units in Area II. Within Unit F, the pattern roughly follows that described for the overall distribution of items. However, for Units G and H, differing patterns in the clustering of bone items is observed from that of the overall distribution of items per Unit. Within Unit G, bone is generally evenly distributed throughout the Unit, with small clusters of bone occurring immediately south of the bank of excavation squares containing the highest flake counts. Unit H likewise presents a pattern of uniform distribution of bones, with three small clusters located in the center of the Unit, surrounding an isolated square of high flake counts.

KDE values for the piece-plotted lithic specimens suggest different distribution patterns from Unit to Unit within Area II. Within Unit F, small, discrete lithic clusters of uniform density distributed across the Unit dominate, while within Unit G more contiguous lithic clustering is observed, while within Unit H denser concentrations of lithics are observed more uniformly across the Unit.

Refits provide a unique window into the spatial patterns present. The pairs comprising the refit/fitted fragment are a direct reflection of cultural processes at work at the site, providing tangible evidence of site linkage and social connectivity of the Folsom site occupants. Within Area I, 31 of 33 (93.9%) refitted fragments occur entirely within Occupation Units A and B. One (3%) refit occurs between Unit A and Unit B, and one (3%) occurs between Unit B and an indeterminate square on the eastern margin of Unit A. The spatial pattern among refits suggests that interactions in Unit A were more frequent, and spanning shorter distances than in Unit B, indicating greater social connectivity among site occupants and/or activities undertaken within Unit A than Unit B.

Similarly within Area II, differences evident among the spatial pattern of refits suggest different degrees of site connectivity. Within Area II, 18 of 25 (72%) refitted fragments occur entirely within Occupation Units F, G, and H, while seven (28%) refits occur between occupation units (Units F and Y = 4%, Units G and Y = 20%, and Units H and Y = 4%). That the most complex pattern among refits occurs within Unit Y (the area between Units G and H) is interesting as the stratigraphic mixing between these Units clouds the picture of what the pattern suggests. It is possible, (again, without knowing the specific character of the fitted fragments) that the high-frequency bank of lithic materials present in this area, in conjunction with the complex refit patterns, represent recycling of lithic resources left from previous site occupants if Wilmsen's assessment of the Units as "autonomous episodes of occupation" (Wilmsen and Roberts 1978:59), or multiple occupations, is correct.

Villa (1982) argued that post-depositional displacement/mixing of archaeological materials within and across originally separate stratigraphic units may generate a palimpsest assemblage, and used refits as an index for this displacement so that appropriate interpretations could be made concerning an archaeological site's stratigraphic integrity. She argued that refits may reveal the presence of post-depositional or taphonomic mixing, which may be invisible in visually determined stratigraphic breaks during excavation. As presented in Chapter 3, Clark and Evan's Test for Spatial Randomness indicates that the distributions of artifacts within each of the Occupation Units within Areas I and II at the Lindenmeier site likely do not represent palimpsest deposits. Thus, if palimpsest deposits are not responsible for the discard patterns evident at the site, obtaining a complete picture of the refits via use-wear analysis will be a productive avenue of research to verify Wilmsen's assertion of the Lindenmeier site as exhibiting multiple occupations (Wilmsen and Roberts 1978:59).

Use-wear analysis, or even simple knowledge of the tool type(s) comprising the refits would lend insight to not only the occupational character of the site, but also whether the spatial patterns among refits are a result of preferential discard of broken projectile point tips and point bases, general patterns of resource-sharing, and other social distance indicators. Even without this information, patterns of spatial connectivity at the site are still evident from the unique distribution of refits within and between Units.

Chapter 5 – NEITHER HIDE NOR HAIR…BUT THAT'S BESIDE THE POINT(S): HIDEWORKING AND PROJECTILE MANUFACTURE ACTIVITIES AT THE LINDENMEIER FOLSOM SITE

While Chapter 4 examined a myriad of approaches aimed to describe the overall spatial patterns among artifacts at the Lindenmeier Folsom site, Chapter 5 seeks to examine whether such spatial patterns are evident among and between artifact types functionally related to the performance of specific activities important to the hunter-gatherer way of life, namely hideworking and projectile manufacture. These questions are interesting for the light they might shed concerning possible gender-differentiated use of space, such as is seen in Jodry's (1999) work at Stewart's Cattle Guard. If certain tool types are associated with a particular activity (i.e. endscrapers=hideworking, points=projectile manufacture, etc.), and the activity is itself associated with a particular gender (i.e. men make points, women mend garments), then the segregated distributions of said artifacts may be mute testament to the segregation of these domestic spheres by gender in camp life at Lindenmeier. In examining this question of gender-based segregation of space, the author in no way wishes to contribute to a sexist approach to archaeology, but rather to explore an intriguing aspect of Folsom social organization raised, and discussed so much more eloquently, by Jodry.

Hideworking

Describing the toolkit used in processing skin clothing among the ethnographically-documented Evensk and Sami hunter-gatherer cultures of the Arctic, Klokkernes reports, "Various forms of scrapers and knives along with various implements…to remove substance from the surface, to work substances into the skin and to stretch the skin" (Klokkernes 2007:51), as well as "additional series of implements which assist during the different stages of changing a raw pelt into a material suitable for clothing and footwear [such as] frames or racks for drying and scraping, smoking constructions, scraping boards, softening chairs, wooden sticks, pegs and nails" (Klokkernes 2007:51). An additional important point integral to Klokkernes' discussion of the manufacture of skin-based clothing, is the consideration that not only are different tools required to effect different parts of the process, but also that they are used during different stages (2007:51) during the process(es). While temporal data is not available for the present study, Klokkernes' point does suggest that a temporal, as well as spatial, element is important in understanding hideworking activities.

Among the 23 different tool types mapped, several artifact types mentioned above and functionally associated with hideworking activities are reported for the Lindenmeier site. These items include bifaces, endscrapers, and bone needles, with channel flakes (Roberts 1936:27) and flake knives (Roberts 1936:28) also being mentioned by Roberts as making useful and effective knives. Additionally, Roberts mentions "leaf-shaped blades and several large [projectile] points" that "may be considered as combination knives and scrapers" (Roberts 1936:29). Unfortunately, not all of the artifact types mentioned in Roberts' fieldnotes and field summaries were included in Wilmsen's distribution maps. Moreover, tool types such as utilized flakes, single-edge tools and double-edge tools (Wilmsen and Roberts 1978:84) were reported. Though these tool types were not directly implicated in association with any specific task, it is reasonable that such tools could prove useful within the context of a hideworking activity. Therefore, in order to examine hideworking activities based upon the distribution of artifact types associated with their performance, the following artifact types will be explicitly incorporated into the spatial auto and cross-correlation analyses where available: bifaces, bone needles, endscrapers, grinding stones, hematite and ochre. In order to control for other such items not explicitly mentioned but potentially used in hideworking activities (i.e. channel flakes), spatial auto and cross-correlation statistics were calculated for all possible pairwise combinations of the 23 artifact types included in Wilmsen and Roberts' (1978) *Concluding Report*, so that the spatial relationships or patterns between such classes may likewise be revealed.

Essentially, bifaces make useful knives for both removing a hide from a freshly killed animal and cutting it to the desired size/shape. Endscrapers are used to remove hair, muscle, and fat from the hide, and bone needles are used to join the prepared hides together to form clothing, footwear, and lodge covers. Additionally, hematite/ochre and sandstone grinding stones were recovered at Lindenmeier; many of which (10 of 28, 35.7%) were noted as exhibiting abrasion and hematite together (Wilmsen and Roberts 1978:125, Table 53; LaBelle and Newton 2010). Such evidence suggests that hematite/ochre, among its many uses in Paleoindian contexts (Roberts 1936, Roper 1991, Stafford et al. 2003), may have been a component of the hide preparation process, possibly as a desiccant or preservative. Thus, hematite/ochre is explicitly included in SAC/SCC analyses for those Units in which it occurs (F, G and H).

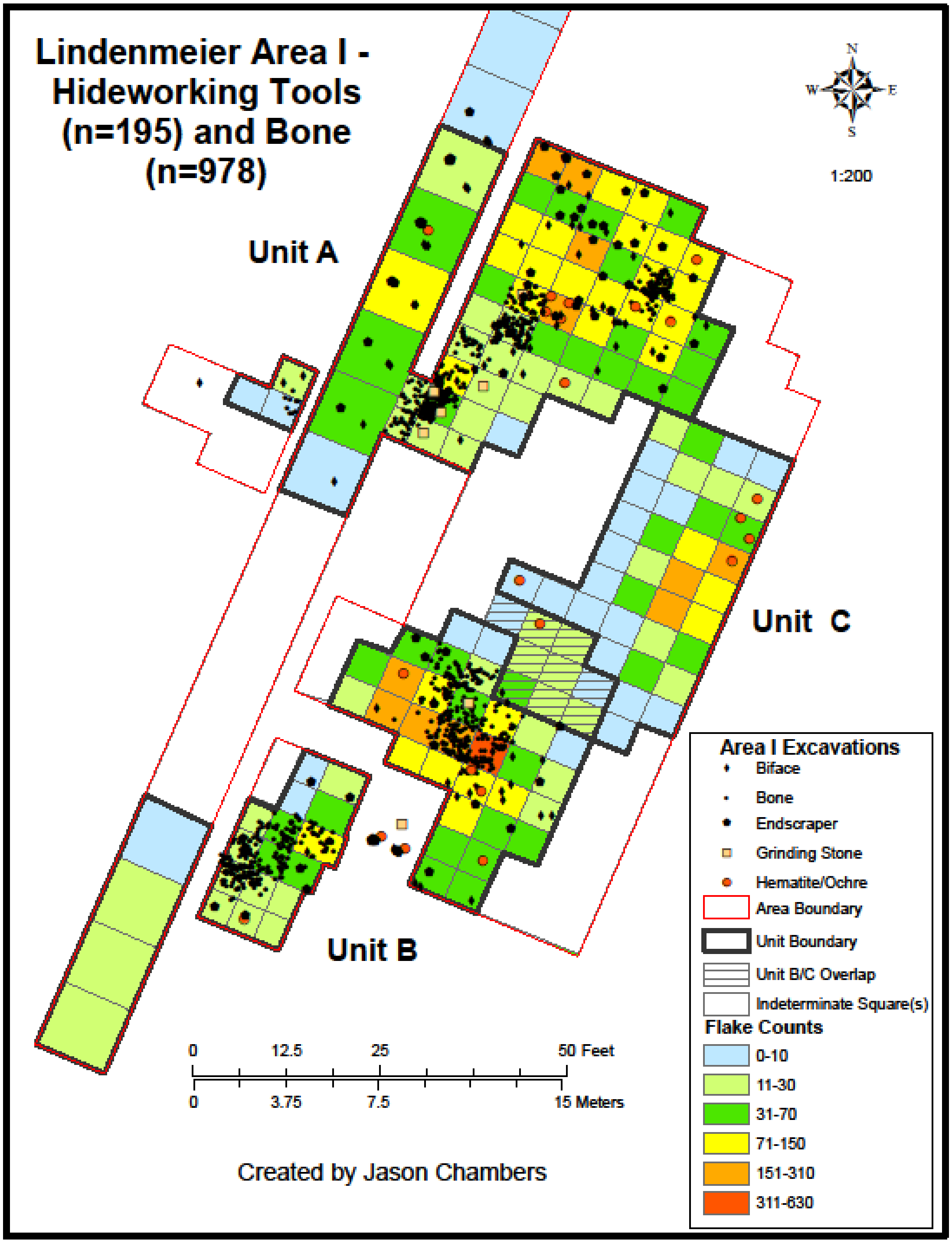

Figure 30: Distribution of Hideworking-Related Artifacts in Area I, With Plotted Bone

Hideworking Distribution Map for Area I - Within Area I (Figure 30), higher frequencies of bifaces and endscrapers, and ochre/hematite are distributed in Unit A than in Unit B. In Unit A, bifaces are linearly distributed in a general northeast-southwest trending line immediately to the east of the bone clusters. An additional cluster of bifaces is located in the northwest section of the Unit, to the north of the bone clusters, as well as evenly represented in Trench A. Endscrapers are distributed in two perpendicular linear segments, with one segment co-occurring alongside the bone clusters and another segment distributed perpendicular to this in a northwest-southeast trending line and clustering in the northern portion of Unit A. Grinding stones are located in near proximity to the largest bone clusters in Unit A; though noticeably absent in the northeastern-most bone cluster. Ochre/hematite specimens are generally evenly distributed between Units A and B, with all of the specimens in Unit A located outside of, though in close proximity to, the northeastern-most bone clusters.

Within Unit B, bifaces appear to generally surround the bone cluster in a horseshoe shape, and are aggregated to the southeast of the bone cluster within the contiguous part of the Unit. Endscrapers are clearly distributed in horseshoe shaped patterns surrounding the two bone clusters in Unit B. A single grinding stone is located within the bone cluster in the contiguous portion of Unit B, with an additional less-provenienced specimen occurring between the portions of the Unit excavated by the Smithsonian Institution. Ochre/hematite specimens appear less tightly clustered in Unit B than A, and likewise occur at the margins of, though in close proximity to, the bone clusters.

Hideworking Artifact Frequencies in Area I - The frequency and percentage of occurrence of artifact types functionally related to hideworking activities (derived from Table 6) in Areas I and

II are presented in Table 11 for artifact type representation among total items as well as total tools per Unit.

Table 11: Lindenmeier Hideworking-related Artifact Distributions per Unit, Area I versus Area II

	Area I				Area II					
Occupation Unit	A		B		F		G		H	
Number of 5x5 Units	57		50		38		43		25	
	#	%	#	%	#	%	#	%	#	%
Total Items	1178	-	1283	-	1214	-	1060	-	800	-
Total Tools	598	50.8%	497	38.7%	415	34.2%	639	60.3%	517	64.6%
Total Bone	580	49.2%	786	61.3%	799	65.8%	421	39.7%	283	35.4%
Percent of Total Items										
Biface	40	3.4%	19	1.5%	23	1.9%	36	3.4%	24	3.0%
Bone Needle	0	0.0%	0	0.0%	0	0.0%	5	0.5%	11	1.4%
Endscraper	37	3.1%	16	1.2%	31	2.6%	24	2.3%	36	4.5%
GrindingStone	5	0.4%	1	0.1%	2	0.2%	0	0.0%	1	0.1%
Hematite	6	0.5%	4	0.3%	6	0.5%	4	0.4%	8	1.0%
Ochre	2	0.2%	1	0.1%	0	0.0%	0	0.0%	1	0.1%
Totals	90	7.6%	41	3.2%	62	5.1%	69	6.5%	81	10.1%
Percent of Total Tools										
Biface	40	6.7%	19	3.8%	23	5.5%	36	5.6%	24	4.6%
Bone Needle	0	0.0%	0	0.0%	0	0.0%	5	0.8%	11	2.1%
Endscraper	37	6.2%	16	3.2%	31	7.5%	24	3.8%	36	7.0%
GrindingStone	5	0.8%	1	0.2%	2	0.5%	0	0.0%	1	0.2%
Hematite/Ochre	8	1.3%	5	1.0%	6	1.4%	4	0.6%	9	1.7%
Totals	90	15.1%	41	8.2%	62	14.9%	69	10.8%	81	15.7%

Within Area I, differences are seen in the proportional distribution of artifact types related to hideworking, with Unit A containing more than twice as many hideworking-related tools as Unit B (90 versus 41). Of the total items, Unit A contains more than twice the proportion of hideworking tools as Unit B (7.6% versus 3.2%). Of the total tools, however, the disparity in this proportion is somewhat less (15.1% versus 8.2%). Thus, based solely on the quantities and proportions of artifacts within both Units, it appears that twice as many hideworking-related tools were discarded in Unit A as compared to Unit B. If these discard frequency indices are taken as a relative estimate of hideworking activity intensity within these two units, then it follows that: 1) twice as many hideworking activities were undertaken in Unit A versus Unit B, or 2) twice as many individuals were practicing hideworking activities in Unit A than in Unit B, or 3) items related to hideworking were preferentially discarded in Unit A versus Unit B.

While scenarios 1 and 2 cannot be tested with the existing dataset, scenario 3 suggests a possible temporal sequence of events. If the bone clusters in Area I represent the remains of bison carcasses utilized as resource piles by the Folsom occupants of the Lindenmeier site, and (assuming Units A and B are contemporaneous) given the higher proportions of hideworking-related artifacts discarded in Unit A versus Unit B (typically twice the proportion), then preferential discard may be seen in the frequency of distribution of these items. Were the bison resources in Unit A more desirable for hides than those in Unit B? Were hideworking activities undertaken first at Unit B, with practitioners and toolkits then moved to Unit A, where the tools suffered attrition and subsequent discard? The discard pattern observed in Unit B may therefore have been conditioned by tool use activities undertaken in Unit A. Unfortunately, such fine distinctions are unlikely to be revealed through the information provided by this analysis, so such speculation is namely that, speculation. However, what is certain from the differential discard patterns is that hideworking activities, or at least discard of items functionally related to hideworking activities, are more prevalent in Unit A than B.

Hide working Spatial Associations in Area I– Using a special case of Clark and Evan's Nearest Neighbor, indices were generated using the R statistical software to calculate the Euclidean distances between the X and Y coordinates for all specimens in a dataset containing spatial information. These indices show the frequency and percentage of occurrence of least-distance nearest neighbor occurrences for each specimen per each of the 16 piece-plotted artifact types in the Lindenmeier spatial dataset.

Within Unit A, the spatial association results are presented in Table 12. Only three of the artifact types associated with hideworking activities have specific X,Y coordinates suitable for spatial association analysis: bifaces, channel flakes and endscrapers. These results are presented in Table 12. Of the 40 bifaces contained within Unit A, bifaces never occur as their own neighbor. Of the 37 endscrapers in Unit A, endscrapers occur as their own neighbor most often, 10.8% of the time. Of the 39 channel flakes observed in Unit A, only four cases (10.3%) occur as their own neighbor.

Table 12: Area I Unit A Hideworking Artifact Spatial Association Results

	Channel Flakes	Endscraper	Biface
Channel Flake	4	0	3
Endscraper	0	4	2
Biface	3	1	0
	Channel Flake	Endscraper	Biface
Channel Flake	10.3%	0.0%	7.7%
Endscraper	0.0%	10.8%	5.4%
Biface	7.5%	2.5%	0.0%

Within Unit B, the spatial association results are presented in Table 13. Variation from Unit A is observed in the distribution of hideworking related implements. Endscrapers never occur as their own neighbor, and endscrapers are never neighbor to bifaces. Channel flakes occur in nearly identical distributions in both Unit A and B, except for neighboring a single endscraper in Unit B. Channel flakes occur as neighbors to bifaces in 21.1% of cases, suggesting projectile point fluting efforts being undertaken within Unit B.

Table 13: Area I Unit B Hideworking Artifact Spatial Association Results

	Channel Flake	Endscraper	Biface
Channel Flake	4	1	3
Endscraper	1	0	0
Biface	4	1	1
	Channel Flake	Endscraper	Biface
Channel Flake	9.8%	2.4%	7.3%
Endscraper	6.3%	0.0%	0.0%
Biface	21.1%	5.3%	5.3%

Hideworking Spatial Auto and Cross-Correlation Statistic Results in Area I – The spatial correlation (SAC/SCC) statistics suggests gross spatial patterns at the scale of the 5'x5' excavation unit, revealing whether observed spatial patterning is present between artifacts of the same type (SAC) and between artifacts of different types (SCC). These are used to document statistically significant positive, spatial relationships within or between artifact types, or alternatively, an inverse relationship between artifact types, indicating segregation.

In Jodry's (1999) study of the Stewart's Cattle Guard Folsom site, she demonstrates that the distribution of refuse associated with projectile manufacture (associated with males) is spatially segregated from Folsom ultrathins (associated with females), arguing for the segregation of space based on gender in the performance of activities involving these tool types.

To reiterate, to interpret the SAC/SCC statistics, the Moran's I value is a positive or negative number indicating the strength and direction of the relationship between two artifact types. Positive values indicate positive relationships (+) between artifact types, with negative values indicating a negative, or inverse, relationship (-). The p-value is a confidence measure, indicating the Moran's I statistic's reliability measured by how many errors are likely per 100 iterations. For this study, p-values of <.01 indicate a greater than 99% probability that the relationship is accurately depicted, regardless of how many iterations of Moran's I are conducted. P-values between 0.11 and .05 are reliable at the 95% confidence level, p-values between .051 and .10 are reliable at the 90% level, and p-values between .101 and .15 are reliable at the 85% confidence level. For the purposes of this study, p-values exceeding .15 are considered not significant (NS), or random/spatially independent. Four (4) categories of statistical relationship are highlighted using color, with the highest confidence results (p<.01) highlighted in red, and decreasing with yellow (p<.05), green (p<.10), and finally to the lowest confidence results considered included in this analysis highlighted in blue (p<.15).

Within Lindenmeier Area I Unit A, and presented in Table 14, only one artifact type associated with hideworking showed a statistically significant spatial relationship; a strong positive spatial auto-correlation (SAC) relationship was observed between endscrapers (p<0.038).

Table 14: Lindenmeier Area I Unit A Hideworking SAC/SCC Results

Hideworking						
Biface	Bone Needle(#X)	Endscraper	Grinding Stone	Hematite	Ochre	
-0.107 NS 0.234	NA NA	-0.037 NS 0.584	0.039 NS 0.456	-0.064 NS 0.263	0.064 NS 0.275	Biface
	NA NA	NA NA	NA NA	NA NA	NA NA	Bone Needle
		0.132 +++ 0.038	-0.039 NS 0.462	-0.022 NS 0.718	-0.072 NS 0.179	Endscraper
			-0.079 NS 0.33	-0.01 NS 0.839	0.066 NS 0.245	Grinding Stone
				-0.042 NS 0.515	-0.013 NS 0.801	Hematite
					-0.035 NS 0.779	Ochre

Within Unit B, presented in Table 15, statistically significant positive SAC is observed between bifaces ($p<0.014$), a weak negative SAC between grinding stones ($p<0.125$), and a strong positive SCC between bifaces and ochre ($p<0.005$).

Thus, differences are observed among the Units in Area I in the spatial correlations of items related to hideworking. The spatial relationships hinted at thereby suggest different activities were the focus in these separate areas, with relatively intensive hide scraping activities performed in Unit A, while related activities dominated by the use of bifaces in conjunction with ochre in Unit B. Taken together, these activities likely represent complementary components of the hide treatment or preparation process, and are spatially segregated in space within Area I. This indicates that the tools used and discarded in Units A and B were functionally integrated, though spatially segregated, components of a comprehensive hideworking process occurring in Area I.

Table 15: Lindenmeier Area I Unit B Hideworking SAC/SCC Results

Hideworking						
Biface	Bone Needle(#X)	Endscraper(#X)	Grinding Stone	Hematite	Ochre	
0.178 +++ 0.014	NA NA	0.064 NS 0.292	0.024 NS 0.715	0.042 NS 0.514	0.169 ++++ 0.005	Biface
	NA NA	NA NA	NA NA	NA NA	NA NA	Bone Needle
		0.073 NS 0.249	-0.042 NS 0.478	0.068 NS 0.273	0.008 NS 0.913	Endscraper
			-0.011 - 0.125	-0.051 NS 0.403	-0.03 NS 0.627	Grinding Stone
				-0.105 NS 0.266	-0.061 NS 0.346	Hematite
					-0.03 NS 0.169	Ochre

Hideworking Distribution Map for Area II – Figure 31 depicts the distribution of artifact types functionally related to hideworking activities in Area II of Lindenmeier. Bone needles are an artifact type present in Area II, but are not seen in Area I, and are included in the visual description of spatial distributions.

Within Unit F, bifaces appear more or less evenly distributed throughout the Unit, and are both located at the margins of the bone concentrations, as well as interspersed with individual bone specimens. Bone needles are not present within Unit F. Endscrapers are distributed throughout the unit, generally occurring along the margins of the bone distributions, though also within the main bone cluster in the northern portion of the Unit. Two grinding stones are observed within Unit F, both are located in the far southwest corner of the Unit near the margin of the bone specimens and separated by 1.4 m. Ochre/hematite specimens are distributed in two perpendicular lines that form an ‘L’ shape in the southern portion of the Unit.

Within Unit G, bifaces are distributed throughout the Unit. They appear along the outside margins of the distribution of bone specimens as well as occurring intermingled with the bone in the center of the Unit; greater frequencies appear more tightly distributed along the western edge than to the east. Several bone needles are present in Unit G, with the majority linearly distributed along the southern margin, and a single specimen located along the northern margin, of the bone distributions within the Unit. Two small clusters of endscrapers are located near the western margin of the Unit boundary and another at the far eastern portion of the Unit, with the remainder located along the margin of the bone specimens as well as within the area of bone concentration. No grinding stones are observed within Unit G. Ochre/hematite specimens are distributed along the margins of the bone specimen concentration, with the majority located to the west of the bones.

Within Unit H, bifaces are distributed throughout the Unit; a pattern is visible between several individual bifaces and bone specimens. The majority of bone needle specimens recorded during excavations are located within Unit H; the needles appear in two main clusters, one in the southeast corner of the Unit independent of the bone specimens, and another about 3.5m to the north and intermingled with the bone specimens. Endscrapers are distributed throughout Unit H, though two generally linear, east-west distributions are suggested. A single grinding stone is observed in Unit H, at the southeast corner of the Unit just to the north of the Indeterminate squares, and positioned along the southern margin of the bone specimens. Ochre/hematite specimens occur clustered at the southern portion of the Unit, along the southern margin of the bone specimens, as well as linearly distributed east-west along the northern margin of the majority of bone specimens.

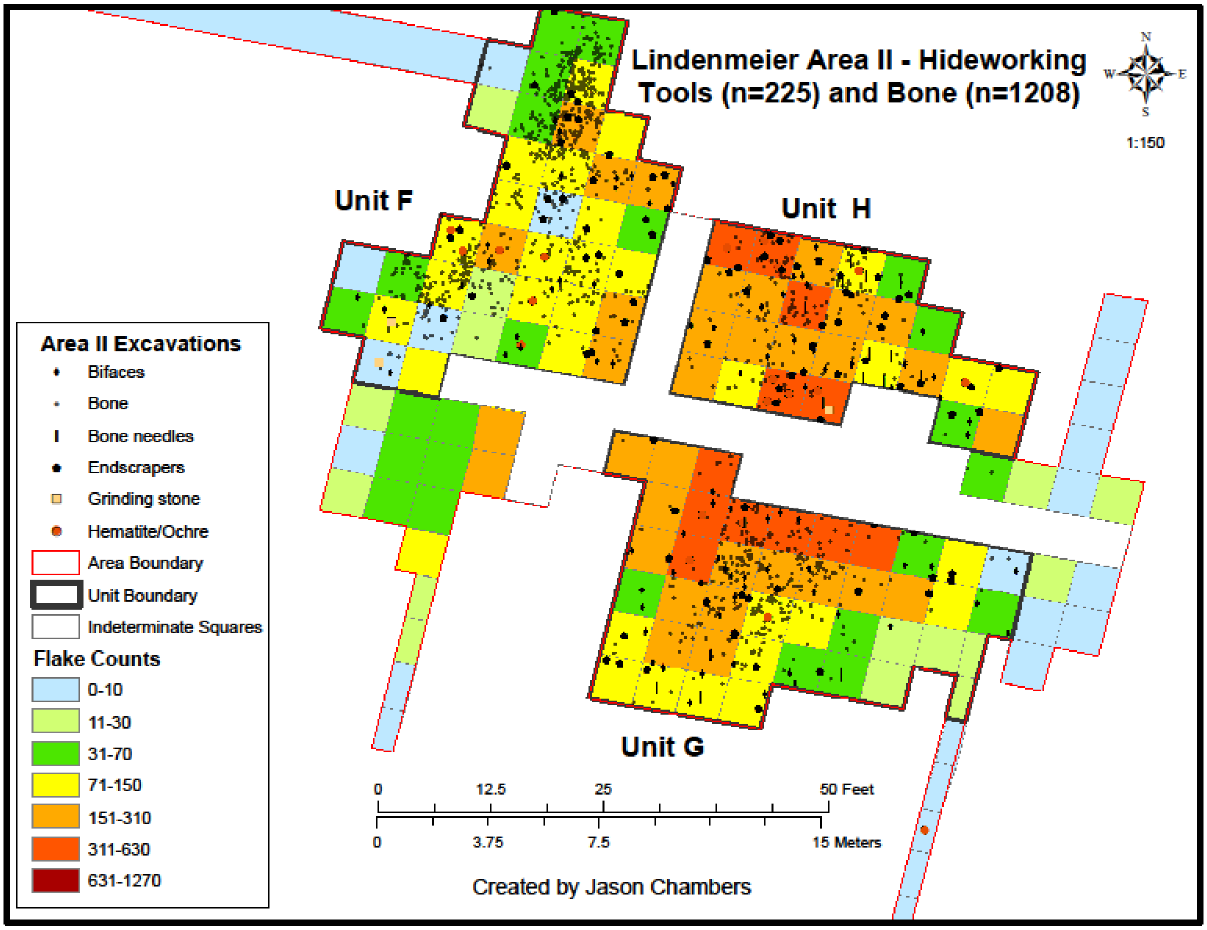

Figure 31: Distribution of Hideworking Related Artifacts in Area II, with Plotted Bone

Hideworking Artifact Frequencies in Area II - Within Area II, variation is seen in the discard of hideworking related items between Units F, G and H. While similar frequencies of hideworking tool types are presented in Table 11 for Units F, G, H, Unit H typically contains a greater proportion of these hideworking related items relative to the total number of items and tools, within the Unit. Proportionally, among total items in each Unit (middle rows in Table 11), Unit H contains roughly 200% more (10.1% versus 5.1%) hideworking related items than Unit F. Among total tools within each Unit (bottom rows in Table 11), these proportions are roughly equal (14.9% versus 15.7% respectively). Unit G contains frequencies similar to that of Unit F, but differs from Units F and H in proportional representation of hideworking related items. Among the total items in Unit G, 6.5% are hideworking related items, compared to 10.8% of the total tools within the Unit. The variation in these proportions is likely due to the different distribution of total bones versus tools within Unit G, demonstrating higher proportions of tools versus bones compared to Unit F and H, both of which contain higher proportions of bones versus tools.

Of all the Units in Areas I and II, Unit H is noteworthy in that it contains the highest proportion of hideworking related tools among total items, as well as total tools. Additionally, all 11 of the bone needles depicted in Wilmsen's maps occur within Units G and H, indicating that bone needles were either preferentially utilized or discarded within Units G and H at Lindenmeier. Considering that all of the bone needles mapped for the Agate Basin Area 2 Folsom component are within what is proposed as interior space within a Folsom lodge structure (Frison and Stanford 1982:42), perhaps taking advantage of a sheltered or well-lit location, Lindenmeier Units G and H should be regarded as exhibiting discard patterns more suggestive of a residential signature than other Units. Units G and H are therefore deserving of treatment as areas most likely representing domestic, residential use of space.

Hideworking Spatial Associations in Area II – The pair-wise spatial associations among and between artifact types functionally related to hideworking activities and associated with X,Y 2-D coordinates in Units F, G, and H in Area II are presented here. Within Unit F, 23 bifaces were found but they never occurred as their own neighbor or as neighbor to endscrapers. Bifaces were neighbor to channel flakes in 10.3% of cases, while channel flakes occurred as neighbor to bifaces in 21.7% of cases.

Table 16: Area II Unit F Hideworking Spatial Association Results

	Channel Flake	Endscraper	Biface
Channel Flake	6	3	8
Endscraper	4	2	0
Biface	5	0	0
	Channel Flake	Endscraper	Biface
Channel Flake	7.7%	3.8%	10.3%
Endscraper	12.9%	6.5%	0.0%
Biface	21.7%	0.0%	0.0%

Unit G (Table 17) showed different spatial association patterns than Unit F described above. Notably, though frequencies of neighboring occurrence are low, all hideworking artifacts are co-associated. Likewise, channel flakes are often a good indicator of other channel flakes. Of the 246 channel flakes found in Unit G, they occurred as their own neighbor in 28.9% of occurrences. Endscrapers were also a good predictor of channel flakes, as channel flakes occur as nearest neighbor in 37.5% of endscraper cases.

Table 17: Area II Unit G Hideworking Artifact Spatial Association Results

	Channel Flake	Endscraper	Biface
Channel Flake	71	6	7
Endscraper	9	2	1
Biface	7	1	2
	Channel Flake	Endscraper	Biface
Channel Flake	28.9%	2.4%	2.8%
Endscraper	37.5%	8.3%	4.2%
Biface	18.4%	2.6%	5.3%

Though differences in frequency are noted from those in Unit G, Unit H (Table 18) had similar percentages of spatial association observed for channel flakes (24.3% versus 28.9%). Inverse spatial association relationships are noted between the co-occurrences of endscrapers (8.3%), endscrapers/channel flakes and endscrapers/bifaces (2.4% and 2.6%, respectively) in Unit G, and endscrapers (2.8%), endscrapers/channel flakes, and endscrapers/bifaces (9.0% and 8.3%, respectively) in Unit H versus Unit G.

Table 18: Area II Unit H Hideworking Artifact Spatial Association Results

	Channel Flake	Endscraper	Biface
Channel Flake	35	13	5
Endscraper	6	1	0
Biface	5	2	2
	Channel Flake	Endscraper	Biface
Channel Flake	24.3%	9.0%	3.5%
Endscraper	16.7%	2.8%	0.0%
Biface	20.8%	8.3%	8.3%

Hideworking Spatial Auto and Cross Correlation Statistic Results in Area II – The spatial correlation (SAC/SCC) statistics suggests gross spatial patterns at the scale of the 5'x5' excavation unit, revealing whether observed spatial patterning is present between artifacts of the same type (SAC) and between artifacts of different types (SCC). These are used to document statistically significant positive, spatial relationships within or between artifact types, or alternatively, an inverse relationship between artifact types, indicating segregation at varying confidence levels.

Within Lindenmeier Area II Unit F, the following statistically significant results were found. Bifaces showed a weakly negative SAC ($p<0.127$), while grinding stones had a moderately strong positive SAC ($p<0.093$). Bifaces and endscrapers had a strongly positive SCC ($p<0.007$), while endscrapers and grinding stones had a strongly negative SCC ($p<0.003$). Thus, while bifaces were diffuse throughout the Unit, where they did occur was often in close proximity to endscrapers. Grinding stones co-occurred throughout Unit F in the relative absence of endscrapers. It is interesting that no relationship, either positive or negative, was observed between bifaces and grinding stones in this Unit, given each respective types' spatial relationships to endscrapers.

Statistically significant artifact types within Unit G were: strongly positive SAC observed for bifaces ($p<0.035$), weakly positive SAC for bone needles ($p<0.113$), and moderately positive SAC for hematite ($p<0.07$). A strongly positive SCC was observed between bifaces and hematite ($p<9.90e-05$). Thus, bifaces and hematite tend to co-occur, both with themselves and with each other, while bone needles tend towards clustering independent of the bifaces-hematite occurrences.

Table 19: Lindenmeier Area II Unit F Hideworking SAC/SCC Results

Area II Unit F Hideworking						
Biface	Bone Needle	Endscraper	Grinding Stone	Hematite	Ochre	
-0.161 - 0.127	N/A N/A	0.179 ++++ 0.007	-0.068 NS 0.334	-0.051 NS 0.503	N/A N/A	Biface
	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	Bone Needle
		0.077 NS 0.242	-0.198 ---- 0.003	0.011 NS 0.89	N/A N/A	Endscraper
			0.087 ++ 0.093	0.075 NS 0.28	N/A N/A	Grinding Stone
				-0.073 NS 0.557	N/A N/A	Hematite
					N/A N/A	Ochre

Table 20: Lindenmeier Area II Unit G Hideworking SAC/SCC Results

Area II Unit G Hideworking						
Biface	Bone Needle	Endscraper	Grinding Stone	Hematite	Ochre	
0.148 +++ 0.035	0.065 NS 0.306	0.048 NS 0.448	NA NA	0.249 ++++ 9.90E-05	NA NA	**Hideworking** Biface
	0.106 + 0.113	0.012 NS 0.843	NA NA	-0.021 NS 0.775	NA NA	Bone Needle
		0.046 NS 0.383	NA NA	0.014 NS 0.864	NA NA	Endscraper
			NA NA	NA NA	NA NA	Grinding Stone
				0.12 ++ 0.07	NA NA	Hematite
					NA NA	Ochre

Table 21: Lindenmeier Area II Unit H Hideworking SAC/SCC Results

Area II Unit H Hideworking						
Biface	Bone Needle	Endscraper	Grinding Stone	Hematite	Ochre	
0.118 NS 0.158	-0.078 NS 0.319	-0.088 NS 0.296	0.041 NS 0.699	-0.024 NS 0.715	0.022 NS 0.796	Biface
	-0.09 NS 0.609	0.002 NS 0.931	0.028 NS 0.699	-0.069 NS 0.42	0.01 NS 0.943	Bone Needle
		-0.007 NS 0.759	0.135 + 0.122	0.056 NS 0.373	0.005 NS 0.834	Endscraper
			-0.054 NS 0.3	0.031 NS 0.628	0.092 NS 0.288	Grinding Stone
				-0.02 NS 0.837	-0.041 NS 0.804	Hematite
					-0.056 NS 0.2	Ochre

Within Unit H, the only statistically significant observable spatial relationship was a weakly positive SCC between endscrapers and grinding stones ($p<0.122$). In contrast to the pattern seen in Unit F, the relationship between endscrapers and grinding stones in Unit H is a positive one.

Collectively, the Units F, G, and H in Area II exhibit different patterns in the co-occurrence of artifacts related to hideworking. The differences between the relationships between artifacts within the Units suggest differences in the performance of hideworking related activities within these Units as well. These differences depict segregation of space in discrete activities utilizing distinct suites of tools related to a more comprehensive process of hideworking performed within Area II of Lindenmeier.

Hideworking Discussion of Significance

A consideration raised by Klokkernes, and pursuant to examining hideworking activities undertaken by Folsom occupants at Lindenmeier, is that of perishable items/features/structures for which direct evidence is lacking. Specifically, this refers to "frames or racks for drying and scraping, smoking constructions, scraping boards, softening chairs, wooden sticks, pegs, and nails" (Klokkernes 2007:51). Unfortunately, any such frame-and-rack-type features, manifest in the archaeological record as circular posthole stains, were not reported by Roberts for Lindenmeier. While the spatial arrangement of drying/smoking racks may be logically inferred from their positioning in relation to functionally related hearth features, evidence for such features is scarce for Lindenmeier, with only two hearths reported by Roberts (Roberts 1939a:103). Lacking specific provenience information for these hearth features however, the presence of smoking constructions, and hence, their mutual role in structuring the distribution of activities around the site is currently undetermined.

Variation is observed between the nearest neighbor spatial association relationships between Units within Area I and II for artifact types functionally related to hideworking activities. These artifacts co-occur more frequently in Area II than in Area I, and specifically, much more frequently in Units G and H than in Unit F within Area II. Bifaces are evenly distributed in terms of frequency and percentage within all Units of Areas I and II. Channel flakes are much more frequently observed in Units G and H than in Units A, B, and F. While endscrapers tend to co-occur in similar frequencies across all Units, they tend to occur in proximity to other endscrapers more frequently in Units G and H than other Units.

This indicates, at least, preferential discard of hide-working related artifact types was practiced more frequently in some locations across the site than others. This also suggests, however, that hideworking activities were likely a greater conditioning factor in the spatial patterns of artifact discard in Units G and H than in other Units. If, then, hideworking activities were undertaken primarily at their location of discard and were considered a part of domestic camp life for Folsom people, occurring within the residential setting and integrated into domestic space, then Units G and H are the Units most likely representing residential space.

Projectile Point Manufacture

The manufacture of projectile points for hunting prey species is considered an important activity necessary to the hunter-gatherer lifeway. This was undoubtedly true for Folsom peoples as well, and fortunately, the production of diagnostically-fluted Folsom projectile points provides “a strong and consistent archaeological signature” (Sellet 2004:1555). For the following discussion, functionally related items providing this signature include bifaces, channel flakes, fluted, indeterminate, and unfluted projectile points, and preforms.

The remainder of Chapter 5 examines the spatial distributions of these projectile manufacture related artifacts to determine if these artifacts may reveal an activity-centered area of space at Lindenmeier and if this space is coincident or distinct from the space where hideworking activities were performed.

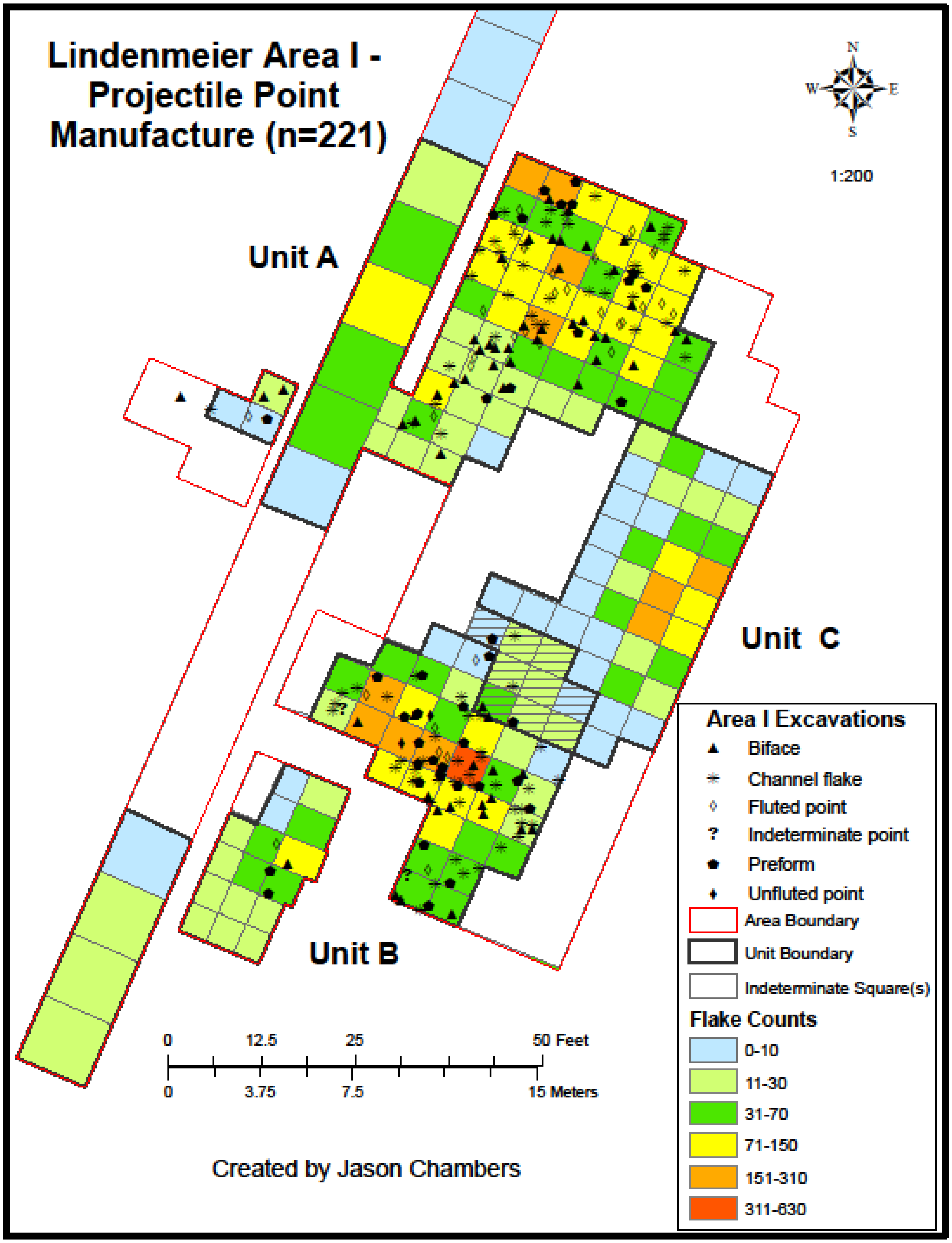

Figure 32: Distribution of Projectile Manufacture-Related Artifacts in Area I

Projectile Point Manufacture Artifact Distribution Map for Area I– The majority of piece-plotted artifact types functionally related to projectile manufacturing activities appear clustered within Units A and B. Within Unit A, these items are generally clustered in the northern portion of the Unit, with a tail extending to the southwest. This pattern mimics the distribution of bone specimens discussed prior. The main cluster contains the majority of channel flakes, as well as a cluster of preforms in the northwest, while the tail contains primarily bifaces and fluted Folsom points. Interestingly, within the main cluster, fluted Folsom points appear in two linear distributions, generally trending northwest to southeast. Indeterminate points and unfluted points were not observed in Unit A.

Within Unit B, the projectile-related artifact types appear to cluster surrounding the excavation square containing the highest concentration of flake debris. Indeterminate and unfluted points were not observed in Unit A, but they do occur in Unit B. Channel flakes appear dispersed throughout the cluster, while preforms appear to congregate immediately surrounding the highest flake count excavation square in a horseshoe shape open towards the north. Interestingly, none intrude into this square and are located only along its margins. Fewer fluted Folsom points are observed in Unit B than Unit A, with the majority of these clustered on the western edge of the cluster of items in Unit B.

Projectile Point Manufacture Artifact Frequencies in Area I - Table 22 presents the artifact frequencies and percentages of occurrence for artifact types functionally associated with projectile manufacture activities within each Unit.

Table 22: Area I Projectile Manufacture Artifact Frequencies

	Area I				Total
Occupation Unit	A		B		
Number of 5x5 Units	57		50		107
	#	%	#	%	#
Total Items	1178	-	1283	-	2461
Total Tools	598	50.8%	497	38.7%	1095
Total Bone	580	49.2%	786	61.3%	1366
Percentages of Total Items	#	%	#	%	#
Biface	40	3.4%	19	1.5%	59
Channel Flake	39	3.3%	40	3.1%	79
Fluted Folsom point	27	2.3%	8	0.6%	35
Indeterminate point	0	0.0%	2	0.2%	2
Unfluted Point	0	0.0%	1	0.1%	1
Totals	106	9.0%	70	5.5%	176
Percentages of Total Tools	#	%	#	%	#
Biface	40	6.7%	19	3.8%	59
Channel Flake	39	3.3%	40	3.1%	79
Fluted Folsom point	27	2.3%	8	0.6%	35
Indeterminate point	0	0.0%	2	0.2%	2
Unfluted Point	0	0.0%	1	0.1%	1
Totals	106	12.3%	70	7.8%	176

Units A and B within Area I contained different frequencies and percentages of occurrence for artifacts. Unit A contains both higher frequencies and percentages of projectile related artifacts, with 9% of the total items and 12.3% of the total tools located within the Unit. The differing frequency and proportion of the items in each of these Units suggests that discard of projectile point manufacture related artifact types was preferentially practiced in Unit A.

Twice as many bifaces occur in Unit A than B, while similar numbers of channel flakes are observed in both Units. Interestingly, more than three times as many fluted Folsom points are observed in Unit A than in Unit B.

Projectile Point Manufacture Spatial Associations in Area I – Tables 23 and 24 present the spatial association statistical results for projectile-manufacture-related artifact types in Units A and B respectively.

Table 23: Unit A Projectile Manufacture Spatial Association Results

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	1	-	-	0	3	3
Unfluted Point	-	-	-	-	-	-
Indeterminate Point	-	-	-	-	-	-
Preform	0	-	-	0	1	1
Channel Flake	1	-	-	2	4	3
Biface	2	-	-	1	3	0

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	3.7%	-	-	0.0%	11.1%	11.1%
Unfluted Point	-	-	-	-	-	-
Indeterminate Point	-	-	-	-	-	-
Preform	0.0%	-	-	0.0%	7.1%	7.1%
Channel Flake	2.6%	-	-	5.1%	10.3%	7.7%
Biface	5.0%	-	-	2.5%	7.5%	0.0%

Within Unit A, channel flakes occur as their own nearest neighbor more frequently than the other artifact types. Similar to the pattern seen in the SAC/SCC tables for Unit A, spatial relationships were seen between bifaces and preforms, bifaces and channel flakes, bifaces and fluted Folsom points, and between fluted Folsom points and channel flakes. Interestingly, neither bifaces nor preforms ever occur spatially as their own neighbor within Unit A.

Table 24: Unit B Projectile Manufacture Spatial Association Results

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0	-	0	0	0	0
Unfluted Point	0	-	0	0	0	0
Indeterminate Point	0	-	0	0	0	0
Preform	0	-	0	0	0	1
Channel Flake	0	-	0	3	4	3
Biface	0	-	0	0	4	1

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0.0%	-	0.0%	0.0%	0.0%	0.0%
Unfluted Point	0.0%	-	0.0%	0.0%	0.0%	0.0%
Indeterminate Point	0.0%	-	0.0%	0.0%	0.0%	0.0%
Preform	0.0%	-	0.0%	0.0%	0.0%	4.5%
Channel Flake	0.0%	-	0.0%	7.3%	9.8%	7.3%
Biface	0.0%	-	0.0%	0.0%	21.1%	5.3%

Within Unit B, a somewhat different spatial association pattern is observed for projectile-manufacture-related artifact types. Bifaces and channel flakes occur more frequently as neighbors in Unit B than Unit A. Within Unit B, fluted Folsom, indeterminate and unfluted points never occur as their own neighbor. Interestingly, neither do any of these artifact types co-occur with the other projectile point types, nor with preforms, channel flakes or bifaces.

Projectile Point Manufacture Spatial Auto- and Cross- Correlations in Area I – Tables 25 and 26 present the spatial auto and cross-correlation statistic results calculated for artifact types functionally related to projectile point manufacture per Unit in Area I. SAC results are along the bottom diagonal portion of the table, with the remainder being the SCC results between pair-wise combinations of artifact types.

Table 25: Unit A Projectile Manufacture Spatial Auto- & Cross- Correlation Results

Biface	Channel Flakes	Fluted Point	Indeterminate Point	Preform	Unfluted Point	
						Overall
-0.006 NS 0.976	-0.003 NS 0.931	-0.005 NS 0.969	NA NA	-0.067 NS 0.233	0.163 ++++ 0.002	Tools
-0.04 NS 0.551	-0.023 NS 0.692	0.066 NS 0.206	NA NA	-0.076 NS 0.164	-0.064 NS 0.24	Bones
-0.077 NS 0.172	0.091 ++ 0.088	0.046 NS 0.363	NA NA	-0.039 NS 0.524	0.096 ++ 0.074	Flake Count
						Projectile Manufacture
-0.107 NS 0.234	-0.113 --- 0.046	-0.029 NS 0.667	NA NA	-0.041 NS 0.481	0.034 NS 0.485	Biface
	-0.065 NS 0.537	-0.042 NS 0.546	NA NA	-0.026 NS 0.624	0.05 NS 0.383	Channel Flakes
		0.043 NS 0.406	NA NA	-0.054 NS 0.326	0.058 NS 0.311	Fluted Point
			NA NA	NA NA	NA NA	Indeterminate Point
				-0.064 NS 0.471	-0.06 NS 0.301	Preform
					-0.024 NS 0.361	Unfluted Point

Within Unit A, a statistically significant strong positive spatial cross-correlation was observed between unfluted points and the general distribution of tools within the Unit at the 5’x5’ excavation square scale. Moderately strong positive cross-correlations are observed between both channel flakes and flake counts, and unfluted points and flake counts. Among individual artifact types, a strong negative spatial cross-correlation was observed between bifaces and channel flakes, suggesting spatial segregation of these artifact types at the excavation square scale for Unit A.

Within Unit B, many more spatial relationships are evident. All projectile related artifact types, with the exception of indeterminate points, are positively associated spatially with the overall distribution of tools. Of all the artifact types discussed, only preforms and unfluted points are positively associated with the distribution of bone specimens. Bifaces, channel flakes, fluted Folsom points, and preforms are positively associated with high flake counts within Unit B.

Table 26: Unit B Projectile Manufacture Spatial Auto- & Cross- Correlation Results

		Biface	Channel Flakes	Fluted Point	Indeterminate Point	Preform	Unfluted Point
Overall							
Tools	Moran's I	0.106	0.203	0.105	0.01	0.275	0.094
	Significance	++	++++	++	NS	++++	++
	P-Value	0.081	0.001	0.082	0.869	2.60E-05	0.072
Bones		-0.024	0.033	-0.012	-0.077	0.139	0.101
		NS	NS	NS	NS	+++	++
		0.709	0.584	0.958	0.195	0.017	0.094
Flake Count		0.141	0.223	0.134	0.035	0.177	0.069
		+++	++++	+++	NS	++++	NS
		0.023	0	0.024	0.584	0.005	0.245
Projectile Manufacture							
Biface		0.178	0.229	0.032	0.024	0.149	-0.01
		+++	++++	NS	NS	+++	NS
		0.014	0	0.566	0.645	0.012	0.908
Channel Flakes			0.117	0.029	-0.037	0.111	0.01
			++	NS	NS	++	NS
			0.091	0.607	0.607	0.062	0.892
Fluted Point				-0.075	-0.026	0.155	0.081
				NS	NS	++++	NS
				0.482	0.655	0.007	0.196
Indeterm. Point					-0.056	0.026	0.051
					NS	NS	NS
					0.569	0.708	0.418
Preform						0.154	0.074
						+++	NS
						0.031	0.171
Unfluted Point							-0.028
							NS
							0.255

Among the projectile related artifacts in Unit B, statistically significant spatial auto-correlation was observed only for bifaces, channel flakes, and preforms. This indicates that where bifaces are observed, other bifaces are likely located nearby, and similarly with channel flakes and preforms.

Positive spatial cross-correlation was observed between bifaces and channel flakes and bifaces and preforms. This suggests that in addition to the observation stated above, bifaces, channel flakes, and preforms are all good predictors of the other artifact types. Additionally, preforms and fluted Folsom points are good spatial predictors of one another. Interestingly though, fluted Folsom points are not likewise spatially cross-correlated with the other types related to preforms, indicating that another conditioning factor in the discard of these items is at work.

Projectile Point Manufacture Artifact Distribution Map for Area II – Figure 33 presents the distribution of projectile-manufacture-related artifact types located within Area II. These artifact types are observed in all Units in Area II; however, visibly more are located in Units G and H than in Unit F. Within Unit F, these items appear generally dispersed, although a tight cluster of fluted Folsom points, preforms, bifaces and channel flakes occur at the southeast corner of the Unit.

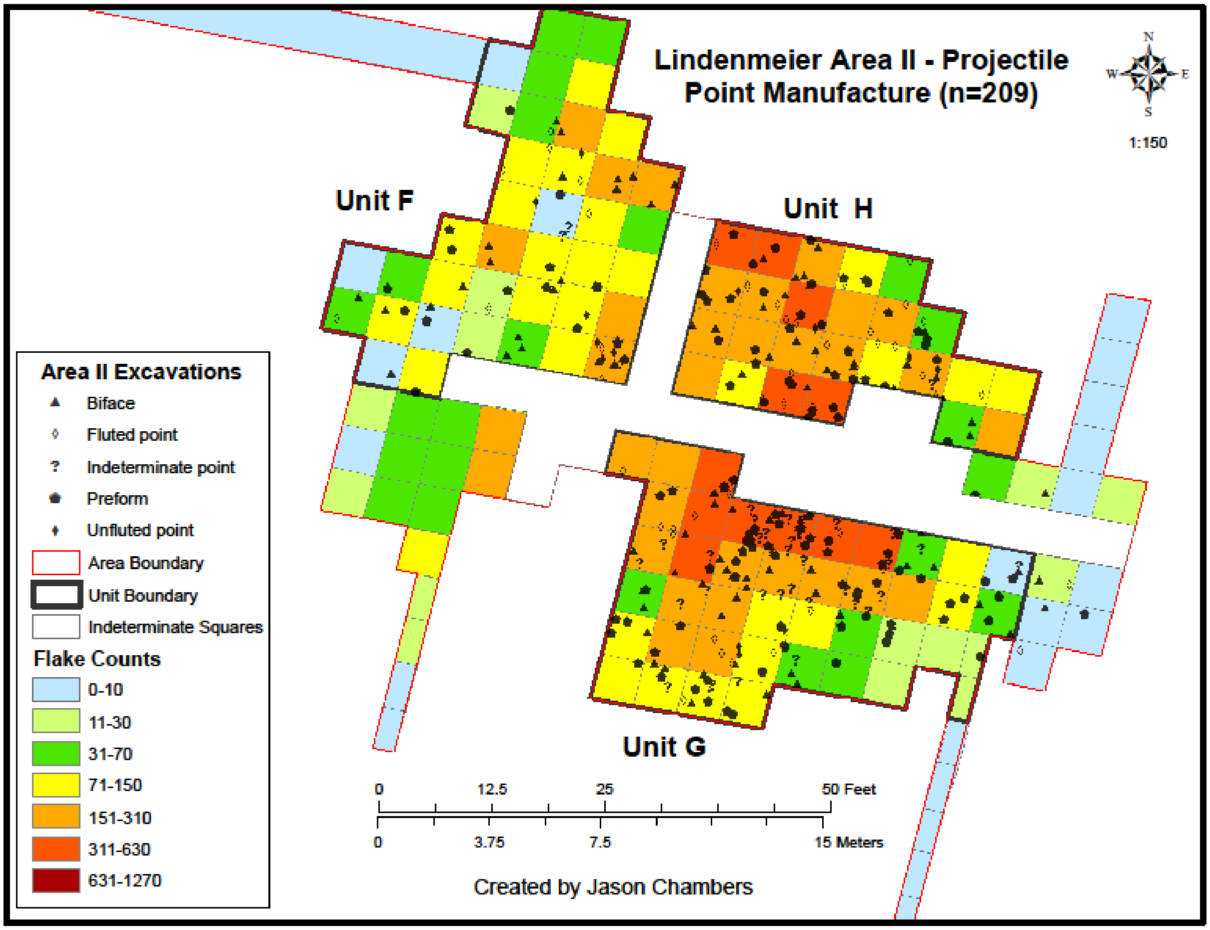

Figure 33: Distribution of Projectile Manufacture-Related Artifacts in Area II

While projectile-manufacture-related items are distributed throughout Unit G, they appear tightly clustered within several excavation squares containing the highest flake counts. Preforms are also located within this cluster, but are also observed surrounding the western-southern-and-eastern margins of the excavation squares with high flake counts. Channel flakes appear concentrated toward the center of Unit G, with dispersion toward the margins.

Within Unit H, projectile-manufacture-related artifact types are more dispersed than in Unit G, but more clustered than in Unit F. Channel flakes are distributed throughout Unit H, but clusters appear in the northwestern portion and in the southern portion of the Unit. This area is associated with high flake counts, several preforms, and fluted Folsom projectile points found adjacent to the Indeterminate Squares separating Units G and H (Unit Y). In all directions beyond this cluster, the distribution of projectile-related artifacts become more dispersed, and taper off towards the east.

Projectile Point Manufacture Artifact Frequencies in Area II– Within Area II, variation was observed between the frequency and percentage of occurrence of projectile-manufacture-related artifact types between Units. While Unit F contains greater proportions of total bone versus total tool specimens, the inverse relationship is observed in Units G and H. Units G and H both contain similar proportions of tools to bone artifacts.

Table 27: **Area II Projectile Manufacture Artifact Frequencies**

	Area II						Overall
Occupation Unit	F		G		H		Total
Number of 5x5 Units	38		43		25		106
	#	%	#	%	#	%	#
Total Items	1214	-	1060	-	800	-	3074
Total Tools	415	34.2%	639	60.3%	517	64.6%	2666
Total Bone	799	65.8%	421	39.7%	283	35.4%	2869
Percentages of Total Items	#	%	#	%	#	%	#
Biface	23	1.9%	36	3.4%	24	3.0%	142
Channel Flake	79	6.5%	246	23.2%	144	18.0%	548
Fluted Folsom point	11	0.9%	16	1.5%	20	2.5%	82
Indeterminate point	2	0.2%	36	3.4%	1	0.1%	41
Unfluted Point	6	0.5%	4	0.4%	4	0.5%	15
Totals	121	10.0%	338	31.9%	193	24.1%	828
Percentages of Total Tools	#	%	#	%	#	%	#
Biface	23	5.5%	36	5.6%	24	4.6%	142
Channel Flake	79	6.5%	246	23.2%	144	18.0%	548
Fluted Folsom point	11	0.9%	16	1.5%	20	2.5%	82
Indeterminate point	2	0.2%	36	3.4%	1	0.1%	41
Unfluted Point	6	0.5%	4	0.4%	4	0.5%	15
Totals	121	13.6%	338	34.1%	193	25.8%	828

Both Units G (31.9% of total items and 34.1% of total tools) and H (24.1% of total items and 25.8% of total tools) have higher overall frequencies and percentages of occurrence of projectile-manufacture-related artifacts than Unit F (10% of total items and 13.6% of total tools). This indicates that discard of projectile-related artifacts was preferentially practiced in Unit G and H compared to Unit F. Unit G and H both contain two to three times as many channel flakes and fluted Folsom points than Unit F. Unit G contains the vast majority of indeterminate points, whereas, these items are poorly represented in Units F and H. If these functionally-related artifacts represent broken tools discarded at the site of manufacture (primary deposition), then Units G and H likely represent areas in which projectile manufacture was preferentially practiced.

Projectile Point Manufacture Spatial Associations in Area II – Tables 28-30 present the spatial association statistical results for artifacts with associated X, Y coordinates related to projectile manufacture.

Table 28: Unit F Projectile Manufacture Spatial Association Results

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0	0	0	1	1	0
Unfluted Point	0	0	0	0	0	0
Indeterminate Point	0	0	0	0	0	0
Preform	1	0	0	0	1	1
Channel Flake	2	0	0	1	6	8
Biface	0	1	0	1	5	0

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0.0%	0.0%	0.0%	9.1%	9.1%	0.0%
Unfluted Point	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Indeterminate Point	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Preform	6.3%	0.0%	0.0%	0.0%	6.3%	6.3%
Channel Flake	2.6%	0.0%	0.0%	1.3%	7.7%	10.3%
Biface	0.0%	4.3%	0.0%	4.3%	21.7%	0.0%

Within Unit F, preforms and channel flakes, which occur in similar frequencies and percentages, are associated with fluted Folsom points. Bifaces and channel flakes are also often found in near association. Fluted Folsom, unfluted, and indeterminate points and preforms never occur as their own nearest neighbor in the Unit. Also, preforms never occur alongside unfluted or indeterminate points.

Table 29: Unit G Projectile Manufacture Spatial Association Results

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	2	0	0	3	2	2
Unfluted Point	0	2	0	1	0	0
Indeterminate Point	0	0	4	0	9	2
Preform	1	2	2	6	19	4
Channel Flake	3	0	15	19	71	7
Biface	0	0	2	4	7	2

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	12.5%	0.0%	0.0%	18.8%	12.5%	12.5%
Unfluted Point	0.0%	50.0%	0.0%	25.0%	0.0%	0.0%
Indeterminate Point	0.0%	0.0%	11.1%	0.0%	25.0%	5.6%
Preform	1.6%	3.2%	3.2%	9.7%	30.6%	6.5%
Channel Flake	1.2%	0.0%	6.1%	7.7%	28.9%	2.8%
Biface	0.0%	0.0%	5.3%	10.5%	18.4%	5.3%

Within Unit G, higher frequencies and percentages of occurrence were observed for the spatial associations between projectile-manufacture-related artifact types than in Unit F. More clustering of items was observed, as artifact types do occur as their own neighbor, though in differing proportions. Both preforms and channel flakes are often individually spatially associated, while channel flakes are often associated with indeterminate points and preforms. Meanwhile, fluted Folsom points were as commonly associated with themselves as they were with channel flakes, bifaces, and preforms.

Table 30: Unit H Projectile Manufacture Spatial Association Results

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0	0	0	1	3	0
Unfluted Point	0	0	0	0	1	0
Indeterminate Point	0	0	0	0	1	0
Preform	0	0	0	7	8	1
Channel Flake	4	1	1	11	35	5
Biface	0	0	0	1	5	2

	Fluted Point	Unfluted Point	Indeterminate Point	Preform	Channel Flake	Biface
Fluted Folsom	0.0%	0.0%	0.0%	5.0%	15.0%	0.0%
Unfluted Point	0.0%	0.0%	0.0%	0.0%	25.0%	0.0%
Indeterminate Point	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
Preform	0.0%	0.0%	0.0%	18.4%	21.1%	2.6%
Channel Flake	2.8%	0.7%	0.7%	7.6%	24.3%	3.5%
Biface	0.0%	0.0%	0.0%	4.2%	20.8%	8.3%

Within Unit H, spatial association patterns differed from Unit G, and appeared more similar to those observed in Unit F. Fluted Folsom, unfluted, and indeterminate points never occurred as their own nearest neighbor, while channel flakes often occurred in association with all the artifact types related to projectile point manufacture.

Projectile Point Manufacture Spatial Auto and Cross- correlation in Area II– Tables 31-33 present the results of the SAC/SCC statistics for each of the Occupation Units in Area II. Within Unit F, positive spatial cross-correlation was observed between channel flakes, indeterminate and unfluted points, and the overall distribution of tools. Negative spatial cross-correlation was observed between preforms and bones, indicating that these items are generally exclusive and found in the absence of each other. Channel flakes and unfluted points were both positively correlated with high flake counts, while preforms are negatively correlated with high flake counts.

Within Unit F, positive spatial auto-correlation was observed among channel flakes and preforms, indicating individual clustering of these items. However, bifaces were negatively auto-correlated, indicating dispersion of these items. Positive spatial cross-correlation was observed between bifaces and fluted Folsom points, bifaces and preforms, and channel flakes and unfluted points.

Table 31: Unit F Projectile Manufacture Spatial Auto- & Cross- Correlation Results

	Biface	Channel Flakes	Fluted Point	Indeterm. Point	Preform	Unfluted Point	
Moran's I	-0.031	0.136	0.01	0.103	0.007	0.119	**Overall**
Significance	NS	+++	NS	+	NS	+++	Tools
P-Value	0.793	0.035	0.7	0.125	0.845	0.035	
	-0.024	-0.065	0.003	0.079	-0.092	-0.001	Bones
	NS	NS	NS	NS	-	NS	
	0.701	0.319	0.974	0.24	0.149	0.982	
	0.053	0.12	0.005	0.043	-0.122	0.123	Flake Count
	NS	++	NS	NS	--	++	
	0.37	0.067	0.872	0.581	0.061	0.052	
	-0.161	0.037	-0.102	-0.022	-0.112	-0.062	**Projectile Manufacture**
	-	NS	+	NS	++	NS	Biface
	0.127	0.497	0.132	0.703	0.082	0.382	
		0.12	-0.024	-0.08	-0.043	0.105	Channel Flakes
		++	NS	NS	NS	++	
		0.088	0.818	0.201	0.492	0.051	
			-0.045	0.094	0.04	0	Fluted Point
			NS	NS	NS	NS	
			0.797	0.17	0.436	0.701	
				-0.033	0.058	0.06	Indeterm. Point
				NS	NS	NS	
				0.422	0.346	0.383	
					0.207	0.015	Preform
					++++	NS	
					0.009	0.689	
						0.032	Unfluted Point
						NS	
						0.331	

Table 32: Unit G Projectile Manufacture Spatial Auto- & Cross- Correlation Results

	Biface	Channel Flakes	Fluted Point	Indeterminate Point	Preform	Unfluted Point	
Moran's I	0.291	0.371	0.065	0.303	0.204	-0.045	**Overall**
Significance	++++	++++	NS	++++	++++	NS	Tools
P-Value	7.00E-06	1.00E-06	0.291	6.00E-06	0.001	0.467	
	0.313	0.286	0.093	0.307	0.123	0.118	
	++++	++++	+	++++	+++	++	Bones
	1.00E-06	1.80E-05	0.148	2.00E-06	0.046	0.056	
	0.258	0.373	0.276	0.262	0.158	0.004	
	++++	++++	++++	++++	+++	NS	Flake Count
	5.50E-05	0	3.40E-05	5.70E-05	0.012	0.947	
							Projectile Manufacture
	0.148	0.191	0.036	0.214	0.071	0.098	
	+++	++++	NS	++++	NS	+	Biface
	0.035	0.002	0.632	0	0.228	0.143	
		0.346	0.028	0.289	0.191	-0.092	
		++++	NS	++++	++++	-	Channel Flakes
		1.70E-05	0.636	9.00E-06	0.002	0.14	
			0.16	0.078	-0.0366	0.06	
			+++	NS	NS	NS	Fluted Point
			0.025	0.231	0.554	0.288	
				0.167	0.159	0.01	
				+++	++++	NS	Indeterm. Point
				0.016	0.008	0.914	
					0.115	-0.05	
					++	NS	Preform
					0.093	0.419	
						0.157	
						++++	Unfluted Point
						0.005	

Within Unit G, projectile-related artifact types are generally spatially correlated, and exhibit a much more complex pattern than was observed in Unit F. The only observed negative correlation was between channel flakes and unfluted projectile points.

Within Unit H, a very different pattern of spatial correlation was observed than Unit G, despite their similarities in the ways previously discussed. In Unit H, only channel flakes were positively correlated with the overall distribution of tools, while fluted points were negatively correlated with bone specimens. Similarly, fewer correlations were observed between projectile-related artifact types. Bifaces were positively cross-correlated with indeterminate and unfluted points, while only channel flakes appear positively auto-correlated in Unit H.

Table 33: Unit H Projectile Manufacture Spatial Auto- & Cross- Correlation Results

	Biface	Channel Flakes	Fluted Point	Indeterm. Point	Preform	Unfluted Point	
Moran's I	0.037	0.191	-0.123	-0.079	0.105	-0.0708	**Overall**
Significance	NS	+++	NS	NS	NS	NS	Tools
P-Value	0.595	0.024	0.26	0.385	0.165	0.458	
	-0.047	0.021	-0.017	-0.028	0.028	-0.037	Bones
	NS	NS	--	NS	NS	NS	
	0.637	0.695	0.08	0.757	0.623	0.718	
	0.048	0.069	-0.085	-0.058	0.088	-0.05	Flake Count
	NS	NS	NS	NS	NS	NS	
	0.571	0.318	0.355	0.515	0.243	0.62	
							Projectile Manufacture
	0.118	0.093	0.069	0.147	0.096	0.205	Biface
	NS	NS	NS	++	NS	+++	
	0.158	0.254	0.399	0.062	0.223	0.011	
		0.179	-0.036	-0.05	0.083	-0.053	Channel Flakes
		+++	NS	NS	NS	NS	
		0.024	0.786	0.578	0.226	0.528	
			-0.095	0.045	0.006	0.046	Fluted Point
			NS	NS	NS	NS	
			0.635	0.494	0.852	0.491	
				-0.041	0.077	0.013	Indeterm. Point
				NS	NS	NS	
				0.952	0.387	0.355	
					-0.013	0.099	Preform
					NS	NS	
					0.798	0.212	
						-0.006	Unfluted Point
						NS	
						0.678	

Projectile Manufacture Discussion of Significance

There are interesting spatial patterns present among the distribution of projectile-related artifacts in Area I. More than three times as many fluted Folsom points are in Unit A as Unit B. Significant dispersion is present among bifaces in Unit A, while clustering of bifaces is exhibited in Unit B. The differing character of the distributions of bone between Areas I and II likely contribute to the variation in the distributions of hideworking-related artifacts, and it is possible that the presence of projectile-related artifacts in Area I is related to the presence of articulated bison carcasses, and possibly indicative of the situation at the Mountaineer site, at which Stiger (2006) posited broken distals and point bases reflecting point failure during (successful) hunting events being afterward reunited in the discard of processed skeletal elements at the site. The pattern of refits could clarify this at Lindenmeier if use-wear data becomes available to characterize the fitted fragments.

However, if the projectile-related artifacts represent broken tools discarded at the site of manufacture, and considering the greater intensity of complex spatial relationships present among projectile-related artifacts within Units G and H in Area II, these represent areas in which projectile manufacture was preferentially practiced within Area II. Use-wear data would likewise be useful to clarify the picture of resource sharing and social connectivity associated with performance of this activity within Area II.

Chapter Summary

Simple visual interpretation of the artifact distribution maps alone is not sufficient to reveal subtle patterns among the spatial distribution of artifacts at Lindenmeier; to use the old adage; one simply 'cannot see the forest for the trees'. Visually the maps seem to depict considerable overlap between hideworking and projectile manufacture related artifacts, and hence, activities. It requires other methods to determine the more subtle spatial patterns among and between artifacts related to hideworking and projectile manufacture.

Using other more quantitative methods to examine spatial patterning, variation was observed across the Lindenmeier site in terms of the distributions artifacts related to hideworking and projectile manufacture. These different patterns were revealed not only in the different Units within Areas, but also between Areas I and II; artifacts functionally related to hideworking activities co-occur more frequently in Area II than in Area I, and specifically, much more frequently in Units G and H than in Unit F within Area II. The descriptions of the distributions within each Unit describe a situation in which many similarities exist between Units A and B in Area I, and Units G and H in Area II; Unit F appears to have a somewhat different pattern of discard than the other units, in terms of both hideworking and projectile point manufacture activities.

Hideworking activities were a conditioning factor in the spatial patterns of artifact discard in Units G and H than in other Units. If hideworking activities were undertaken primarily at their location of discard and were considered a part of domestic camp life for Folsom people, occurring within the residential setting and integrated into domestic space, then Units G and H are the Units most likely representing residential space at Lindenmeier.

Projectile manufacture related activities were also likely a conditioning factor in the spatial patterns of artifact discard in Units G and H than in Unit F of Area II. There are interesting spatial patterns present among the distribution of projectile-related artifacts in Area I, with more than three times as many fluted Folsom points observed in Unit A than in Unit B, clustering of bifaces in Unit B, and significant dispersion of bifaces in Unit A. However, if projectile manufacture related artifacts represent broken tools discarded at the site of manufacture, just as with hideworking-related artifacts, Units G and H in Area II likely represent areas in which projectile manufacture was preferentially practiced within Area II.

The spatial coincidence of both hideworking and projectile manufacture related artifacts and activities specifically within Units G and H suggests that segregation of space by activity and, arguably by gender, does not seem to be the situation at Lindenmeier. In contrast to Stewart's Cattle Guard, the overlap between artifact discard patterns (interpreted as evidence of said activities) appears to indicate integration of these activities in the Folsom use of space at Lindenmeier rather than gendered segregation of these activities in space. Elevational, or depth, data would provide insight as to whether this overlap represents reoccupation or contemporaneous occupation however.

CHAPTER 6 – DISCUSSION AND CONTEXTUAL OBLIGATIONS

Chapter 6 seeks to provide a context for those elements of Lindenmeier site structure discussed in chapters 4 and 5, both pertaining to the site structure as a whole as well as activity-specific behavior. This chapter seeks to relate these elements to archaeological theory, ethnographic analogy, as well as via archaeological comparison to other major known Folsom sites.

Site Formation Processes- Site formation processes (Schiffer 1978, Binford 1983) provide alternative ways to interpret the activities undertaken by hunter-gatherer, and specifically Folsom, people at the Lindenmeier site. Primary deposition of cultural remains refers to items discarded with no immediate future consideration; items were left where they fell. Secondary deposition of artifacts refers to discard related to site cleanup/maintenance behaviors, including periodic cleanout of hearths, sweeping of interior spaces, and generally, the intentional rearrangement of items within a space. These two types of deposition suggest very different approaches to take when interpreting the distribution of archaeological remains.

Articulation of bison skeletal elements noted by Roberts, for example, suggests primary deposition as an explanation for the distribution of items in Units A and B in Area I of the Lindenmeier site. However, the lack of articulated bison skeletal elements within Area II is absence of evidence and not evidence of absence. The distribution is one clue used in conjunction with middle-range theory (Binford 1983). Specifically, the demonstrated differences in the distributional patterns of overall bones and tools, as well as types related to hideworking and projectile manufacture activities, suggest that articulated skeletal elements were removed from Area II for secondary butchering. Preparation and consumption assessments are not possible at this time.

As the distance between Areas I and II is only approximately 88m, differences in soil chemistry affecting post-depositional preservation of materials is considered unlikely. This means taphonomic processes are less likely to be conditioning factors resulting in the lack of skeletal articulation in Area II versus Area I than systemic cultural processes. Therefore, this thesis proposes that cultural processes enacted by the Folsom site occupants was the main explanatory agent for the lack of bison skeletal articulation in Area II.

Other clues for evidence of secondary deposition of items are difficult to interpret from the Lindenmeier data, as specific size class information is not currently available for the artifact specimens with spatial information. Should that information become available in conjunction with this dataset, taphonomic processes, as well as drop-and-toss models (Binford 1983) of discard, could be examined.

Ethnographic Analogy – Kroll (1991) described the anticipated duration as the primary conditioning factor determining the distribution of items in ethnographically-documented hunter-gatherer camps. According to Kroll, short-term, understood to be expedient, encampments will likely not undergo site cleanup/maintenance activities by the site occupants, whereas, long-term residential encampments will likely require periodic cleanup and maintenance activities in order to maintain not only spatial segregation between parts of a camp, but also to preserve the pathways between site furniture (i.e. hearths, structures, drying racks, etc). The prevalence of excavation squares containing high counts of flake debris in both Areas I and II at the Lindenmeier site are a good indication that, at least some portions, were occupied for long periods in order to accumulate such large quantities of debitage. Whether these high flake-count squares represent secondary cleanup areas, dumps, or are the accumulated product of primary-deposited, lithic reduction activities performed repeatedly in specific activity-associated, communal, or household space (Kroll 1991), remains unclear. Regardless, multiple areas containing large numbers of small debris items that are spatially independent though present in each Unit provides strong evidence for an anticipated long-term duration of encampment by Folsom peoples at the Lindenmeier site.

Alternatively, if Lindenmeier was serially occupied, then it follows that these banks of lithic refuse present at the site would likely have structured subsequent use of space. In this case, each subsequent occupation would have adapted the structure of their camp to accommodate the existing site furniture (hearths, pits, middens, etc) established by previous occupants at the site. The areas of high flake counts would have acted as material resource piles, or special activity areas (Kroll 1991), from which to borrow/recycle/scrounge workable material or tools.

Archaeological Comparison to known Folsom sites - Wilmsen's explicit mention of a sterile layer of soil between Units G and H (termed Unit Y) provides good evidence of multiple occupations. However, as artifacts were also described as floating between the cultural layers, further refinement of the occupational character at Lindenmeier will have to await more explicit vertical, stratigraphic data to resolve.

Mention should also be made that with the artifact distributions presented chiefly in the form of two-dimensional plan maps, it is easy to assume that cultural processes alone were responsible for the spatial arrangement of materials in the systemic context. However, topographical particulars at the site certainly dictate that spatial patterns should be analyzed with other considerations in mind. In describing the stratigraphy for Area I, Wilmsen noted, "The indeterminate squares in the center of the excavation are those through which extends the Brule ridge identified in Figures 157 and 158" (Wilmsen and Roberts 1978:54). Without that particular piece of information, the researcher may conclude that the low density of materials within this area may indicate some particular element of site structure that in the systemic cultural context could indicate an area subject to maintenance/sweeping behaviors, such as the interior of a structure or a communal/gathering space. The above topographical consideration may thus necessitate a description of the physical environmental context in each of the areas to be examined. It is interesting to note that the general direction of the Brule Ridge is similar (northeast to southwest) to that of the bone distribution adjacent to Occupation Unit A within Area I.

Mountaineer Folsom Site – Andrews (2010) described spatial differences evident between Areas A and D of the Mountaineer Folsom Site based upon their relation to elements comprising the site furniture, specifically a hearth and habitation structure, at the site. The patterns are described at such fine scale to identify differences between interior versus exterior spaces. Unfortunately, no feature information is available to aid interpretations of the distribution of items at Lindenmeier; likewise, no specific artifact size information is currently available for the items comprising the Lindenmeier spatial dataset. Andrews' focus on the distribution of specific size-class artifacts in delimiting interior versus exterior space associated with the hearth and habitation features is of limited utility to the derived Lindenmeier spatial data examined in this study, which is driven mainly by consideration of artifact type and not size. Should this information become available, however, it will allow specific and powerful inferences to be made concerning space and the distribution of activities at the household scale at the Lindenmeier site.

Fortunately, some analogies between Lindenmeier and Mountaineer Folsom sites are possible. As suggested by Andrews for Mountaineer, "large assemblage size, overall high cluster diversity and patterns in artifact representation within the clusters strongly suggest that

Area A is the results of a long occupation" (Andrews 2010:267). Similar characteristics are observed at Lindenmeier in general in the large assemblage size and multiple locations of clustering of flake debris, and more specifically in the different artifact representations and distributions within and between Units in Areas I and II at the Lindenmeier site.

Stewart's Cattle Guard Folsom Site – Jodry (1999:262) describes the spatial structure present within the distribution of artifacts at the Stewart's Cattle Guard as representing three distinct, though functionally related settings. The first setting is the scene of initial butchery in proximity to bison carcasses. The second setting is "a special use area roughly twenty meters away where hideworking and a variety of other tasks took place". The third is "a residential camp where portions of carcasses were extensively processed, weaponry repaired and manufactured, and other activities conducted in household activity areas near hearths and possibly shelters" (Jodry 1999:262).

Differences observed by Wilmsen in the distribution of material types between Areas I and II at the Lindenmeier site were similarly observed by Jodry (1999) for the Stewart's Cattle Guard Folsom Site in the San Luis Valley, CO. At Stewart's Cattle Guard, distribution differences are interpreted to represent residue of separate social components of a communal hunt. While this explanation has obvious merits, this thesis proposes an alternative explanation based upon technological decisions exploiting specific functional qualities inherent in the material types.

Specifically, Jodry inferred five hearth-centered activity areas from concentrations of flaking debris, bison remains, burned lithics and bone, abraded pieces of red pigment, remains of weaponry repair and replacement, and concentrations of flake tools and broken edge fragments. These five concentrations are regularly spaced and separated by nearly 4.5 meters from center point of one to center of the next (Jodry 1999:294). While similar distances between clusters are observed between some of the high density clusters identified via KDE and described previously, specimen-specific attribute information is not available to see if the clusters detected for Lindenmeier exhibit burning, and are therefore not exactly analogous to those described by Jodry for Stewart's Cattle Guard.

Jodry described the northern and central part of [cluster] K-1 consisting of "an outdoor area where hideworking and other maintenance tasks were carried out cooperatively by women" (Jodry 1999:297), and the southern end of the cluster "suggesting that men were working on weaponry replacement in this area" (Jodry 1999:297). Such fine-grained spatial segregation by gender interpretations is not, and will not be, possible with the Lindenmeier dataset until specimen-specific attribute information derived from use-wear analyses are available. Crucially, the bifaces reported for Lindenmeier, and included in the distribution maps, are not necessarily the same ultra-thin bifaces described by Jodry and associated specifically with women. Jodry's quotation is still useful in highlighting the scale at which social differentiations were made spatially by Folsom people, and it suggests that such spatial relationships should (at least) be evident in the SAC/SCC statistics employed in this thesis at the excavation square scale.

Chapter Summary - As seen in other sections of this thesis, I have sought to use a variety of methods by which to make conclusions about the spatial patterning at the Lindenmeier Folsom site. A variety of comparative approaches, using both published ethnographic and archaeological sources, is valuable in expressing the range of variation seen in human habitation through time. The utility of multiple comparative references is such that, should new evidence develop casting doubt upon previously held assertions of human activity in antiquity, then the underpinnings for my conclusions relating to the Lindenmeier site may continue to have some validity.

Chapter 6 discussed other means to contextualize my findings for the spatial patterns at the Lindenmeier Folsom site. Site formation processes, ethnographic analogy and archaeological comparison to known Folsom sites such as Mountaineer, Stewart's Cattle Guard and Agate Basin combine to offer a robust benchmark against which to evaluate and discuss the conclusions reached in this thesis. Chapter 7, the final and concluding chapter of this thesis, offers closing remarks concerning the spatial structure observable by a variety of methods for the Lindenmeier Folsom site and their relevance to the greater field of Paleoindian archaeology.

CHAPTER 7 – CONCLUSION AND CLOSING THOUGHTS

"Understand man is not a machine,
He needs a surface, and a purpose, and a reason for being"
– Vinnie Paz, 'Death Messiah'

This thesis required many dedicated hours spent in front of a computer screen in order to incorporate sophisticated mapping capabilities combined with advanced statistical analyses to arrive at the conclusions presented herein. However, it is hoped these conclusions have greater relevance than promoting a strictly academic obsession with how people long ago disposed of their trash and treasures. The conclusions reached herein relate rather essentially to a story of people.

The Lindenmeier Folsom site is not purely an archaeological phenomenon, oddity of the past, or a grand freak of preservation despite its relative fame; however abstract the methods employed by this thesis upon which these conclusions are derived, let us not forget that the effort expended here is an attempt to understand people. Here I have endeavored to make sense of some of the ways in which these people long ago dealt with life at the intersection of socio-cultural and natural processes, how they used the material objects and immaterial space around them to interact with the physical realm. I have sought understanding of the past within the scope of this thesis by evaluating the former elements of the final couplet referenced in the quote above; examining the surface upon which they lived and helped create and testing observable patterns against assumptions about their guessed-at purposes for doing so.

As for the latter element of the above-referenced quote, and greater existential theme of the piece, the reason for being of Folsom people, it is beyond the scope of this work to assess the philosophical underpinnings for why people nearly 11,000 years ago carried out their lives from one minute to the next, from one activity to another. I will suffice it to say that I believe they're likely those very same reasons that motivate people today: to share the love of family and friends, to find comfort during dark and dangerous nights, to find enough food to fill empty bellies, to hope the days ahead offer more than those behind. So as we consider the datasets described, the analyses employed and discussions of significance presented bringing us to this point, let us remember that we are in fact talking about and attempting to understand formerly living, breathing people not unlike ourselves with real concerns and problems of their own and how they specifically attempted to overcome them.

This thesis examined both general patterns structuring the use of space in the Folsom occupation at the Lindenmeier site, as well as specific patterns in artifact discard relating to hideworking and projectile manufacture activities. General patterns visible among and between Areas I and II were discerned using visual interpretation of numerous site maps generated via the dataset. Site maps depicting flake counts, artifact distributions, proportional symbols, and Kernel Density Estimate values served to provide baseline assessments of the visible spatial patterns present across the Lindenmeier site. The patterns garnered from visual interpretation of the various maps were accompanied by quantification of those patterns derived from statistical analyses of significance among artifact frequencies, spatial associations, spatial auto- and cross-correlations, kernel density estimates and refits.

Differences are seen within overall flake counts between Area I and Area II, with higher overall flake counts present in Area II than in Area I. Variation in the frequencies of flake counts per excavation square in Area I is observed in Units A, B, and C, with high-frequency flake counts clustered within each Unit; these frequencies diminish towards the margins of these clusters and between Units. Within Area II, flake counts per excavation square likewise differ in terms of frequency between Units F, G, and H indicating nuances in discard patterns. In both Areas, excavation squares with high flake count frequencies tend to be clustered, with the same diminishing of frequencies observable towards the margins between Units.

Similarly, differences are visible in the spatial patterns exhibited among plotted lithics and bone fragments in each Area. Bones are Area I are tightly clustered with the clusters spatially segregated, likely representing the remnants of bison carcasses given their majority among the site's vertebrate faunal assemblage. An alternative interpretation is that the bone clusters represent bone refuse piled by the site occupants. Roberts reported the presence of articulated bison skeletal elements in Area I within his yearly fieldwork summaries (Roberts 1935:41); thereby lending credence to the interpretation of Area I bone distributions representing the remains of a multiple bison kill location, or a secondary processing area nearby the kill location. The distribution pattern of bones in Area II is much more dispersed among the Units, lacking the overt clustering of Area I, suggesting that different discard patterns are at work within Areas I and II.

The proportional symbol maps presented offer a visual assessment of the relation of lithics and bone artifacts present within each excavation square. In Area I more excavation squares contain relatively more lithic artifacts than contain bone artifacts, reflecting the distributional patterns seen within the individual bone and lithic artifact distributions. Within Area II variation is likewise observed in the proportional distributions of bone and lithic artifacts. Within Unit F, the majority of excavation squares exhibit higher proportions of bone to lithic artifacts. Within Unit G, more even proportions of bone and lithic artifacts are seen, with relatively even bone and lithic artifact proportions, surrounded by excavation squares containing little or no bone and relatively even, low lithic proportions that taper off toward the boundaries of the Unit. Within Unit H, similar proportions of bone and lithic artifacts are observed for some excavation squares, though tending generally toward higher lithic artifact proportions, and likewise tapering off toward the Unit's margins.

The spatial associations among and between different items of each tool type distributed across the Lindenmeier site reveal some interesting patterns. Similarities are observed among and between unspecified flake/tools and plotted bone associations with other artifact types in Units A and B in Area I, and in Unit F, but not the other two Units in Area II. Given the different distributional patterns observed in the plotted bone found in Area I versus II, it is surprising that similar patterns in the spatial associations exist between these Units. This suggests that bone specimens were a conditioning factor in the distribution of lithic items within Unit F. Additionally, given the dispersed nature of bone specimens in Unit F, coupled with Roberts' refit evidence linking Area I and II (Roberts 1941:79), it suggests this area was a bone processing area, likely related to secondary butchery practices (disarticulation, marrow extraction, etc.).

Units G and H in Area II exhibit different spatial association patterns than those in Units A and B in Area I, as well as Unit F in Area II. Considering differences in the frequencies of items present in different Units, there generally are more occurrences of positive spatial association in Units G and H than in Units A, B, and F. These increased numbers of associations indicate more complex spatial relationships among the tools classes represented, and hence, greater spatial connectedness between multiple, different activities performed in Units G and H than in Units A, B and F.

Spatial Auto & Cross Correlation statistics also reveal some interesting spatial patterns amongst the distributions of artifacts across Areas I and II of the Lindenmeier site. Within Occupation Unit A tools are found with other tools, bones are found with other bones, and similar flake counts cluster together. Statistically significant positive spatial cross-correlation (SCC) is observed within the co-distributions of tools and flake counts (p=.001) suggesting that within Occupation Unit A, tools and flake counts are positively related. However, statistically significant negative spatial cross-correlation (SCC) was observed within the co-distributions of bones and flake counts (p=.072); indicating that where high flake counts are observed, bones tend to be lacking, and vice versa. No statistically significant pattern was observed between tools and bone, suggesting that tools are not a good predictor of bones, and vice versa, for Occupation Unit A. Within Occupation Unit B, statistically significant positive spatial auto-correlation (SAC) was observed within the overall distribution of tools (p=.001), bones (p=.137) and flake counts (p=.025). Though still statistically significant, the p-values associated with the SAC statistics for the individual distributions of bones and flake counts were somewhat weaker than those observed for Occupation Unit A.

In contrast to Occupation Unit A, the spatial auto & cross correlation statistics indicate no negative relationships were present in Occupation Unit B. Instead, bones and high flake counts exhibited a positive relationship, suggesting a somewhat different pattern present in the distribution of these items in relation to one another, and likewise suggesting that different spatial patterning practices are responsible for the differing use of space from Occupation Unit A to Unit B. This suggests the production of flake debitage is related not only to tool refurbishment or manufacture, but also to the processing of bone items in Unit B.

Spatial auto & cross correlation statistics also reveal interesting patterns among the artifact distributions in Areas I and II. Within Occupation Unit F, the presence of tools is a good predictor of other tools, high flake counts tend to occur together, and bones are neither positively or negatively associated with either tools or flake counts. In Occupation Unit G, tools, bones and flakes are useful predictors of other items of the same type, while within Occupation Unit H tools tend to occur together in space while bones are spatially dispersed.

The patterns observable in the frequency-of-occurrence tables, figures, and proportional symbol maps, and presented visually in the lithic and bone distribution maps, are more visually striking when combined with the various Kernel Density Estimate maps. These accentuate the differences visible in the clustering of bone, as well as lithic, material in Area I vs. II. KDE values for all piece-plotted specimens located within Area I portray five discrete, non-contiguous clusters of items within Unit A. Within Unit B, two main non-contiguous clusters are observed, a multi-part cluster composed of four hotspots and another three non-contiguous hotspots surrounded by background values. The KDE for plotted bone bolsters the previously described clustering of bone in Area I showing discrete clusters of bone surrounded by background values.

The distribution of lithics is definitively different from that of bone within both Units A and B of Area I. Lithics occur in less-discrete and non-contiguous clusters. Within both Units A and B, linearity is suggested from the banks of lithic distributions, in contrast to the more ovoid bone clusters. Within Area II, greater overall clustering of specimens is visible in Unit F versus Units G and H. Within Unit G, KDE values indicate one main cluster. Unit H exhibits patterns in KDE values that differ from both Units F and G. Within Unit H, several smaller non-contiguous clusters of roughly uniform density are present.

Variation is seen in the distribution of bones between Units in Area II. Within Unit F, the pattern roughly follows that described for the overall distribution of items. However, for Units G and H, differing patterns in the clustering of bone items is observed from that of the overall distribution of items per Unit. Within Unit G, bone is generally evenly distributed throughout the Unit, with small clusters of bone occurring immediately south of the bank of excavation squares containing the highest flake counts. Unit H likewise presents a pattern of uniform distribution of bones, with three small clusters located in the center of the Unit, surrounding an isolated square of high flake counts.

KDE values for the piece-plotted lithic specimens suggest different distribution patterns from Unit to Unit within Area II. Within Unit F, small, discrete lithic clusters of uniform density distributed across the Unit dominate, while within Unit G more contiguous lithic clustering is observed, while within Unit H denser concentrations of lithics are observed more uniformly across the Unit.

Refits provide a unique window into the spatial patterns present. The pairs comprising the refit/fitted fragment are a direct reflection of cultural processes at work at the site, providing tangible evidence of site linkage and social connectivity of the Folsom site occupants. Within Area I, 31 of 33 (93.9%) refitted fragments occur entirely within Occupation Units A and B. One (3%) refit occurs between Unit A and Unit B, and one (3%) occurs between Unit B and an indeterminate square on the eastern margin of Unit A. The spatial pattern among refits suggests that interactions in Unit A were more frequent, and spanning shorter distances than in Unit B, indicating greater social connectivity among site occupants and/or activities undertaken within Unit A than Unit B.

Similarly within Area II, differences evident among the spatial pattern of refits suggest different degrees of site connectivity. Within Area II, 18 of 25 (72%) refitted fragments occur entirely within Occupation Units F, G, and H, while seven (28%) refits occur between occupation units (Units F and Y = 4%, Units G and Y = 20%, and Units H and Y = 4%). That the most complex pattern among refits occurs within Unit Y (the area between Units G and H) is interesting as the stratigraphic mixing between these Units clouds the picture of what the pattern suggests. It is possible, (again, without knowing the specific character of the fitted fragments) that the high-frequency bank of lithic materials present in this area, in conjunction with the complex refit patterns, represents recycling of lithic resources left from previous site occupants if Wilmsen's assessment of the Units as 'autonomous episodes of occupation" (Wilmsen and Roberts 1978:59), or multiple occupations, is correct.

Villa (1982) argued that post-depositional displacement/mixing of archaeological materials within and across originally separate stratigraphic units may generate a palimpsest assemblage, and used refits as an index for this displacement so that appropriate interpretations could be made concerning an archaeological site's stratigraphic integrity. She argued that refits may reveal the presence of post-depositional or taphonomic mixing, which may be invisible in visually determined stratigraphic breaks during excavation. As presented in Chapter 3, Clark and Evan's Test for Spatial Randomness indicates that the distributions of artifacts within each of the Occupation Units within Areas I and II at the Lindenmeier site likely do not represent palimpsest deposits. Thus, if palimpsest deposits are not responsible for the discard patterns evident at the site, obtaining a complete picture of the refits via use-wear analysis will be a productive avenue of research to verify Wilmsen's assertion of the Lindenmeier site as exhibiting multiple occupations (Wilmsen and Roberts 1978:59).

Use-wear analysis, or even simple knowledge of the tool type(s) comprising the refits would lend insight to not only the occupational character of the site, but also whether the spatial patterns among refits are a result of preferential discard of broken projectile point tips and point bases, general patterns of resource-sharing, and other social distance indicators. Even without this information, patterns of spatial connectivity at the site are still evident from the unique distribution of refits within and between Units.

Solely using visual interpretation of artifact distribution maps alone is not sufficient to reveal subtle patterns among the spatial distribution of artifacts at Lindenmeier; to use the old adage; one simply ‘cannot see the forest for the trees’. The maps seem to visually depict considerable overlap between hideworking- and projectile manufacture- related artifacts, and hence, activities. Other, more quantitative methods to determine the more subtle spatial patterns among and between artifacts related to hideworking and projectile manufacture.

Using quantitative measures to examine spatial patterning, variation was observed across the Lindenmeier site in terms of artifact distributions related to hideworking and projectile manufacture. These different patterns were revealed not only among the different Units within Areas, but also between Areas I and II; artifacts functionally-related to hideworking activities co-occur more frequently in Area II than in Area I, and specifically, much more frequently in Units G and H than in Unit F within Area II. The descriptions of the distributions within each Unit describe a situation in which many similarities exist between Units A and B in Area I, and Units G and H in Area II; Unit F appears to have a somewhat different pattern of discard than the other units, in terms of both hideworking and projectile point manufacture activities.

Hideworking activities were more of a conditioning factor in the spatial patterns of artifact discard in Units G and H than in other Units. If hideworking activities were undertaken primarily at their location of discard and were considered a part of domestic camp life for Folsom people, occurring within the residential setting and integrated into domestic space, then Units G and H in Area II are the Units most likely representing residential space at Lindenmeier.

Projectile manufacture related activities were also likely more of a conditioning factor in the spatial patterns of artifact discard in Units G and H than in other Unit F of Area II. There are interesting spatial patterns present among the distribution of projectile-related artifacts in Area I, with more than three times as many fluted Folsom points observed in Unit A than in Unit B, clustering of bifaces in Unit B, and significant dispersion of bifaces in Unit A. However, if projectile manufacture related artifacts represent broken tools discarded at the site of manufacture, just as with hideworking-related artifacts, Units G and H likely represent areas in which projectile manufacture was preferentially practiced within Area II.

The spatial coincidence of both hideworking- and projectile manufacture- related artifacts and activities specifically within Units G and H of Area II suggests that segregation of space by activity and, arguably by gender, does not seem to be the situation at Lindenmeier. In contrast to Stewart's Cattle Guard, the overlap between artifact discard patterns (interpreted as evidence of said activities) appears to indicate integration of these activities in the Folsom use of space at Lindenmeier rather than gendered segregation of these activities in space.

Closing Thoughts - Three questions were raised regarding the site structure, or spatial organization, of the Folsom component of the Lindenmeier site from the distribution of artifacts. These questions were chosen in order to take advantage of the efforts of previous researchers in examining similar themes among hunter-gatherers in general, and specifically Folsom, spatial patterning studies.

Artifacts mapped by Frank Roberts nearly eighty years ago were examined to determine if the distribution was the product of random chance. Tests for spatial randomness indicate they are not. Similarly, these tests indicate that the distribution of artifacts likely do not represent palimpsest. Cultural practices are patterned, so too are patterns present in the distributions of items associated with culturally specific activities, such as hideworking and projectile point manufacture. These spatial patterns are evident at different scales, which this study attempted to control for by the use of multiple scales of spatial analysis (individual artifact and excavation square) in examining the Lindenmeier spatial dataset.

Large-scale differences in spatial patterns were observed between Areas I and II of the Lindenmeier site, with smaller-scale differences observed between Units within these Areas, and even finer distinctions were observed among and between individual artifacts. Not only were identifiable spatial patterns observed in the overall distribution of flake debris, tools, and bone items, as well as within functionally related artifact types, but differences in the spatial relationships of these items were also demonstrated among and between Units.

This study proposes that the differences between these Units and between Areas are the product of (mainly) cultural patterns in the use of space. Units in Area I most likely represent the location of a kill site dominated by bison faunal remains with associated areas of high quantities of lithic reduction debris and discarded tools used in the butchery and hideworking process. Within Area II, Unit F was found to be more different than Units G and H. This suggests that secondary disarticulation and processing of butchered elements likely were focused in Unit F, while hideworking and projectile manufacture activities were widely practiced in Units G and H.

The inclusion of specimen-specific data, including vertical artifact data derived from Roberts' field notes, as well as use-wear studies upon existing Lindenmeier collections, are recommended as important steps to increase the utility of the spatial dataset presented in this thesis. Specimen-specific information will lead to more meaningful interpretations of the spatial relationships depicted in this thesis, while filling in important understandings of burning, artifact size, refit status, etc. that in turn allow more meaningful assessments to be made of the use of space at the site. This information could then be used in conjunction with observations by other researchers of specific spatial and attribute-related patterns in other hunter-gatherer, and specifically Folsom sites, to make statements about the culturally patterned use of space in these types of sites.

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APPENDICES

SUPPLEMENTARY FILES ATTACHED