To the Graduate Council:

I am submitting herewith a dissertation written by Charles L. Hall entitled "Exploring Archaic Settlement in the Midsouth: The Surface Archaeology of Cannon and Cheek Bends of the Duck River, Tennessee." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Walter E. Klippel, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor
and Dean of the Graduate School

EXPLORING ARCHAIC SETTLEMENT IN THE MIDSOUTH: THE SURFACE ARCHAEOLOGY OF CANNON AND CHEEK BENDS OF THE DUCK RIVER, TENNESSEE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Charles L. Hall

December, 1992

To Mary,

without you there would be nothing.

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ABSTRACT

During the late 1970s and early 1980s the Department of Anthropology at the University of Tennessee in Knoxville conducted an inventory and assessment of archaeological resources potentially affected by the proposed Columbia Reservoir on the Duck River in Middle Tennessee. Two environmental subdivisions of the Nashville Basin were present in the reservoir area: the patchy Inner Basin and the more homogeneous Outer Basin. As the majority of the archaeological material found was referable to the Middle and Late Archaic Periods, the research design focused on an investigation of Archaic adaptation in this environmentally variable landscape.

Two river bends selected as representative of the Inner (Cheek Bend) and Outer (Cannon Bend) basin environments were surface collected in a non-site manner. Approximately 82,000 artifacts were collected. The goals of this study are to describe the patterning of Middle and Late Archaic materials across the surfaces of these two bends, and to evaluate the power of two models derived from optimization theory to explain the observed distributions.

Description is aided through the definition of two analytic units: projectile point types and sites. Discriminant analysis is used to define five projectile point types and to classify approximately 300 recovered specimens. Sites are recognized as non-random artifact density levels defined through comparison with Poisson distributions.

The distribution of artifacts is compared to expectations derived from a model of optimal nest spacing among Brewer's blackbirds. This model leads to the expectation that dispersed settlement would have resulted in shorter foraging trips in the predictable Inner Basin, while a nucleated settlement pattern would

have been more efficient in the unpredictable Outer Basin. The observed pattern generally conforms to these expectations.

Specific site locations are evaluated in terms of a generalized energy minimization model; settings near the river, on level ground, and with a southern exposure, are expected to have been selected for settlement. The observed pattern of site distribution is found to generally conform to these expectations.

It is concluded that Archaic hunter-gatherers in the Nashville Basin of Tennessee were efficient foragers who responded through settlement arrangement to environmental variability.

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CHAPTER 1

INTRODUCTION

During the early 1980s an ambitious systematic collection of the prehistoric cultural material found on the ground surface of two bends of the Duck River in Middle Tennessee was undertaken. Prehistoric artifacts recovered from the 8448 grid units, the vast majority of which were contiguous and 10 meters square, totalled 82,087. In the only analysis of this material, by Turner and Klippel (1989), it was found that most of the diagnostic material (projectile points) was referable to the Middle and Late Archaic periods (7500 - 3000 B.P.). Turner and Klippel's study was primarily an interbend comparison that stressed the effect of the contrasting environmental settings on the intensity of landscape utilization. The present study examines the intrabend aspect of this important data set: the spatial distribution of prehistoric material within each bend. The topic of concern is human settlement, with the basic assumption being that the pattern of artifactual material on a surface reflects the pattern of human utilization of that surface. The periods of interest are the Middle and Late Archaic (7500 - 3000 B.P.), reflecting the temporal affiliation of the majority of the collection while controlling for the basic subsistence economy of the producers of the material: Archaic groups in the Midsouth were hunter-gatherers.

The goals of this study are twofold; to describe the pattern of human settlement during these periods, and to investigate this pattern in an attempt to understand and explain the system underlying it. Description is viewed as a worthy goal in itself as documentation of the past is a contribution to knowledge. Description is also a necessary prerequisite to understanding, and as such its' value is enhanced. The thorough and careful description of the pattern of settlement during the Middle and Late Archaic periods, as a result,

receives considerable attention in this study. To understand or explain variability in past behavior is, however, the primary goal of anthropological archaeology. In this study a scientific approach is employed to assess the power of explicit theory and derived models to explain the observed settlement pattern.

Method

Epistemology

The positivistic approaches (Watson et al. 1971) that characterized American archaeology in the 1970s and 1980s were based on the assumption that given a well formulated research design and an appropriate data set there was a reasonable chance of reaching true conclusions. For archaeologists this meant that there is a real chance of knowing and understanding the human past (Binford 1964).

The method employed in this study, however, has been designed in recognition of the fact that we can never be absolutely certain concerning our knowledge of past behavior. Many behaviors can produce identical patterns, and many patterns can be produced by identical behaviors; the identification of a pattern, even one predicted by a theory, cannot prove a theory. The process of prediction from theory in archaeology is one of derivation, not deduction, and it is an imperfect process (Salmon 1982). Two researchers are perfectly capable of deriving radically opposing predictions from the same theory. The confidence one has in a given prediction or conclusion must be based on an evaluation of the supporting argument. However strong the argument, the linkage between theory and implication will never be greater than sufficiency; a theory may be sufficient to predict a given pattern or an observed pattern sufficient to conclude the explanatory power of a theory, but neither will ever be necessary. In the present study, an effort is made to clearly explicate the arguments by which implications and hypotheses are derived, but no

claims will be made to have proven or disproved the parent theory, regardless of results. Rather, it will be concluded that the theory was either sufficient or insufficient to explain the patterns observed in the archaeological record.

Theory

The premise of the present study is that human settlement is in large part a response to economic considerations. Specifically, it is suggested that the pattern of human dispersal over a landscape is designed, either by evolution (natural selection) or by human intention, to conserve energy. Two models derived from this economic theory are employed in an effort to understand Duck River Archaic settlement.

Horn's model. In an important study of the colonial nesting of the Brewer's blackbird, Horn (1968) found that the birds' behavior was a response to the variable nature of their food supply. As a result of his observations, he was able to model nesting behavior given two characteristic resource types. When resources were mobile and unpredictable the birds tended to congregate in large centrally located colonies. In contrast, when resources were stable and predictable colonies tended to be small and dispersed. By calculating the distance to the resource points, weighted by the chance of encounter at each point, Horn showed that the observed pattern of colonization minimized the average round trip distance, thereby minimizing the energy expended in resource acquisition. The potential value of Horn's model for the analysis of human settlement has been appreciated by several anthropologists (Smith 1983, 1987; Winterhalder 1981), and two such analyses have been undertaken (Heffley 1981; Wilmsen 1973). It will be argued that the proposed study presents an opportunity to apply Horn's model to the archaeological record.

Geographic gravitational model. While Horn's model may explain the overall pattern of settlement (congregated or dispersed) the location of specific archaeological sites may be analyzed with reference to a variety of situational variables. In the present study specific locations will be evaluated in terms of a gravity model in which settlements are "attracted" or "pulled" toward certain features of the natural environment that minimize the effort required to render them suitable for habitation. The environmental features investigated will be derived from anthropological and archaeological literature and in general will constitute a set of "common-sense" variables, such as slope of terrain, water sources, and facing aspect. Gravitational models have allowed previous researchers to predict or explain settlement location with varying degrees of confidence (Hall and Klippel 1988; Jochim 1976; Kellogg 1987; Kvamme 1985; Plog and Hill 1971) and similar success is anticipated for the present study.

Materials

Attempts to investigate prehistoric settlement systems are commonly limited by the quality of the data available, and the present study will be no exception. The data available for this study, however, are exceptional in a number of respects. In addition to the quality and quantity of the data already mentioned, it will be argued that the environmental characteristics of the study area, and the temporal periods considered, combine to afford an unique opportunity to investigate a pattern and system of prehistoric settlement.

Cheek and Cannon Bend Surface Collections

A period of intense archaeological investigation in the central Duck River drainage during the 1970s and early 1980s was initiated and sponsored by the Tennessee Valley Authority in anticipation of the construction and inundation of the Columbia Reservoir. Initial survey

results indicated that the archaeological record in the central Duck River Valley was dominated by Archaic material, especially that of the Late and Terminal Archaic periods (Dickson 1979; Johnson 1977). Anthropological studies, both archaeological and ethnographic, have repeatedly posited the primary importance of the natural environment to any understanding of hunter-gatherer variability (Jochim 1976; Lee 1979; Steward 1968). The presence of contrasting environmental settings within the proposed reservoir area presented a natural laboratory for examining the influence of environment on hunter-gatherer adaptations. To this end an important component of the early archaeological work in the reservoir area included the systematic recovery of surface archaeology in two bends chosen as representative of the contrasting environments (Klippel 1977). Cannon Bend, with deep soils throughout, was selected for it's affinities with the outer portions of the Nashville Basin , while Cheek Bend represented the typical situation in the inner Nashville Basin (these settings are more fully defined in Chapter II).

Extensive surface collections were systematically conducted on all tillable land in both bends. Between 125 and 150 ha in each bend were involved. To ensure comparability of collections, plowing and disking were standardized, and prepared surfaces were not examined until at least 6.35 cm of rain had fallen on them. Continuous grids were established across the entire area, and all units were examined regardless of proximity to areas of artifact concentration ("sites"). The resulting material represents the raw data for the present study.

In addition to being spatially variable, the environment of the study area was also variable temporally. During the mid-Holocene period (8000 - 5000 B.P.) a general postglacial warming trend coupled with a shift to westerly continental air circulation patterns resulted in a climatic interval commonly referred to as the Hypsithermal (Wright 1976) that was dryer and warmer than current conditions.

Regional consequences of this climatic interval are seen in the faunal (Klippel and Parmalee 1982), floral (Delcourt and Delcourt 1979), and geomorphological (Brakenridge 1982) records for the period. On the basis of their work with the microfauna from Cheek Bend Cave, Klippel and Parmalee (1982) have suggested that the cedar glades of the inner Basin were most extensive during this mid-Holocene interval. All evidence suggests that by 5000 B.P. paleoenvironmental conditions were essentially modern.

It has recently been noted that the cultural and paleoenvironmental histories of the Southeast present a very similar chronology (Smith 1986). The mid-Holocene Hypsithermal interval and the Middle Archaic both date to approximately 8000 - 5000 B.P. It is not necessary to assign causative supremacy to the climatic variability in order to appreciate the convenience of this concordance: archaeological assemblages, frequently assigned to temporal periods based on the morphology of associated projectile points, may confidently be assigned to climatic periods.

Analysis

Settlement Implications

Horn's model will be shown to predict "colonial" settlement (clumped) in response to unpredictable resources, and dispersed settlement when resources are relatively predictable. It will be argued that the inner Basin (Cheek Bend), characterized by a more predictable resource pattern, should have supported Archaic settlement that tended toward a dispersed pattern. In the outer Basin (Cannon Bend), with a resource pattern that will be characterized as relatively unpredictable, the pattern of settlement should have been more clumped.

Diachronic patterns of environmental change will be included in the model, and implications regarding differences in Middle and Late

Archaic settlement will also be derived. Mid-Holocene expansion of cedar glade area in the inner Basin, it will be argued, would have resulted in an even more predictable environment than during the Late Archaic. Consequently the advantage of dispersed settlement within Cheek Bend was greater during the Middle Archaic than during the Late Archaic. The outer Basin would not have been affected as dramatically by the mid-Holocene climatic interval, and as a result no difference in settlement between the Middle and Late Archaic in Cannon Bend is implied.

Selection of Specific Locations

Regardless of the time period or environmental setting being considered, the economizing assumption indicates that settlements will be located in situations that minimize the effort required to render them suitable for habitation. While other variables may be considered in the proposed study, it is minimally implied that situations providing southern exposure and level terrain (minimizing the effort required to make a location comfortable), as well as ready access to water (minimizing the effort required to acquire this necessary resource), would have been preferred for settlement.

Analytical Units

The definition of two types of analytical units will be required to perform the intended analyses: projectile points types, and sites. Projectile points represent the only means of temporal definition and control in these surface collections, and as a result their defintion and identification will be of considerable importance. While a siteless approach was employed in the collection of the river bends, and several analyses will attempt to utilize the power of these data untransformed, some tests will require the definition of sites. My premise is that neither sites nor projectile point types are observational; both are analytical constructs (Clarke 1968).

Considerable care will be taken to explicitly and objectively define them, as all subsequent arguments, analyses, and conclusions can only be as convincing as these essential units.

Archaeological Implications

Archaeological and experimental literature will be reviewed to support the assumption that the distribution of archaeological materials over a surface reflects the manner in which that surface was used in the past. Based on this argued equivalence, the following archaeological implications may be derived from the settlement predictions.

In a reflection of the dispersed settlement pattern in Cheek Bend, an even distribution of archaeological materials is expected there. In contrast, a relatively clumped pattern of archaeological materials in Cannon Bend is expected.

Middle Archaic material in Cheek Bend will be more evenly distributed than Late Archaic material. No differences between the distributions of Middle and Late Archaic archaeological material are expected in Cannon Bend.

The implications regarding specific site locations fall into two categories. For continuous variables it is expected that specific states of these variables are most desirable, and that as this specified state is approached energy conservation is facilitated (i.e. south facing exposure and level terrain). Archaeological sites are therefore expected to be located in situations that are closer to these desirable variable states than random locations. In the case of discrete variables (present or absent, such as water and other resources), settlements will be located closer to the resource than random locations, minimizing the energy expended in acquisition.

Tests

These predictions fall into two types: those dealing with the overall pattern of settlement, and those concerned with the situation of specific sites.

Pattern Analysis. The primary technique employed in the testing of pattern implications will be trend surface analysis (Dunnell 1983; Jermann and Dunnell 1979). This statistical technique is well suited to grid data as opposed to point provenience data, where a cluster analysis technique would be appropriate. Much like a three dimensional regression analysis, trend surface analysis is an attempt to find the best fit surface for the observed distribution, and proceeds in polynomial progression. A first order surface is flat, a second order surface has a single peak or depression, a third order surface has two peaks or depressions or one of each, and so on. For the proposed test, it is expected that the best fit for Cheek Bend will be a lower order trend surface than for Cannon Bend as fewer peaks and valleys indicate a more dispersed pattern of material. The Middle Archaic trend surface should likewise be a lower order one than the Late Archaic surface in Cheek Bend.

The pattern of settlement dispersion will also be investigated through a nearest neighbor analysis of the defined sites. It is expected that this analysis will indicate a clustered site pattern in Cannon Bend, while the Cheek Bend site pattern will tend toward maximum dispersion.

Situational Analysis. Two types of statistical analysis will be used to test the gravitational attraction of various situational variable states and specific resources. Trend surface analysis will be used to indicate the directional tendency of the surfaces. It is expected that they will trend in the direction of critical resources. It is further expected that major peaks in the best fit surface will

be in the area of identified variable states (e.g. in level areas, or on south facing slopes).

A Kolmogorov-Smirnoff analysis (Kellogg 1987; Kvamme 1985) will be used to compare the locations of identified sites with random locations. If the specified variable states (or resources) do indeed attract settlement, the sites should score nearer the specified variable state (or resource) than random locations.

Conclusions

If the results of the statistical analyses are as expected it will be concluded that the settlement of Middle and Late Archaic hunter-gatherers in the Columbia Reservoir area was responding to the economizing principles as expected. Deviations from expectations will be discussed, and alternative explanations will be forwarded.

CHAPTER II

TEMPORAL AND ENVIRONMENTAL SETTING

The Archaic

The term "Archaic" was first used by Ritchie (1932) to denote archaeological assemblages in the New York area that lacked ceramics. As the term connotes, Ritchie viewed the creators of these assemblages as technologically less well developed or sophisticated than those who had knowledge of ceramic manufacture and use. Although a chronological sequence was seen as possible, the coexistence of these two technologically different groups was envisioned. The temporal precedence of a technologically inferior culture followed by one exhibiting the fruits of innovation and progress, however, was compatible with the then prevalent notions concerning cultural evolution, and the Archaic was soon commonly thought of as a pre-ceramic cultural stage (Ritchie 1944).

Chronology

By the 1950s a pre-ceramic "Archaic" stage in New World prehistory was firmly established in the archaeological literature (Willey and Phillips 1958). Vaguely perceived as at once a temporal unit, a technological stage, and an adaptive pattern, but undifferentiated and poorly understood, Griffin first defined two (1952) then three (1967) "periods" or "substages" within the Archaic of the Eastern Woodlands. These periods were primarily distinguished by technological innovation; during the Early Archaic the fluted lanceolate projectile points of the first Americans were replaced by notched types, the Middle Archaic witnessed an explosion in ground stone tool manufacture, and the Late Archaic was characterized by the use of copper in some (northern) areas, and an increase in the number of grinding stones and woodworking tools. Griffin also postulated

population growth and increasingly local adaptations throughout the Archaic (1967).

In the Midsouth it was the work of Lewis and Kneberg (1947, 1959) that refined and clarified the Archaic and attempted to define structure within it. Based primarily on their work at the Eva site (and 4 others) in the West Tennessee River Valley (Lewis and Lewis 1961), they defined two traditions within the Archaic. The Midcontinent Tradition was represented by the Eva site, and other shell middens along the main river valley, and was seen as a specialized adaptation to riverine resources. The Eastern Tradition was represented by the Cherry site and others situated in upland and non-riverine settings, and was envisioned as forest adapted. As with their explanations of other patterns of cultural variability, Lewis and Kneberg appealed to migrations from other areas to account for these two traditions. In their scheme the Midcontinent Tradition was earliest, arriving from the northwest sometime before the arrival of the Eastern Tradition from the Southeast. The two traditions coexisted in peace due to differences in exploitative niches. Internal temporal differentiation was defined for the Midcontinent and Eastern Tradition (Lewis and Kneberg 1959:180) in which phases were primarily defined by characteristic projectile point types (Lewis and Lewis 1961:173). The date ranges offered by Lewis and Kneberg (1959; see also Lewis and Lewis 1961) are somewhat compressed, but it is the interpretation of these variable assemblages that strikes the modern reader as most curious; the "paleo-Indian" (also termed "Early Lithic"), Archaic (Midcontinent and Eastern), and Woodland are each conceived of as "peoples". These different cultures (in the ethnographic sense) were seen as not strictly arranged in lineal temporal fashion, but considerable overlap was envisioned. Conflict between the groups did not occur to any great extent, according to Lewis and Kneberg (1959) because they were adapted to different

resources; while there may have been interaction, there should not have been competition.

Considerable clarity was added to our understanding of the Archaic during the 1970s by University of Tennessee researchers engaged in the Tennessee Valley Authority sponsored Normandy and Tellico Reservoir projects. It is here argued that the primary contribution of the Normandy project to Archaic research was in a synthetic reformulation of knowledge and understanding regarding the Archaic in the Midsouth. In addition, the Normandy researchers enhanced our knowledge of the various periods through the investigation of several Archaic sites.

Faulkner and McCollough (1973) were the first researchers to apply the tri-partite period division (cf. Griffin 1967) being used by other Southeastern researchers (Broyles 1966, 1971; Coe 1964) to the Midsouth Archaic. Taking a strictly chronological view, Faulkner and McCollough (1973:412) used the cultural period concept as "a segment of time when new cultural traits appear which make each period distinct." Periods, in turn, were divided into phases. Following Willey and Phillips (1958:22), the phase was seen as "an archaeological unit possessing traits sufficiently characteristic to distinguish it from all other units similarly conceived." In practice, this translated into morphologically distinct projectile point forms. However, a staggering array of Archaic projectile point types had previously been defined with little regard for their temporal meaning (e.g. Cambron and Hulse 1975; DeJarnette et al. 1962). Because many types were seen to "share a number of similar attributes", Faulkner and McCollough (1973:88) combined them into 5 type clusters "that appear to be distinctive horizon markers." These type clusters, from earliest to most recent, are arranged into periods as follows: the Early Archaic includes Kirk and Bifurcate clusters; the Middle Archaic includes the Eva - Morrow Mountain and White

Springs - Sykes Cluster; and the Late Archaic includes the Ledbetter Cluster (Faulkner and McCollough 1973:151-155, 415-421). When examining the chronological meaning of these clusters, however, these researchers concluded that there was insufficient evidence to fix the position of the White Springs - Sykes Cluster, and as a result a single Eva - Morrow Mountain phase for the Middle Archaic was defined. The other Archaic clusters were taken as isomorphic with phases. Date ranges for the periods and phases were suggested based on the results of radiocarbon dating of similar assemblages in the region. In overall aspect, the chronological units defined by Faulkner and McCollough for the Normandy Reservoir bear a remarkable resemblance to those in common use today.

The changes in artifact assemblage were accompanied by changes in site number, size, and distribution in the Normandy Reservoir area. These perceived changes were explained using two variables: population growth and environment (Faulkner and McCollough 1973:418-420). A general increase in population was inferred from successively more sites through time (Faulkner and McCollough 1974:574-575). As population grew groups became less mobile. This trend culminated in Late Archaic sites with midden and large storage features, together taken as evidence of a "greater degree of sedentariness" (Faulkner and McCollough 1974:575). While environmental change was initially postulated as a potential factor contributing to differences in Middle and Late Archaic settlement patterns (Faulkner and McCollough 1973:418-419), the resource potential of the various biogeographic zones of the upper Duck River Valley became the focus of ongoing research (Faulkner and McCollough 1974:1-12). In general, successive Archaic cultures were seen as exploiting an ever diverging spectrum of resources in an increasingly efficient manner. In this perspective on Archaic adaptations, the Normandy researchers may be seen as significantly influenced by the work of Caldwell (1958).

Caldwell's theory of Primary Forest Efficiency was based on a perceived pattern observed in the archaeological record of the Eastern Woodlands of North America. Beginning with the first inhabitants of the region and continuing until the advent of food production and the reliance of groups on agricultural resources a trend toward more "complete" use of the bounty of the forest was said to be empirically supported. Earlier groups utilized only a few resources, while successive periods were characterized by a more diverse diet. Caldwell explained this pattern in a typically Malthusian manner: increasing familiarity with the environment led to a developing awareness of the resources available in it. As new resources were "discovered" they were incorporated into the diet. Additionally, cultural evolution resulted in increasing sophistication of technology, which permitted the exploitation of new and different resources through time. The result of these processes was a continuously expanding diet which provided increased stability and reliability, hence efficiency, of the subsistence base. By postulating population growth as a prime mover in Archaic cultural change, Faulkner and McCollough modified the Caldwell position in a Boserupian direction: increased diet breadth was made necessary in order to meet the needs of the larger group (cf. Cohen 1977).

The unique geomorphological setting of the Tellico Reservoir at the foot of the Appalachian mountains resulted in the fortuitous preservation of stratified Early Archaic deposits. The opportunity afforded Tellico researchers to refine Early Archaic chronology was admirably seized (Chapman 1975, 1977, 1978) and the results remain unsurpassed today. In addition to the fine tuning of Early Archaic chronology, however, Chapman was also able to substantially expand our knowledge of site structure. Where earlier researchers had seen Early Archaic peoples as highly mobile and practicing a focal subsistence economy (Cleland 1976), the excavation of well preserved Early Archaic

sites in the Tellico Reservoir area revealed features and biotic remains indicative of greater residential stability and more diverse and complex subsistence pursuits than previously envisioned (Chapman 1975, 1977, 1978).

The increased appreciation for the complexity of Early Archaic adaptations led to a renewed interest in alternative models of cultural change. The Columbia Reservoir project was explicitly aimed at an examination of environmental variability as a key factor in a complex system in which humans participated (Klippel 1977). The present study continues a search for understanding in the patterned relationship of environment and past human activity.

Environmental Variability

Holocene Environmental Dynamics

The past two decades have witnessed an explosion of research regarding the character of Holocene environmental change in the Midsouth. The most proximate measure of environmental change available for such research is pollen. The investigation of pollen and plant macrofossils from extensive sediment cores from the Eastern Highland Rim area of Middle Tennessee allowed Delcourt (1979) to suggest a local record of vegetational change spanning the last 25,000 years. Following the full and late glacial (ca. 22,000 to 12,550 B.P.), boreal forests were replaced by mixed mesic forests, perhaps resembling those currently found in the Allegheny Plateau region of Ohio, during the early Holocene (12,500 - 8000 B.P.). Delcourt (1979) inferred a cool temperate environmental regime for this period. During the mid-Holocene (8000 - 5000 B.P.), decreased frequencies of mesophytic forest taxa were interpreted as reflecting a warming and drying climatic trend (Delcourt 1979:271). A similar climatic episode had been previously noted in the literature. While variously described as lasting from 7500 - 4000 B.P. ("Altithermal": Antevs

1955; Lewis and Kneberg 1959), 9000 - 2500 B.P. ("Hypsithermal": Deevey and Flint 1957; McMillan and Klippel 1981), and 8500 - 4500 B.P. ("Atlantic": Bryson et al. 1970), this interval has consistently been described as "a protracted warm dry interval" (Barry 1983). Following the mid-Holocene interval Delcourt (1979:271) detected a resurgence of mesic deciduous forest taxa, culminating in an essentially modern suite by 2000 B.P.

Secondary effects of the mid-Holocene warming and drying have been identified through sedimentological analysis of the geomorphology of the Duck River in the Columbia Reservoir area (Brakenridge 1982), and paleozoological study of the animal remains from Cheek Bend Cave, also in the study area (Klippel and Parmalee 1982). Brakenridge (1982:69) found the first evidence of floodplain stability and soil formation corresponded to the mid-Holocene climatic interval (ca. 7200-6500 B.P.). A period of renewed deposition followed (ca. 6200 - 4200 B.P. Brakenridge (1982:70) has interpreted the documented hiatus of deposition as a result of reduced trunk stream flooding associated with the altered climatic regime of the mid-Holocene interval.

Klippel and Parmalee (1982:452) documented an increase in the incidence of the least shrew (Cryptotis parva) in mid-Holocene strata at Cheek Bend Cave on the Duck River. As C. parva generally inhabits open grasslands, they took this as an indication of forest deterioration resulting from the warmer and dryer conditions characterizing the mid-Holocene interval.

Central Nashville Basin Environment

In addition to being temporally variable, the study area exhibits marked spatial environmental variability. A topographic depression referred to as the Nashville Basin occupies the central third of Tennessee (Miller 1974). The Basin was created by erosion that followed upwarping of the already present underlying Cincinnati

Arch. Today the Basin can be subdivided into inner and outer portions based on edaphic (Edwards et al. 1974), topographic (Fenneman 1938), and vegetational (Braun 1950; DeSelm 1959; Quarterman 1948, 1950) characteristics (Figure 2.1). The outer portion of the Basin is more dissected than the flatter inner Basin, and contains deep soils high in phosphates. The soils of the inner Basin are more variable. While deep soils are present in the inner Basin, rocky and thin soils are common, as are bare outcrops of limestone.

The vegetation of the inner Basin presents a patchy mosaic reflecting the variability in soil characteristics (Crites and Clebsch 1986). Deep soils support a typical Western Mesophytic forest (Braun 1950), while a unique vegetational community known as Cedar Glades (Quarterman 1950) is coexistent with thin soils over Lebanon limestone. Completing the patchwork are expanses of exposed limestone devoid of soil or vegetation. In contrast, the phosphatic, deep soils of the outer Basin support a homogeneous Western Mesophytic forest.

Research Design of the Columbia Project

Given the setting, Klippel (1977) saw the Columbia Project area as an ideal natural laboratory for the investigation of human response to environmental variability. A focus on Archaic period utilization of the project area was adopted both by design and by happenstance; earlier archaeological survey in the area had documented the dominance of Archaic materials in the local assemblages (Dickson 1979; Johnson 1977). An integral aspect of the investigation of the prehistoric patterns of environmental interaction was the sampling of space to reflect the inner-outer Basin dichotomy.

If a strict edaphic definition of the inner-outer Basin boundary is employed, the entire Columbia Project area was located in the inner Basin. However, the extreme western end of the project area was very near this boundary, and local environmental conditions are very

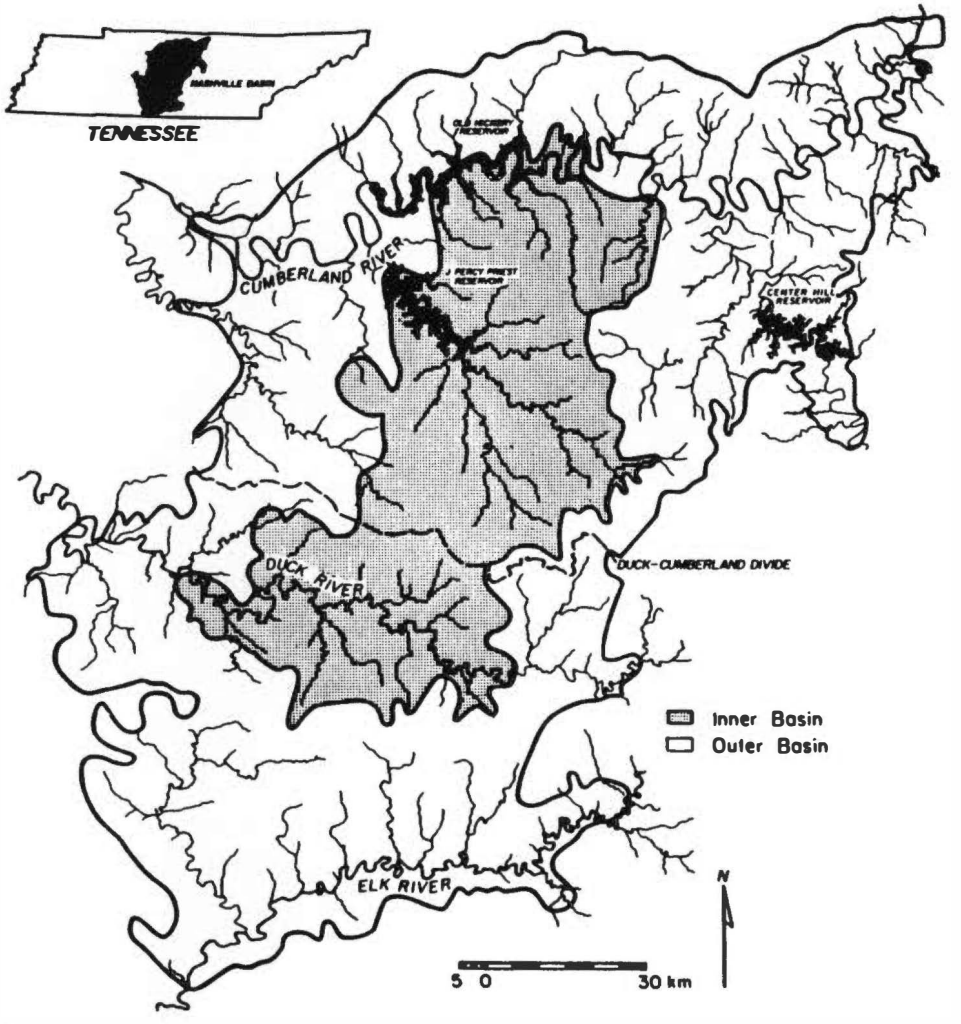


Figure 2.1. Duck River drainage in Middle Tennessee.

similar to those found in the outer Basin: uniformly deep soils that "undoubtedly supported typical Western Mesophytic Forest throughout the Holocene" (Turner and Klippel 1989:50). In contrast, much of the project area was characterized by typical inner Basin soils and vegetation patterns.

The scheme devised to sample the different environmental zones focused on river bends. In the Columbia Project area the Duck River was characterized as an ingrown meandering river (Brakenridge 1984). Lateral migration of the river over time had resulted in broad distinct bends. Inner bend areas were characterized by a system of horizontally distinct sediment terraces, while the outside of the bends were generally defined by vertical limestone bluffs. The potential relevance of these bends to prehistoric patterns of landscape utilization, their naturally operationalized character, and their relatively manageable size (ca. 100 - 200 ha) made them the obvious choice for sampling units. The research design called for the complete archaeological inventory of two bends, one from each division of the Basin, to provide the data for the formation of empirical patterns of prehistoric utilization. These patterns were to be used as expectations and tested against collections from a second similar pair of bends, the results indicating support for the model or potential alternative explanations.

The initial pair selected for survey were Cannon Bend (outer Basin) and Cheek Bend (inner Basin, Figures 2.2, 2.3, and 2.4). Agricultural practices in the project area were intensively focused on the inner terraces of river bends, resulting in near complete cultivation of the surfaces (Figures 2.5 and 2.6). Surface reconnaissance was, as a result, selected as the appropriate method of investigation (see Chapter IV).

The Columbia Project was suspended prior to the surface survey of the second pair of bends. However, the survey of Cannon and Cheek

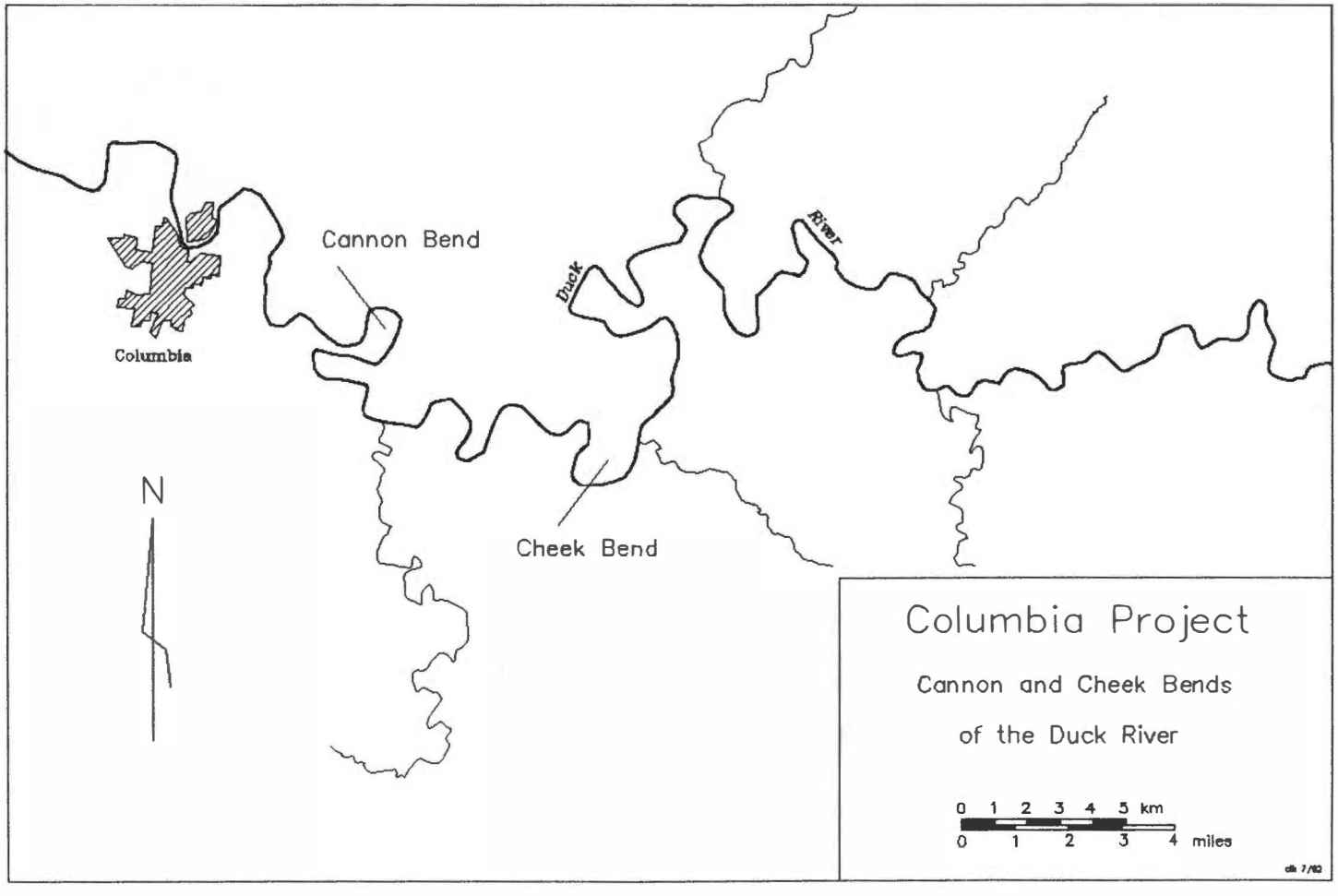


Figure 2.2. The location of Cannon and Cheek bends of the Duck River, Columbia Project area.

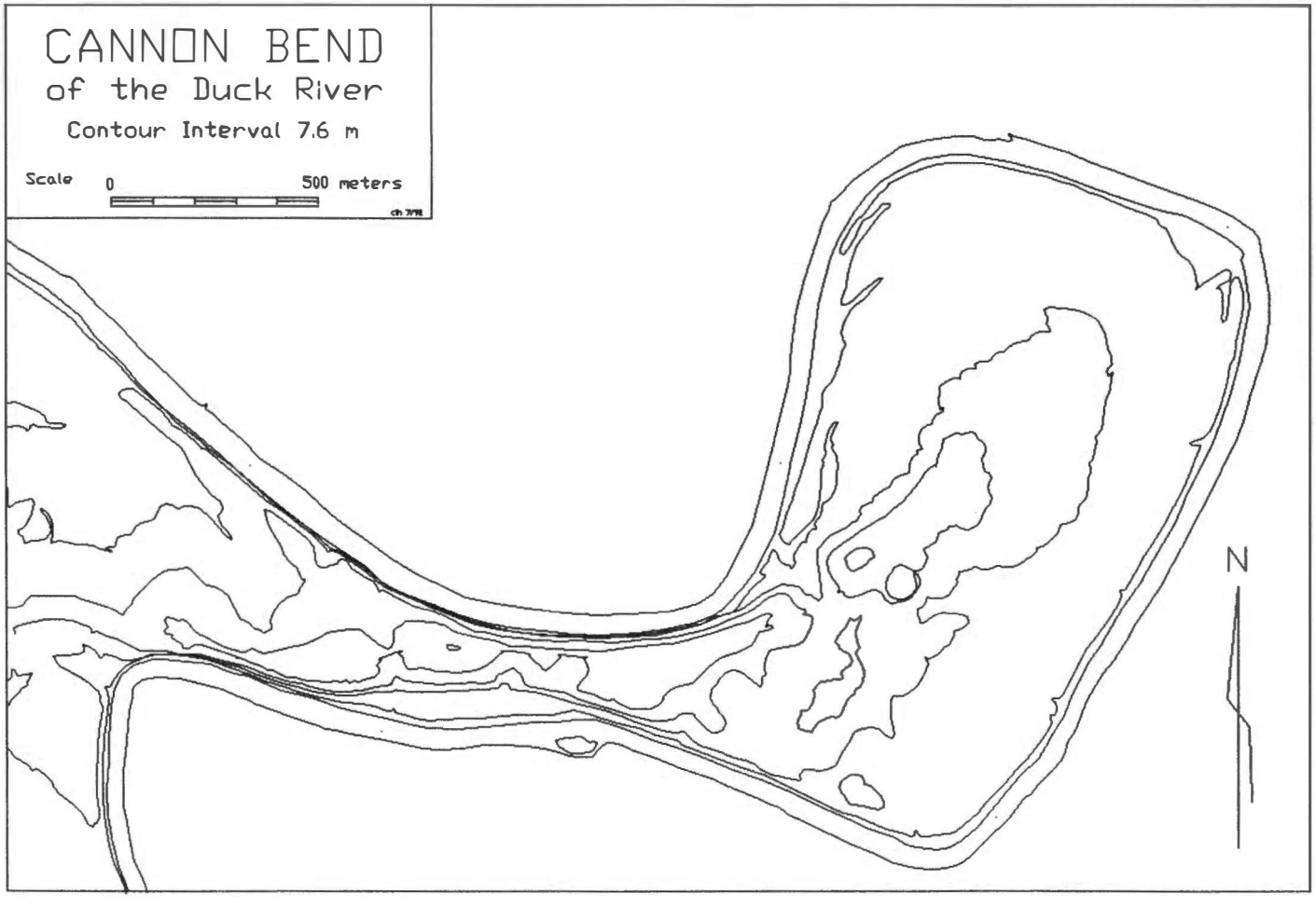


Figure 2.3. Contour map of Cannon Bend.

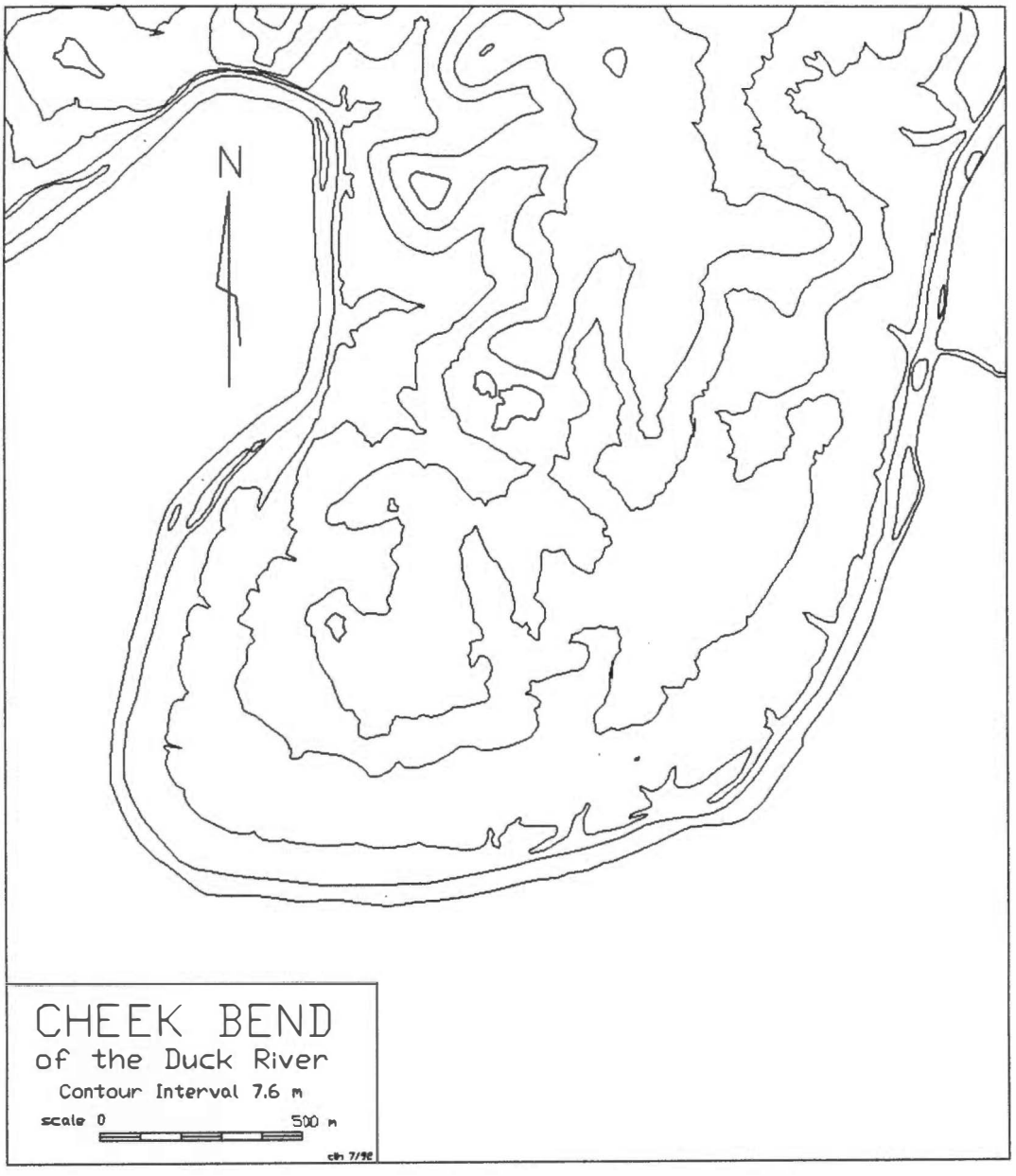


Figure 2.4. Contour map of Cheek Bend.

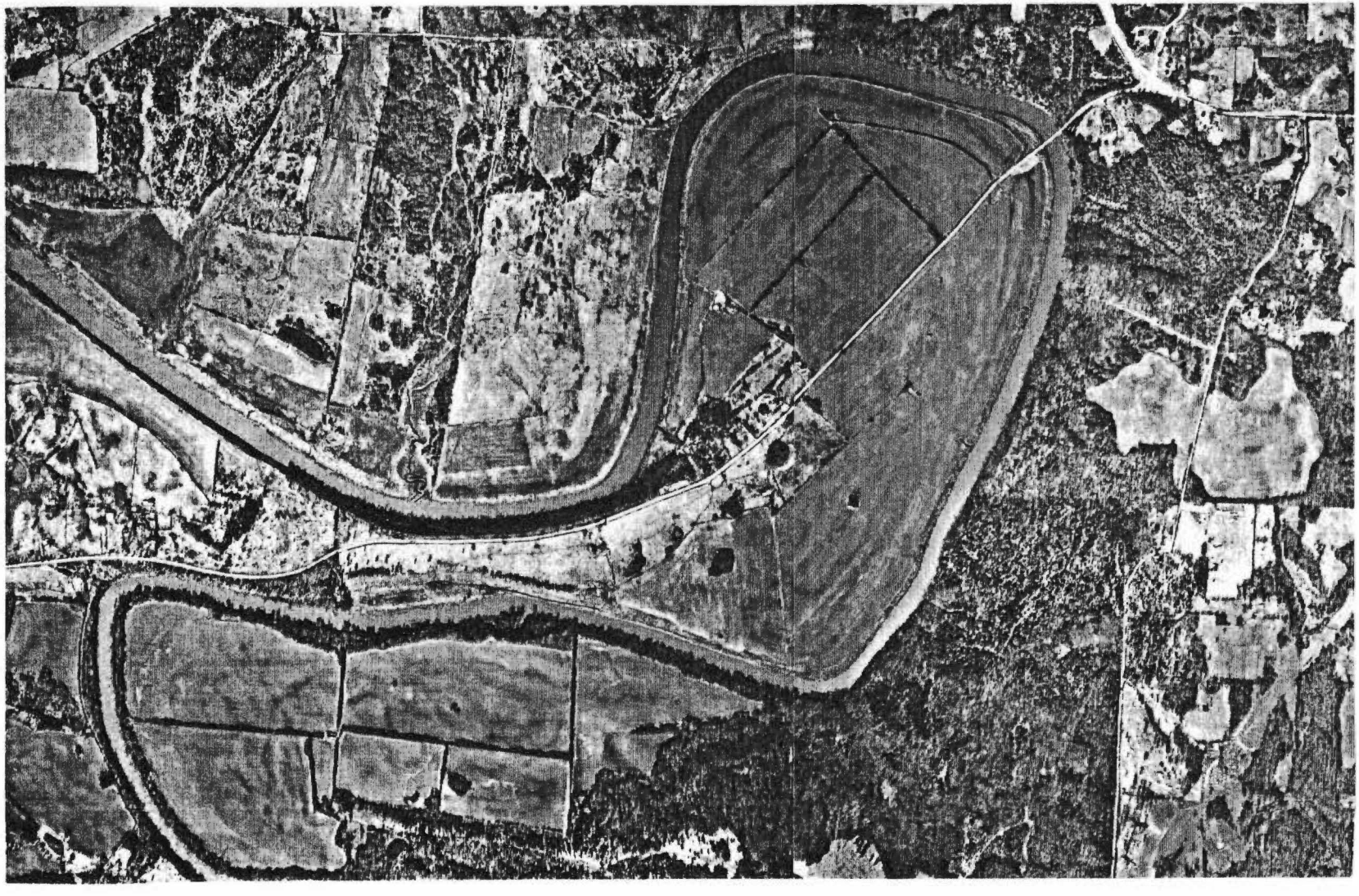


Figure 2.5. Aerial composite photograph of Cannon Bend.



Figure 2.6. Aerial composite photograph of Cheek Bend.

bends was completed. The only analysis of this impressive data set (Turner and Klippel 1989) is focused on broad patterns of interbend utilization. The present study will examine the intrabend aspect of this data set using an explicit model based approach to Archaic settlement.

CHAPTER III

SETTLEMENT ARCHAEOLOGY

Historical Introduction

A research interest in the spatial patterning of archaeological materials across a landscape did not come about in the Americas until the 1940s. This decade witnessed two studies concerned with regional patterns: the lower Mississippi Valley survey (Phillips et al. 1951) and the Virú Valley survey (Willey 1953). The lower Mississippi Valley project was, however, oriented toward the understanding of prehistoric ceramic variability across time and space. It was Willey's Virú Valley survey that saw the first serious interest in the distribution of archaeological settlements. Willey's study also set the theoretical tone for all subsequent settlement archaeology; following Steward (1938) Willey took as a premise that the patterning of human settlements reflected and was determined by "widely held cultural needs", and that their investigation offered "a strategic starting point for the functional interpretation of archaeological cultures" (Willey 1953:1).

A great deal of interest in the value of settlement studies followed the publication of Willey's work. Intellectual debate indicated that while there was general agreement that "settlements are a more direct reflection of social and economic activities than are most other aspects of material culture" (Willey 1956), there were some differences concerning the appropriate scale of settlement analysis. Some researchers were able to discern as many a five levels of settlement patterning (Vogt 1956), while others preferred a two part division that reflects the current intrasite - regional dichotomy (e.g. Chang 1968; Clarke 1977; Sanders 1956). Different research goals were appropriate to the different levels of investigation.

Trigger (1968) suggested that an ecological approach was appropriate at the regional level, while a cultural approach was more profitably applied at the level of the single community.

At the regional level the patterning of sites was seen as a product of the interaction of two variables: environment and technology (Steward 1937; Trigger 1968). Various other influences have been identified, including cultural organization (Binford 1982), material and information exchange (Kay 1980; Paynter 1983), territoriality and spacing (Smith 1978; Winters 1969). It has also been acknowledged that purely sociological factors influence settlement patterns (Jochim 1976; Kvamme 1985). The vast array of potential determinants of settlement at the regional level led Thomas (1975:76) to bluntly offer the observation that "dozens of . . . conditions conspire to pattern prehistoric remains."

While the meaning of settlement patterning is still being debated, three basic approaches have been used to identify the patterning and explain its meaning. Presented in historical order, these are site-based approaches, non-site approaches, and model-based approaches. Examples of these approaches may be seen in three major TVA sponsored University of Tennessee archaeological projects, with the current analysis being included as the third and most recent. As the present study is the inheritor of both methodological and theoretical constructs developed during the earlier two projects, it is instructive to review these projects in some detail before presenting the assumptions, models, methods, and expectations that form the framework of this dissertation. This review will broadly consider methods, but examination of results will be restricted to the Archaic periods.

Site-Based Approaches to Settlement

It is completely appropriate that investigations of settlement patterns should have as their basic unit of analysis the site. In the intuitive behavioral conception of the archaeological record, the equivalent of the settlement is the site (Chang 1968). A fully mature investigation of the distribution of prehistoric sites was undertaken as an integral part of the Normandy Archaeological Project by Prescott (1978).

Normandy

Five years of surface survey in the Normandy locality of the upper Duck River in the Highland Rim - eastern outer Basin regions of Tennessee resulted in the amassment of an impressive amount of information regarding archaeological site locations. Prescott estimated that 90% of alluvial bottoms were surveyed, but noted that the current land use along the steep valley edges (bluffs were wooded) and uplands (wooded or pasture) resulted in significantly less coverage of these areas. This bias, he argued, was overcome in part through road and borrow area surveys, and through the examination of upland areas which were cleared prior to impoundment and development. Prescott used this surface material to address three goals: 1) activity use of the various ecological zones represented in the reservoir (correlation of activity indices and topographically defined strata), 2) diachronic patterns of settlement (taken to reflect subsistence strategies), and 3) the fit of defined patterns to four hypothetical settlement systems.

The four intuitively defined settlement systems are derived from a variety of sources. The Dispersed and Nucleated systems were first defined by Faulkner (1973) with specific reference to the Middle Woodland period. In the Nucleated settlement system cultural groups were envisioned as occupying a primary residential site (village) from

which extractive task forces (hunters, gatherers) would foray. The Dispersed pattern had as primary sites base camps occupied by nuclear or extended family groups for several seasons. These dispersed groups were seen as aggregating seasonally at larger sites for the exploitation of some clumped and temporarily abundant resources, or for social intensification, or for both. Butler's (1977) settlement model, again developed in the context of Middle Woodland groups (Yearwood site) was similar to Faulkner's dispersed model except that the base camps occupied by family social groups were seen as year round habitations. Aggregation in Butler's model was of extremely short duration at special sites for ritual purposes (i.e. interment of high status individuals). Finally, Prescott offers a fourth model variously described as the Dispersed Mobile or Restricted Wandering system. In this system groups are seen as occupying a region within which they adjust settlement location to best exploit seasonally abundant resources.

In considering the archaeological implications of these systems, Prescott defined five site patterns: Village (nucleated system primary site), Base Camp-Ancillary Type (dispersed system primary site, Butler's system primary site), Base Camp - Dispersed Type, Extractive Site (hunting camp), Extractive Site (foraging camp). To these types Faulkner and McCollough (1974) added Ceremonial Sites (such as the Old Stone Fort) and Locations (such as quarries).

The "archaeological signatures" of these site types, however, poses a stumbling block for Prescott. He defined only three site types: village (more than 400 artifacts), base camp (less than 400 artifacts but more than 100 artifacts), and locations (less that 100 artifacts). Using these constructs, he defined the following temporal patterns.

Transitional Paleo-Early Archaic, Early Archaic. This time period witnessed the least utilization of the Normandy locality. Most material was found on small sites (i.e. locations) located on tributary streams and at tributary - main channel confluences. Raw materials utilized reflect the highest incidence of non-local cherts in tool manufacture.

Middle Archaic. Site distribution shifted to the upper reservoir and uplands, and sites were still characterized by small assemblages. Raw material use was the most diverse in this time period.

Late Archaic. A dramatic increase in material diversity was seen throughout the reservoir area. Base camps were first seen. Raw material usage focused on high quality local Ft. Payne cherts.

These patterns were interpreted as reflecting a use of the area by groups utilizing a restricted wandering settlement system until the Late Archaic when a dispersed settlement system first appears. A correlation test of assignable components with identified land forms failed to identify any significant differences in land use through time.

Excavation data confirmed the pattern. Structures were first seen in the Late Archaic (Banks I site, Faulkner and McCollough 1974). In addition, Late Archaic sites frequently contained features including, most notably, large round straight sided flat bottomed storage pits referred to as "silos." Faulkner (1973) has suggested that sites with these features represented collection/storage stations for nut crops, and were therefore most likely occupied during the fall-winter-early spring. Rowe Bowen (1977) has hypothesized that perhaps the Normandy locality represented a portion of a much larger settlement system during the Late Archaic, with summer sites located along the broader river valleys (i.e. lower Duck, Tennessee). The

occurrence of large Late Archaic shell middens in the Columbia area and along the middle and lower portions of the Tennessee River Valley would appear to fit this pattern.

Amick (1984) has pointed out similarities in patterns of lithic raw material use during the Middle and Late Archaic in the Normandy and Columbia localities. In both areas the Middle Archaic is characterized by diverse raw material selection, while the Late Archaic witnesses selectivity for the highest quality locally available types (Ft. Payne cherts). He interprets these patterns as reflections of cultural organization with the Middle Archaic behaving more as foragers and the Late Archaic more as collectors. In his model, environmental deterioration during the Middle Archaic resulted in increased pressure on subsistence resources in middle Tennessee. Groups were more territorially circumscribed and responded through more frequent but less extensive residential moves. Organization was non-logistical and therefore best use was made of the lithic material at hand. In the Late Archaic environmental recovery resulted in more residential stability and therefore increased logistical organization. Embedded in subsistence systems was a procurement subsystem which made possible a focused use of better quality materials.

All of these researchers - Prescott (1978), Faulkner and McCollough (1973, 1974), Bowen (1977), and Amick (1984) - see population expansion during the Late Archaic.

Non-Site Approach

Tellico

It is possible that characterizing the Tellico Project investigation of prehistoric land use as "non-site" is misleading. While explicitly non-site methods were a part of the overall strategy, the majority of the inferences were based on the distributions of sites. Far from diminishing the utility of the analysis, however, the

use of a variety of purposefully defined and implemented recovery strategies (non-probabilistic and probabilistic surface survey coupled with extensive deep site testing) during the archaeological work within the Tellico Reservoir locality has resulted in one of the most impressive data sets yet assembled bearing on settlement in the Southeast. In addition, the probabilistic survey and deep site testing programs represent innovative techniques designed to overcome the biases compromising earlier recovery programs.

Excavations at the Rose Island site (Chapman 1975) indicated that Early Holocene assemblages were preserved in alluvial terraces in the lower Little Tennessee River Valley. An intuitive model of buried site location (lower end of islands, below river constrictions, and the inside lower end of bends, following Coe 1964) led to the discovery of several additional buried sites. Finally, an extensive backhoe survey of all alluvial terraces in the Tellico locality revealed that numerous buried sites were present and not always or exclusively where predicted by the intuitive mode (Chapman 1978). While the addition of buried site detection to the traditional surface site inventories represents a significant development in settlement archaeology, previous researchers, including Prescott, have attempted to address this bias, and Chapman has noted that the unique geomorphological setting of the Little Tennessee River Valley may have resulted in the fortuitous preservation of buried sites.

It rapidly became clear during the Tellico project that complete or near complete surface survey was impractical. Some means of sampling was required. A probabilistic random survey methodology was implemented and tested in Industrial Area II (between Bat Creek and Vonore, Davis 1986). This upland area was divided into 300' square sampling units and a random selection of these SU's for collection was made. Comparable collection conditions were assured through controlled plowing; 6 transects 300' long and 100' on center in a

crosshatched pattern was plowed. After substantial rain (ca. 2") surface artifact collections were made. As this upland area was largely cleared and plowed anyway, a near total "traditional" surface survey was also undertaken. Comparison of results between probabilistic and non-probabilistic surveys revealed no significant differences, and the probabilistic method was applied to the Tellico Reservoir at large (Davis 1986, 1990). One potentially serious bias of this sampling strategy involved the exclusion of wooded areas from selection. Davis compared wooded and non-wooded areas within the reservoir to assess this bias. Using variables both hypothesized to influence site location and selection (distance to water, slope, elevation, etc) and available on maps, he found the areas to be the same with the exception of the knobbed upper reservoir area. He concluded that exclusion of wooded areas would not significantly affect survey results except in this one area. It should be noted that, while an interesting exercise, this comparison depended on assumptions which have not been critically evaluated.

Davis (1986, 1990) has undertaken the overall analysis of the Tellico distributional data. He proposed two hypothetical models: the Collector Settlement System, and the Agricultural Settlement System. In the Collector Settlement System (following Binford) a limited range of site types is expected including Base/Residential Camps, Extraction/Limited Activity Sites, and Locations. In the Agricultural System more site types are expected. These include Villages, Hamlets, Homesteads, Extraction Sites, and Locations.

Operationalizing these site types posed a problem for Davis, as it did for Prescott. In the end three site patterns are recognized: 1) base camps - more than 5 projectile points and also features (note: this pattern is elaborated for Late Archaic and later time periods), 2) limited activity sites - less than 5 but more than one projectile point, and 3) locations - one projectile point. It should be noted

that Baden (1985) has taken issue with this site typology, and demonstrates that multiple components rather than more diverse activities may be represented by Davis's base camps.

A non-site activity analysis (Davis 1986, 1990) indicated a dichotomy between upland and valley use, with extractive activities occurring in the uplands and maintenance activities occurring in the valley.

A chronological assessment of site type patterning was also presented by Davis (1986, 1990).

Lower Early Archaic. Base camps are present and relatively numerous (esp. in the buried alluvial first terrace).

Upper Early Archaic. Significantly fewer sites than in the Lower Early Archaic yet base camps are still present.

Middle Archaic. A continuation of the trend begun in the upper Early Archaic toward fewer sites was seen. This pattern culminated with the Morrow Mountain phase materials which were especially rare. The suggestion is made that Middle Archaic settlement systems were based in the major river valleys (i.e. Tennessee) and that only ephemeral occupation was represented in Tellico. The high percentage of non-local lithic materials appears to support this contention, and focuses attention to the east (quartzites, shales).

Late Archaic. Base camps were once again identified (i.e. Iddins site, Chapman 1981) and the quantity of material and sites was considerably higher than in the preceding periods. The quantity of net sinkers coupled with a preference for site locations along the leading edge of terraces was interpreted as an indication of riverine subsistence focus.

Comparisons

Certainly the most important aspect of these two settlement studies is their impressive scope. These projects, in fact, successfully approached the kind of extensive multistaged program advocated by Struever (1968) as necessary for the recovery and documentation of a complete settlement system. The thoughtful and extensive research Struever cited as mandatory to settlement systems recovery, including probabilistic sampling (or complete coverage), survey, excavation and analysis, was accomplished. The opportunities for such comprehensive research have been rare, and as a result few archaeologists had claimed since Winters (1969) to have documented a complete settlement system. Without question these large scale long term projects made necessary by the creation of vast reservoirs along the Tennessee River system by the Tennessee Valley Authority have come closest to affording the kinds of opportunity required for such an effort in the Midsouth.

Perhaps the most striking parallel between these two settlement systems analysis is that both appeal to elements outside the localities to explain perceived deficiencies in the archaeological record. In Normandy, part of the Late Archaic settlement system is thought to be outside the reservoir area. In the Tellico locality, it is the Middle Archaic record which is perceived as incomplete. Without disparaging either analysis, I would offer two comments on these similar appeals. Both analyses employed a "classification from above" methodology where site types were defined intuitively, without specific reference to the archaeological data base in either locality. It is possible that the proposed classifications and attendant settlement models do not reflect the settlement systems which operated in these localities prehistorically. An alternative approach would have been to create site typologies based on the records in these

localities, and inductively build hypothetical settlement systems which accommodated the data. It is also possible that the conclusions reached are accurate: that incomplete settlement systems have been captured in both localities for certain temporal/cultural periods. The problem of defining prehistoric hunter-gatherer annual territories may partially support this interpretation. Binford (1978a) suggests that archaeologists grossly underestimate these territories, which he says can be on the order of 10,000 square miles (1000 - 10,000). What is certainly clear is that reservoir areas are not designed to reflect past settlement systems (after Winters 1969).

Additional similarities between the Tellico and Normandy analyses include an un-operationalized and uncritical use of the site concept (see Chapter VI), and a lack of pattern analysis. The conclusions of both studies, and their apparent common aim, was to identify diachronic variability in land use patterns. The distribution of sites was compared to defined environmentally distinct zones or areas, but the pattern sites with respect to each other was not considered.

Toward a Model Based Approach to Settlement

The current study is an attempt to explore the power of optimization theory to explain the patterning of prehistoric remains. The optimization concept has been employed in both economics and ecology, and posits a tendency toward maximization (or minimization) of an objective function under certain constraints. Optimization theory has been used in economics to predict or indicate marketing or management decisions that maximize profit, and in ecology to predict foraging and mating behavior that maximizes energy gain (Jochim 1983). Optimization in ecology is generally seen as a derivative of Darwinian Evolutionary Theory in which energy maximization is used as a proximate measure of fitness; the basic assumption is that "in order

to maximize fitness in the long term, [individuals] ought in the short term to maximize net rate of energy (or food) intake" (Krebs and Cowie 1976:99; similar premises are stated by Charnov 1973; Krebs 1978; MacArthur and Pianka 1966; Orians 1971). In economics, optimization is seen as a consequence of rational choice (Smith 1987). There are numerous reasons why optimization as evolution is flawed (Lewontin 1987), and equally as many reasons why it is a poor model of decision making (Jochim 1983). Regardless of the mechanism and the flaws, optimization theory may be good science as it is explicit, allows the derivation of specific (although qualitative) predictions, and is falsifiable (Jochim 1983; Keene 1983). Two models derived from this optimization theory will be employed in the proposed study in an effort to understand Duck River Archaic settlement.

Horn's Model

In an explicit study of the adaptive significance of colonial nesting, Horn (1968) examined the behavior and reproductive success of the Brewer's blackbird in the sagebrush desert of eastern Washington. He was able to conclude that "colonial nesting in the Brewer's blackbird is primarily adaptive to the variable nature of their food supply" (Horn 1968:683). Resources in his study area were very unevenly distributed, while the bird's nest spacing also exhibited spatial variability. As both variates could be expressed in the same scale, Horn (1968: 688) presented a "highly idealized" model to "examine the effect of colonial nesting on the exploitation of an unevenly distributed food source." Nests and resource distributions were conceived of as bivariate; resources were either "evenly distributed and stable" or "highly clumped and transient", while nests were either "dispersed or clumped" (Horn 1968:688 - 689).

In the modeled environment there are sixteen potential resource points and four pairs of nesting birds. There is precisely enough

food distributed among the 16 resource points, each 1 unit apart, to support the four nests. The assumption is made that each nest contains nestlings, and that a constant supply of food must be delivered to them (Orians 1971:533). By varying the distribution of food among the resource points, and the location of the nests, Horn (1968: 689 - 690) is able to calculate the average distance that the adults fly on foraging trips. The four possible combinations of these two two-state variables is presented graphically in Figure 3.1.

When resources are evenly distributed and stable there will be enough food at each quarter set of four resource points to support a nest. If nests are dispersed to the four quadrats of the resource space, then each pair of adult birds need never leave the quadrat to secure sufficient food (Horn's measure of distance, $\underline{d}$, is equal to 1.42 units). If the nests were centrally located or colonial under this resource distribution, then increasingly long foraging trips would be necessary as the near resource points were exhausted. Over time this results in an average foraging distance more than twice as great as that under a spaced nest system as potentially all sixteen resource points must be searched (Horn's $\underline{d}$ = 2.94).

If resources are highly clumped and transient, however, then it is possible that all food will be present at only a single resource point, and the resources will constantly move between points. Under these circumstances it will be necessary, when considered over repeated trips, for each adult pair to travel to all 16 resource points during the average foraging trip. If the nests are dispersed then the average trip distance, over time, will equal Horn's $\underline{d}$ of 3.86. The trip to the most distant resource point would be lessened if the nests were centrally located. A colonial and central nesting pattern, given these resource conditions, would yield a Horn's $\underline{d}$ of 2.94.

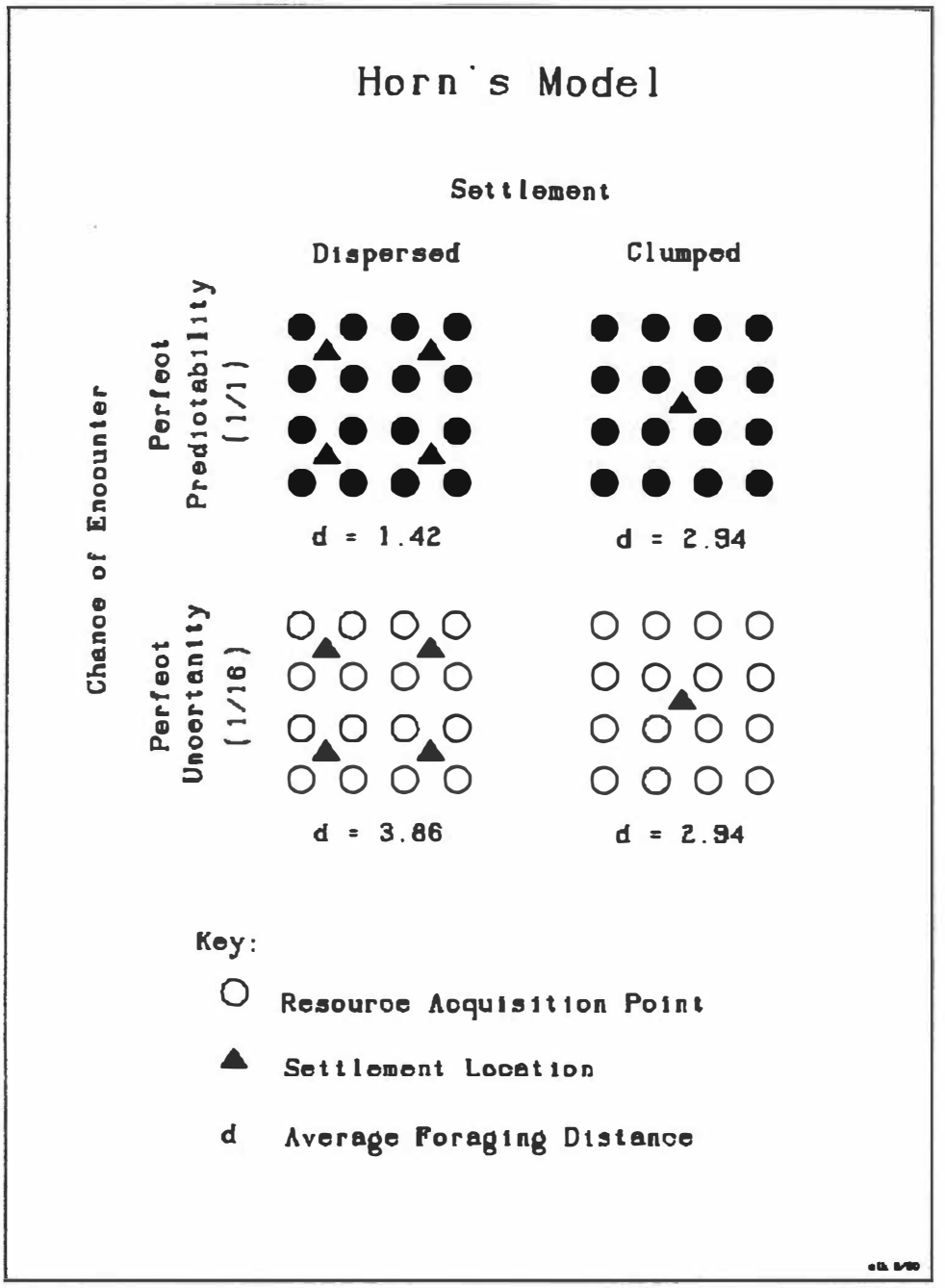


Figure 3.1. Horn's model of optimal nest location.

The optimal nest spacing is that which minimizes average foraging trip distance. For distributed and stable resources the optimal nest spacing is dispersed. For highly clumped and mobile resources the optimal nesting pattern is colonial.

The independent variable in this model is the character of the resource: evenly distributed and dispersed, or highly clumped and mobile. This dichotomy is reasonable when considering the diet of Brewer's blackbirds: winged insects (especially the damselflies) at various life stages. When applied to human foragers various attributes of the dichotomy have been emphasized. Wilmsen (1973:8-9) employed a stable/mobile classification, subordinating the pattern of distribution. Stable resources included plants, burrowing animals, and solitary cervids (e.g. deer). Mobile resources included gregarious ungulates, especially bison, horse, caribou, and antelope. Heffley (1981:126, 133) emphasized the notion of resource availability in the classification. Mobile and clumped resources were characterized as "uncertain," and included migratory herding species such as caribou. Evenly spaced and stable resources were those whose habits could be used to predict availability, and included fish, small animals, mountain sheep, moose, and bear (Heffley 1981:133).

Neither of these researchers has added anything to Horn's intentions. By deemphasizing the pattern of resource distribution, and by focusing on the "habits" of the resources, they have closed in on the essential although not explicit property of Horn's formal model. What these anthropologists have emphasized is resource predictability. Horn's formal model actually ignores resources altogether. What is varied in Horn's model is not the distribution or mobility of any given resource, but rather the chance of encountering a resource at any given procurement point: the "proportion of the time during which foraging is better at (x_i, y_j) than at any other point in the area" (Horn 1968:694). As this proportion moves from perfect

predictability (1/1) to perfect uncertainty (1/n), the advantage of clumped over dispersed settlement increases. This reformulation of Horn's model (note that the labeling of Figure 3.1 uses the language of this reformulation) also takes into account the true statistical nature of the variables. Resources and settlements are not either dispersed or clumped (nominal scale), they are either more or less dispersed or clumped (continuous variables).

It is precisely these previously unexplored yet essential aspects of the model that make it useful for the proposed study. Cannon and Cheek Bend have been characterized as representative of the inner-outer Basin dichotomy (Chapter II). It is here argued that this essential difference placed them near opposite ends of a predictability continuum.

Using basic ecological constructs it can be argued that the resources of Cheek Bend would have been more predictable than those of Cannon Bend. As representative of the inner Basin, Cheek Bend would have presented a vegetative patchwork consisting of Western Mesophytic forest where soils were deep enough, and Cedar Glades where thin Rockland soils overlaid Lebanon Limestones. In places, bare bedrock would have been exposed at the ground surface. In contrast, Cannon Bend would have presented prehistoric hunter-gatherers with a homogeneous Western Mesophytic forest.

Cheek and Cannon bends differed not so much in the resources each presented to prehistoric foragers, but in the number and distribution of resources across potential acquisition points. The patchy mosaic of vegetational communities present in the inner Basin would have limited the number of resource acquisition points while in effect increasing resource density. The edge areas between patches would have been natural points of resource concentration (e.g. ecotones, see Odum 1959:278; Smith 1974: 251). While numerous, these edge areas were limited in number. Outer Basin environments,

being more vegetationally homogeneous, lacked significant edge area. As a consequence there were no points of resource concentration: the number of potential resource acquisition points was unlimited. It is also argued that the occurrence of ecotonal areas in the inner Basin resulted in an increased carrying capacity relative to the outer Basin. Even if the number of resources per unit of area was equivalent for the two environmental contexts, however, the effective resource density was greater in the inner Basin as there were fewer potential acquisition points. The result was that the chance of resource encounter was greater in the inner Basin (Cheek Bend) than in the outer Basin (Cannon Bend).

Given the above argument and the predictions of Horn's model, the following basic implications for prehistoric settlement in Cheek and Cannon bends may be derived. In Cheek Bend, characterized by a more predictable resource pattern, settlement is expected to have tended toward a dispersed pattern. In Cannon Bend, with a relatively unpredictable resource pattern, the pattern of settlement is expected to have been more clumped.

From Horn's model and the above argument two additional implications may be derived. A consequence of dispersed population (Cheek Bend) would be settlements with fewer occupants than in the clumped settlements (Cannon Bend). Cheek Bend settlements, with fewer occupants and requiring fewer potential resource points, would be characterized by a less diverse activity structure than those of Cannon Bend, where more foragers were involved in exploiting larger areas.

It is also interesting to note that as the average round trip distance for resource acquisition in a stable environment was less than that in an unpredictable environment, the economizing forager would have selected Cheek Bend over Cannon Bend for settlement. Turner and Klippel's (1989:64) interbend analysis led to the

conclusion that "upland patchiness attracted prehistoric hunter-gatherers to the inner Basin." The argument presented above is sufficient to explain the observed pattern.

When diachronic patterns of environmental change are included in the model, implications regarding differences in Middle and Late Archaic settlement may also be derived. Mid-Holocene expansion of Cedar Glade area in the inner Basin would have resulted in fewer potential resource procurement areas, effectively increasing the chance of encounter at any given point. Middle Archaic foragers would therefore have experienced an even more predictable environment than Late Archaic foragers in Cheek Bend. It is implied that the advantage of dispersed settlement within Cheek Bend was greater during the Middle Archaic than during the Late Archaic. The number of potential resource acquisition points in Cannon Bend would not have been affected by the mid-Holocene climatic interval, and as a result no difference in settlement between the Middle and Late Archaic settlement in this bend is implied.

A variety of statistical methods are available for the investigation of distributions. The non-site data will be investigated using variance/mean ratios, comparisons with the Poisson distribution, goodness-of-fit tests of Poisson probabilities, and an index of dispersion will be used to examine the randomness of the overall distributions. Polynomial trend surface analysis will also be used to explore the shape of the surface material from the two bends (Chapters VI, VII, and VIII). The dispersion or aggregation of sites (Chapter VI) will be investigated using the nearest neighbor point pattern analysis method .

Geographic Gravitational Model

Optimization theory may also be used to generate expectations regarding the selection of specific locations used by prehistoric

populations. The economizing assumption indicates that settlements will be located in situations that minimize the effort required to render them suitable for habitation. While other variables may be considered in the proposed study, it is minimally implied that situations providing southern exposure and level terrain (minimizing the effort required to make a location comfortable), as well as ready access to water (minimizing the effort required to acquire this necessary resource), would have been preferred for settlement.

The implications regarding specific site locations fall into two categories. For continuous variables it is expected that specific states of these variables are most desirable, and that as this specified state is approached energy conservation is facilitated (i.e. south facing exposure and level terrain). Archaeological sites are therefore expected to be located in situations that are closer to these desirable variable states than random locations. In the case of discrete variables (present or absent, such as water and other resources), settlements will be located closer to the resource than random locations, minimizing the energy expended in acquisition.

Two statistical methods will be used to assess the power of the presumed desirable states of these "common sense" variables to attract prehistoric human settlement. Trend surface analysis will be used to identify directional tendencies in the data. In addition, the Kolmogorov-Smirnov statistic will be used to compare the actual measures calculated for identified sites on each of these variables to those measured for random locations.

CHAPTER IV

THE CHEEK AND CANNON BEND SURFACE SURVEY

Research Setting

By the late fall of 1980 the Cheek and Cannon Bend survey had become the cornerstone of the Columbia Archaeological Project research efforts to investigate hunter-gatherer adaptations in a spatially and temporally variable environment. It will be recalled that Cannon Bend was selected for its affinities to the outer Basin, while Cheek Bend represented typical inner Basin environmental conditions. The research method settled on by fall of 1980 called for a total surface survey of both bends. The patterns of land use revealed were to be used as models from which hypothetical expectations could be derived that would be tested through the total surface survey of two additional river bends that had been selected as representative of the contrasting environmental settings (Vaughn Bend for outer Basin, and Sowell Bend for inner Basin). To the extent that expectations were met, it would have been concluded that an understanding of prehistoric hunter-gatherer land use had been achieved. Deviations from predictions would have been used to refine the models.

When funding for the Columbia Archaeological Project was suspended the work on this research undertaking was unfinished. While nearly all tillable land in Cheek and Cannon bends had been surveyed, the analysis of the data was incomplete. Survey in Vaughn and Sowell bends had not begun in ernest.

Conduct of the Survey

The failure to complete the research program notwithstanding, the Cheek and Cannon Bend survey remains a remarkable data set collected at great effort and expense. Approximately 118 hectares in

Cannon Bend and approximately 139 hectares in Cheek Bend were surveyed. Fifty-two sites in Cannon Bend and 49 sites in Cheek Bend were identified (surface sites), and in excess of 82,000 artifacts were collected (Tables 4.1 and 4.2).

When the research strategy was formalized in late 1980 a non-site total surface area gridded collection was selected as the appropriate technique. Ideally a single grid of 20 meter units was established across the entire bend. Each unit was subsequently quartered and all material was collected and referenced to the resulting 10 meter square quadrats (Hofman 1981; Turner and Klippel 1989). Collections were conducted only after cultivation, or a standardized regime of bushhogging, plowing and discing designed to replicate local cultivation practices, and a minimum of 6.35 cm of rain had fallen on prepared surfaces. All units received intensive scrutiny regardless of their proximity to identified or recognizable archaeological sites; that is, "non-site" areas with little or no surface material were afforded the same treatment as site areas. All artifactual material greater than .64 cm was collected. Forms were completed for each unit collected and contain such information as ground cover and condition, surface visibility, weather conditions, number of surveyors, and the number of passes made by the surveyors across the unit.

Deviations from this ideal occurred even after field methods were formalized in 1980. In areas of extremely low surface material density, individual artifacts were "piece-plotted" using a plane table and alidade, or surveyor's transit, and tape measure. The survey of these two river bends, however, was begun in the spring of 1978, and the most significant departures from the single all-encompassing grid collection occurred before 1980.

Table 4.1. Cannon Bend surface survey summary.

Area	Collection Type	# of Units	Grid Area[1]	Total Area[2]	Sites	# of Artifacts
Uplands	5 m Continuous Quadrats	702	17550	17550	1	3105
	10 m Continuous Quadrats	563	56300	56300	2	1907
	Subtotal	1265	73850	73850	3	5012
Bottoms	10 m Continuous Quadrats	1787	178700	178700	6	6604
	25 m Continuous Quadrats	347	216875	517583	20	8810
	Piece Plot			91494	5	60
	Site Specific Collection			323158	20	4850
	Subtotal	2134	395575	1110935	50	20324
Total		3399	469425	1184785	54[3]	25336

[1] Grid Area represents the total area involved in gridded collections, reported in square meters.

[2] Total Area represents the total area considered by the collection strategy, reported in square meters.

[3] 52 sites were defined during surface survey in Cannon Bend; some sites were involved in more than one collection strategy.

Table 4.2. Cheek Bend surface survey summary.

Collection Type	# of Units	Grid Area[1]	Total Area[2]	Sites	# of Artifacts
10 m Continuous Quadrats	4744	474400	474400	17	48298
20 m Continuous Quadrats	305	122000	122000	7	4434
Piece Plot			448416	6	381
Site Specific Collection			341782	20	8483
Total	5049	596400	1386598	50[3]	61596

[1] Grid Area represents the total area involved in gridded collections, reported in square meters.

[2] Total Area represents the total area considered by the collection strategy, reported in square meters.

[3] 49 sites were defined during surface survey in Cheek Bend; some sites were involved in more than one collection strategy.

Spring and Summer 1978

Beginning in May and continuing through August of 1978 William B. Turner conducted a surface survey of cultivated fields within the reservoir area for which he was able to obtain permission of the landowner. The areas covered were not limited to Cheek and Cannon bends, yet much of Cannon Bend north of Sowell Mill Pike (Figure 4.1) and the eastern fields of Cheek Bend (Figure 4.2) were involved. The focus of this effort was to identify and record archaeological sites. A visual reconnaissance of the fields was made by Turner with the aid of one or many individuals. When archaeological material was observed it was collected, its location was noted on large scale project maps, and a site form was completed. Turner visited and recorded 24 sites in Cannon Bend, and 41 sites in Cheek Bend.

For especially large and dense artifact scatters Turner established grids of 50 meter units, usually oriented to a field edge or fenceline. These grids were site unique and coincided with the extent of the visible material distribution. Three such grids were established in Cannon Bend. Site 40MU271 (sites are discussed again at length, and figured, in Chapter 6) was collected in six units (1x6, ~N45°E), site 40MU314 was collected in 11 units (6x2, ~N130°E), and site 40MU316 was collected in seven units (4x2, ~N135°E). In Cheek Bend eight sites were collected in 50 m grids: 40MU150 (five units, 2x3, N90°E), 40MU288 (five units, 1x5, N18°E), 40MU295 (3 units, 1x3, N270°E), 40MU298 (2 units, 1x2, N0°E), 40MU302 (nineteen units, 5x5, N0°E), 40MU306 (eleven units, 4x4, N0°E), 40MU307 (five units, 1x5, N30°E), 40MU310a (nine units, 3x4, N0°E).

It should be noted that Turner surveyed areas of Cheek and Cannon bends other than those portions noted above (and figured on the accompanying maps). Included were some of the western fields in Cheek Bend and one field adjacent to the Duck River south of Sowell Mill Pike in Cannon Bend. These fields were also surveyed at a later time,

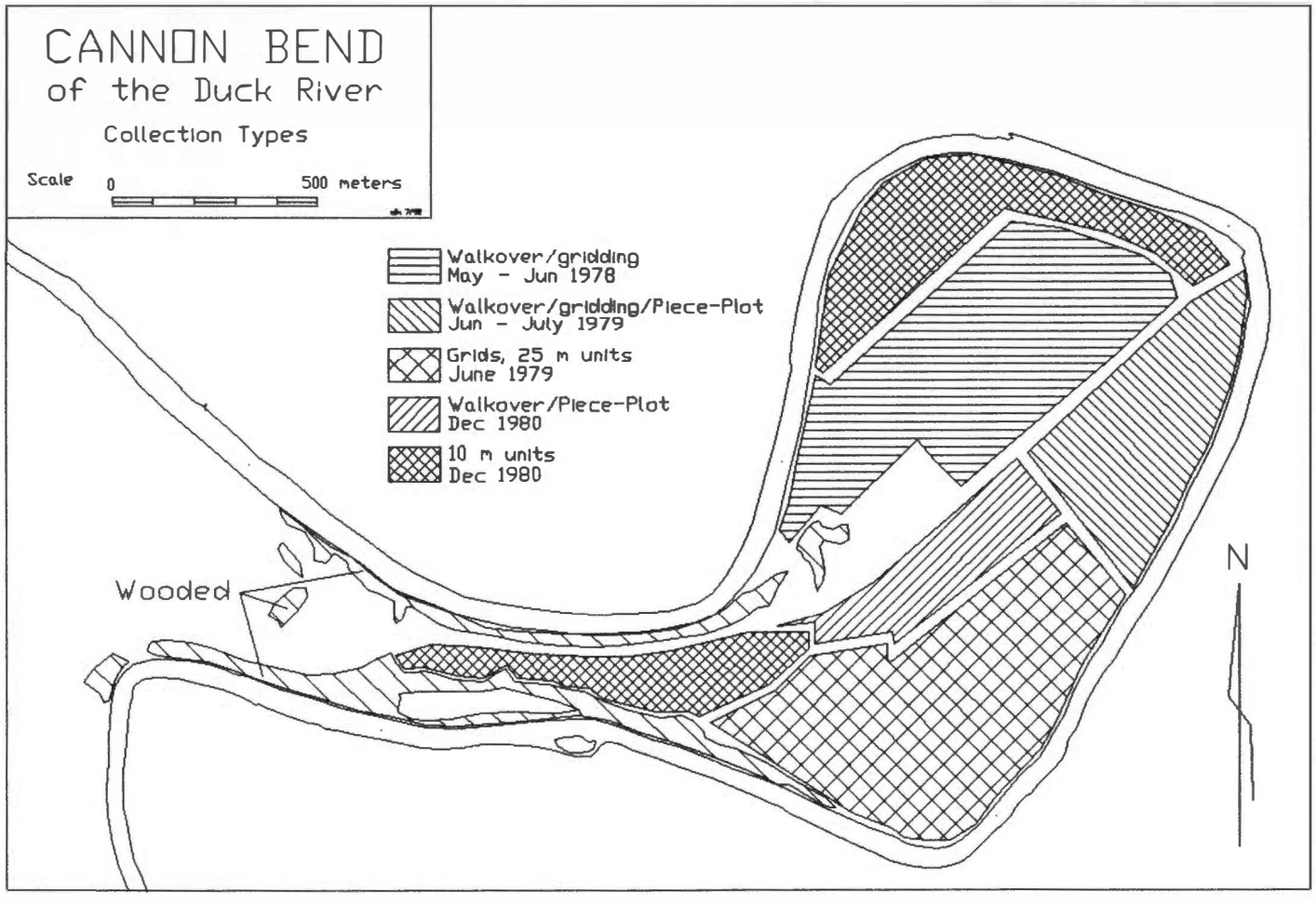


Figure 4.1. Collection strategies employed in Cannon Bend.

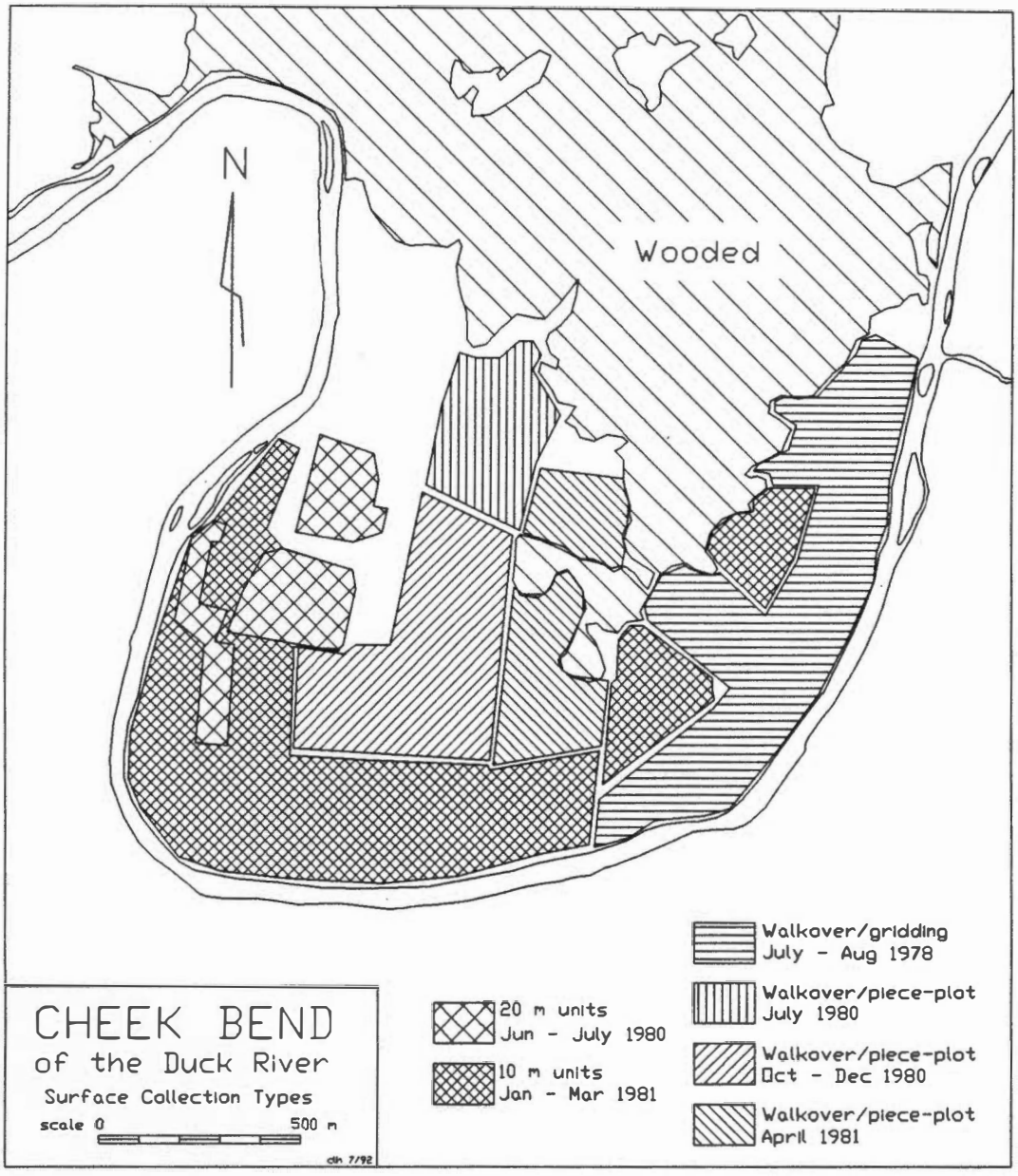


Figure 4.2. Collection strategies employed in Cheek Bend.

and generally received more systematic coverage in the subsequent efforts. For this reason they are considered along with the areas discussed below.

Summer 1979

During June and July of 1979 crews of three to five individuals under the direction of John Mahaffy undertook to survey those fields of Cannon Bend south of Sowell Mill Pike (Figure 4.1). Other areas were surveyed by Mahaffy, but no work was conducted in Cheek Bend. The field strategy was oriented toward the identification and collection of archaeological sites, and 20 sites were recorded.

Collection strategies were initially site unique. Three of the first four sites identified were piece-plotted using a Brunton hand transit and a tape measure (40MU370, 40MU372, 40MU373). The second site identified (40MU371) was gridded and collected in 25 meter square units. This gridded collection strategy was used for all of the 16 sites subsequently identified.

Initially the grids were site unique: 40MU371 (173 units, N30°E), 40MU374 (30 units, N0°E), 40MU375 (two units, N30°E), 40MU376 (one unit, N30°E). As many of the sites identified were small and located in close proximity to one another, Mahaffy began extending grids to incorporate several sites. Sites 40MU377, 40MU378, and 40MU379 were collected on a single grid of eight units oriented N0°E. Another grid of 24 units oriented N0°E covered sites 40MU381, 40MU382, 40MU383, and 40MU384. A third grid of 36 units oriented N0°E encompassed sites 40MU385, 40MU386, 40MU387, 40MU388, and 40MU389. Site 40MU380 was isolated, and was collected with a unique grid of 28 units oriented N30°E.

Summer 1980

During June and July of 1980 crews under the direction of Jack Hofman, William Turner, and Robert Entorf gridded and collected several sites in the western portion of Cheek Bend (Figure 4.2). Beginning with two sites identified by Dickson and bounding Cheek Cemetery (40MU143 and 40MU144), a grid of 20 meter square units was established oriented N11°E. This grid was continued to the south for the collection of the northern portion of site 40MU141.

It should be noted that these collections were site oriented: areas between sites were not collected. However, two important shifts in strategy were apparent by the end of the summer of 1980. Where Mahaffy's use of single grids for the collection of several sites had been opportunistic, the use of a single all-encompassing grid in Cheek Bend beginning in 1980 was by design. Secondly, while collecting 40MU141, an extremely dense scatter of surface material in the southwest corner of Cheek Bend, the 20 m units were for the first time subdivided into 10 m quadrats using a rope form.

In July of 1980, Hofman undertook the collection of two sites in a field to the north and east of Cheek Cemetery (40MU393 and 40MU394). The material density in this field was so light that artifacts were piece-plotted (Figure 4.2) rather than collected on the uniform grid established earlier in the summer.

Fall 1980

Between October and December 1980 Audrey Grubb led crews in the collection of three fields in Cheek Bend. The density of artifactual material in these centrally located fields was so light that a piece-plotting strategy was employed (Figure 4.2).

December 1980

During the fall of 1980 the full-fledged non-site strategy evolved from the methodological advances of the summer. Uniform grids of 10 m units were to be established over the unsurveyed areas of both bends, and the areas between sites were to be given the same attention as site areas (Figures 4.1 and 4.2). The task of implementing this strategy fell to Audrey Grubb and Will Hines.

In December of 1980, Grubb gridded and collected two distinct areas in Cannon Bend (Figure 4.1). The upland "neck" of the bend contained sites 40MU409 and 40MU414. These sites were collected on a single grid oriented N0°E. In the most dense portions of 40MU409, five meter square units were employed. Occasionally the original 20 m units were not subdivided in areas characterized by a sparse material distribution (i.e. between the two sites and on the site perimeters). The second grid established and collected by Grubb was in the northern most fields of Cannon Bend adjacent to the Duck River. The 10 m unit standard was strictly adhered to throughout this grid, oriented N45°E.

Several fields to the east of 40MU409 and south of Sowell Mill Pike were surveyed by Grubb in December of 1980 as well. Two discrete sites were observed (40MU410 and 40MU411). The material from these sites was piece-plotted due to the light density of the material within them, and the total lack of material between them.

Spring 1981

From January through March of 1981 survey efforts focused on Cheek Bend. Beginning in the fields in the western portion of the bend adjacent to the Duck River and working east, the grid first established for sites 40MU143 and 40MU144 in the summer of 1980 was extended and collected in 10 m units (Figure 4.2).

Five fields were piece-plotted in Cheek Bend during the spring of 1981 due to the sparse nature of the material distribution. Two of

these fields (off the figured area to the north) were collected by Will Hines in January, while in April Kay Moneyhun and Mary Ellen Fogarty collected the remaining three fields in the central portion of Cheek Bend (Figure 4.2).

Potential Biases

Whenever surficial artifact distributions are used to characterize past landuse the question of representation must be considered; to what extent does the sample of materials observed on the surface reflect the actual distribution of artifacts across the space examined? There are actually two components to this concern; visibility and location.

The question of visibility is one of mechanism: why or how are artifacts visible on the ground surface, and is the explanatory mechanism adequate to the task of sampling the artifact universe? In the project area intensive agriculture has resulted in the mechanical transport of artifacts to the surface. The question of adequacy is more difficult to address. In many ways the plowing of Cannon and Cheek bends may be argued to have created ideal survey conditions; the vast majority of the area of both bends was cultivated, cultivation practices were standardized to a great extent between and across bends, and artifact collection was conducted only under optimal conditions (after recent plowing and discing, and after substantial rains). In alluvial settings, however, it is likely that overbank alluvial deposition would have buried old surfaces. If these surfaces are out of the reach of the plow, then the mechanism is clearly inadequate.

Brakenridge (1982, 1984) did considerable backhoe and bulldozer trenching of the alluvial terraces in the project area in order to investigate the lithostratigraphy of this section of the Duck River. Radiocarbon dating was used to establish chronostratigraphy. Three

terraces were identified. From earliest to most recent these are: T2, Pleistocene in age (30,000 - 12,000 B.P); T1, Holocene in age (12,000 - 130 B.P.); T0, ultra modern (Brakenridge 1982). As the Duck is a laterally incised river, most of the aggredation of terraces has been horizontal; successively more ancient terraces are increasingly distant from the river. The most recent (T0) terrace, however, "veneers the tread and scarp of T1, so that vertical and lateral aggredation of the T1 surface as well as T0 is still in progress" (Brakenridge 1982:28). If this veneer is thick enough (e.g. greater than the depth of the plow) then there is reason to believe that the mechanism of artifact transport was inadequate.

While there can be little doubt that the ultramodern T0 veneer did prevent the exposure or visibility of artifactual assemblages, three lines of argument are offered to allay the concerns. First, while the T0 was observed to be quite massive in places (ca. 6 m in thickness, Brakenridge 1982:28), the majority of the formation, including the most massive portions, are exceedingly localized at the leading edge of the terraces (directly adjacent to the river). Furthermore, in these locations the T0 does not overlie earlier terrace surfaces. The T0 veneer is not excessive. Brakenridge does not present average measures for the veneer thickness; his illustrations, however, indicate that the veneer was quite thin (Brakenridge 1982:54). Secondly, the T0 veneer was not extensive. Again, while no statistics are presented, an illustration of the areal extent of the T0 indicates a minimal portion of the river bend surface was involved. According to Turner and Klippel (1989:62) the T0 occupied 17% of the surface area in Cheek Bend and 18% of Cannon Bend surface area. It should be noted that they used the Soil Conservation Service's mapped soil units to arrive at these figures, and that the veneer would have been included. As this veneer was most probably of less thickness than the plow zone, it would have had no meaningful

impact of artifact recovery. Finally, the recovery of artifacts and the identification of sites in areas defined as T0 terrace indicates that visibility was obtained, at least occasionally.

The conclusion offered here is that the T0 terrace formation did not significantly bias the information regarding artifact distribution in the project area. This conclusion might appear to directly contradict Turner and Klippel's (1989:63) statement that "the T1 was utilized much more extensively than surface collections indicate" yet essential agreement is indicated; the utilization of the T1 may be under represented without biases being introduced; sites were obscured by the T0 veneer, it is argued here that these hidden sites were relatively uncommon, and that their exclusion from the present study does not constitute a bias.

The question of location is one of material dispersion by the mechanism exposing it. The value of agricultural practices to survey archaeology is well known to anyone working in intensely crop farmed environments: plowing effectively removes obscuring surface vegetation and mechanically brings artifacts to the surface. The result is that survey in plowed fields is an enormously successful technique for the discovery of archaeological materials. Partially as a result of this fact, the reconnaissance of plowed surfaces became an early staple of archaeological investigations, even before the clear conception of settlement archaeology as an interesting avenue of inquiry (e.g. Phillips et al. 1951; see also Dunnell 1985). So powerful is the attraction of plowed surfaces to the archaeologist, that surface preparation mimicking agricultural practices has become a common element of the field archaeologist's repertoire (e.g. Davis 1986; Jermann 1981; Turner and Klippel 1989). The problem, however, lies in a lingering concern that, while transporting artifacts to the surface, the plow may also have severely distorted their spatial arrangement.

Numerous researchers have investigated the question of plow displacement of artifacts in both experimental (Lewarch and O'Brien 1981; Odell and Cowan 1987), and in archaeological context (Roper 1976), and all agree that lateral displacement is less than feared. In Odell and Cowan's (1987:481) experiment artifacts were found to move an average of 1.6 m after 14 passes of the plow. Clearly, movement of this magnitude is not relevant to the study of regional settlement patterns. Of possibly greater concern, however, was their finding that the size of their "site" effectively doubled during the experiment.

It is suggested here that plowing could present a significant problem at the intrasite level, but not when the focus is the distribution of sites across a landscape; the movement of materials by the plow is not significant at a regional level.

The Turner and Klippel Analysis

In the only analysis of the Cannon and Cheek Bend collections undertaken to date, Turner and Klippel (1989) compared the distribution of artifacts across terraces between bends. Part of their investigation involved the distribution of temporal artifacts, so diachronic trends were also investigated. Their conclusions may be summarized as follows; the intensity of prehistoric utilization of Cannon and Cheek bends increased throughout the Archaic, but was most intense in Cheek Bend, and artifact density decreases with increasing distance from the Duck River. The present study will substantially expand and elaborate on these conclusions, and, by examining different aspects of the data, offer new ones.

CHAPTER V

ANALYTIC UNITS 1: PROJECTILE POINT TYPES

Projectile points represent the only time sensitive class of artifacts available for the Archaic periods in the study area. As such they are critical to the argument that the surface materials recovered in Cheek and Cannon bends are representative of Archaic utilization of these areas. They will also be essential to the identification of temporal patterns of intrabend utilization. Consequently the identification of projectile point types is an essential part of the successful analysis and interpretation of the surface collected material from Cheek and Cannon bends.

The analysis of surface material from Cheek and Cannon bends conducted in the early 1980s included the identification of projectile point types present. A number of problems plagued this analysis. Most important of these was an extreme unwillingness on the part of the analysts to accept any great degree of morphological variation within classes, leading to the creation/recognition of a vast number of types (27 named types). While in theory this is not an objectional practice, as classes may later be combined in any manner deemed appropriate, the subsequent loss of the students' coding format has rendered the meaning of the classes questionable (12 undecipherable codes). An additional problem with this analysis was the weight placed on blade attributes, especially beveling, asymmetry, and seriation, in the recognition of classes.

When Turner and Klippel (1989) required summary data regarding projectile point types represented within the surface assemblages from Cheek and Cannon bends, they chose to work with the raw material rather than rely on the data already available from the students' analysis. The abilities of these researchers aside, their analysis has two serious limitations. First, they chose to consider only

Paleoindian and Archaic material. Secondly, they present only summary information (counts by broad subperiod by terrace). As a result of these problems, and because a typological analysis is essential for this study, the projectile points recovered from the surface of Cheek and Cannon bends are reanalyzed here.

An additional benefit of this reanalysis may be the refinement of type definitions for the study area. In spite of the obligatory detailed description of recovered projectile points in both professional and amateur reports, including the compulsory recording of metric attributes, identifying Midsouth projectile point types remains a subjective endeavor in which reliability is positively correlated with analyst experience. At the same time that this is deplorable, it also renders the results of any, including the above mentioned analyses, suspect. A secondary aim of the analysis described below is to find statistical definitions of relevant types based on objective quantitative attributes, and apply these definitions to the recovered artifacts. It is hoped that clarity and reliability in this essential analysis will lend support to the larger investigation, and add to the strength of the conclusions.

Method

The Meaning of Projectile Point Types

The classification of projectile points has long been an obsession of Southeastern prehistoric archaeologists. The energy invested in the discovery and definition of types has been in direct proportion to the utility of projectile points to accurately reflect time: projectile point form changed through time. Following the initial success of research demonstrating the relationship between certain projectile point types and distinct temporal periods (e.g. Coe 1964; Kneberg 1956; Lewis 1955; Lewis and Lewis 1961; Ritchie 1961) there was a flurry of activity directed toward the "fine tuning"

of projectile point chronology that led to a proliferation of defined types (Cambron and Hulse 1975; DeJarnette et al. 1962; Futato 1977; Thorne et al. 1981). In general there have been two kinds of reaction to these "type-heavy" classifications: recombination and rejection.

Recombination was initially pursued as a means of more accurately reflecting chronological reality. Faulkner and McCollough (1973), for example, lumped numerous types into broadly defined "clusters" as an acknowledgement of the state of archaeological knowledge. Sykes and White Springs types were combined into a single cluster as they were quite similar morphologically and there was no solid evidence for their temporal separation. Eva and Morrow Mountain types were similarly combined. More recently investigators have argued for the combinations of these and other types based on an expanding understanding of the effects of lithic tool maintenance (Hoffman 1985; Hofman 1984a).

Another reaction to the enthusiastic definition of types was wholesale rejection. It has been argued that many defined types have no temporal meaning (Chapman 1981; Hoffman 1985). It has also been argued that traditional projectile point types fail to reflect cultural classifications (Read 1989) and should therefore be abandoned.

It is argued here that to reject or ignore the value of projectile points as temporal indicators because certain defined types lack chronological significance, or may not reflect cultural, ethnic, or cognitive distinctions made by the makers, is to confuse very different yet equally important avenues of inquiry. There may be many reasons why projectile form varies; what is certain is that some forms occur only during specified intervals of the prehistoric continuum. The definition of Middle and Late Archaic projectile point types has a long and well documented history in the Midsouth. To paraphrase Thomas (1972: 32), archaeologists have not for the past

four decades been wasting their time in exploring the basic nature of projectile point typology. It would be folly to disregard the wealth of information accumulated in the search for "historical-index types" (Steward 1954: 55). This analysis begins with broadly defined types that have demonstrated temporal significance, and explores the possibility of a statistical automatic classification into these types of the recovered artifacts.

Automatic Classification

Numerous investigators have attempted to create statistical devices that will automatically classify projectile points to traditional types (Ahler 1970; Benfer 1967; Gunn and Prewitt 1975; Johnson 1981; Lucterhand 1970). The attractiveness of automatic classification may be seen in the removal of investigator bias, and in its objectivity.

Each investigator involved in an artifact classification brings to the analysis a unique combination of experiences, abilities, and assumptions. As a result it is unlikely that any two investigators would classify a given assemblage in precisely the same manner. If a statistical definition of the types under study could be formulated, these biases would be removed, rendering the classification replicable and the types more empirically valid.

What appears as a subjective element in artifact classification results from an inability on the part of investigators to specify the essential differences between types; a given specimen may be an example of a certain type for reasons the classifier cannot articulate. In many cases, the analyst may not actually be aware of the variables or attributes that are significantly influencing the classification. In order to employ a statistical classification the variables of presumed importance must be specified. The technique will either identify the truly significant variables, or will

demonstrate that the selected variables are not sufficient to differentiate among or discover classes. Explicit definition of types through attribute specification enhances the empirical validity of the types under study.

Discriminant Analysis

While various statistical techniques lend themselves to the definition of types and classification of artifacts, this analysis will employ a discriminant analysis (Klecka 1980). This multivariate technique is appropriate for two basic reasons. First, it is not a class discovery technique, but a means of exploring the differences between known classes. As a useful typology of Midsouth Archaic projectile point types has previously been defined, it is only reasonable to begin with these types. Secondly, discriminant analysis can be used to classify unknowns. The effect of this is a fully operationalized typology, wholly lacking in the subjective element so typical in archaeological classification that Thomas (1972) has termed "feel."

There are five steps in this discriminant analysis: identify the classes; select type specimens; identify the variables; perform and interpret the analysis; classify unknowns.

The Classes

Over the course of the past several decades of archaeological investigation in the Midsouth, numerous projectile point types have been defined as characteristic of the Middle and Late Archaic periods (Cambron and Hulse 1975; DeJarnette et al. 1962; Faulkner and McCollough 1973; Futatto 1977; Griffin 1974; Johnson 1981; Thorne et al. 1981). Attempts by researchers working in the Middle Duck River Valley over the past two decades have resulted in the identification of four projectile point types, or type clusters, that are characteristic of the Middle and Late Archaic periods. From

earliest to most recent these are Eva - Morrow Mountain, White Springs - Sykes, Benton, and Ledbetter (Faulkner and McCollough 1973; Fogarty et al. 1985; Hall et al. 1985). A fifth type is added to the analysis presented here: the Claymine type. Representative examples of each type are illustrated in Figure 5.1.

Claymine. The Claymine type, as defined here, was first recognized in the Columbia project area at 40MU347, a multicomponent buried Archaic site discovered during systematic deep site testing utilizing a backhoe in the Cheek Bend area (Amick 1983, 1984). Due to the extremely clayey nature of the sediment matrix, this site was known as the Claymine, hence the name used here for the projectile point form that dominated the recovered biface assemblage from the upper component. This biface form is characterized by a broad symmetrical blade, straight to slightly barbed shoulders, and an expanding stem. Similar projectile point forms have been recognized frequently throughout the Southeast, and are commonly considered within the range of variation for the Ledbetter cluster (Faulkner and McCollough 1973). A previously defined type resembling the Claymine is the Anderson type (Morse 1967), yet the form has rarely been found in a context that suggested its temporal independence. Carbon dating of the discrete and well defined cultural strata at the Claymine site placed the type at 3215 $\pm$ 125 years BP (Amick 1983).

The type was also recovered in relatively large numbers from a post-Ledbetter Late Archaic context at Tom's Rockshelter (40MU430: Hall 1985). Six examples of the type were recovered from a very limited stratigraphic position that was carbon dated to 3205 $\pm$ 150 BP (Hall 1985). The similarity of the specimens from the Claymine and Tom's Rockshelter sites led to the suggestion that the type was emerging as a horizon marker, and it was invoked as part of an explanation for the clustering Archaic period carbon dates in the

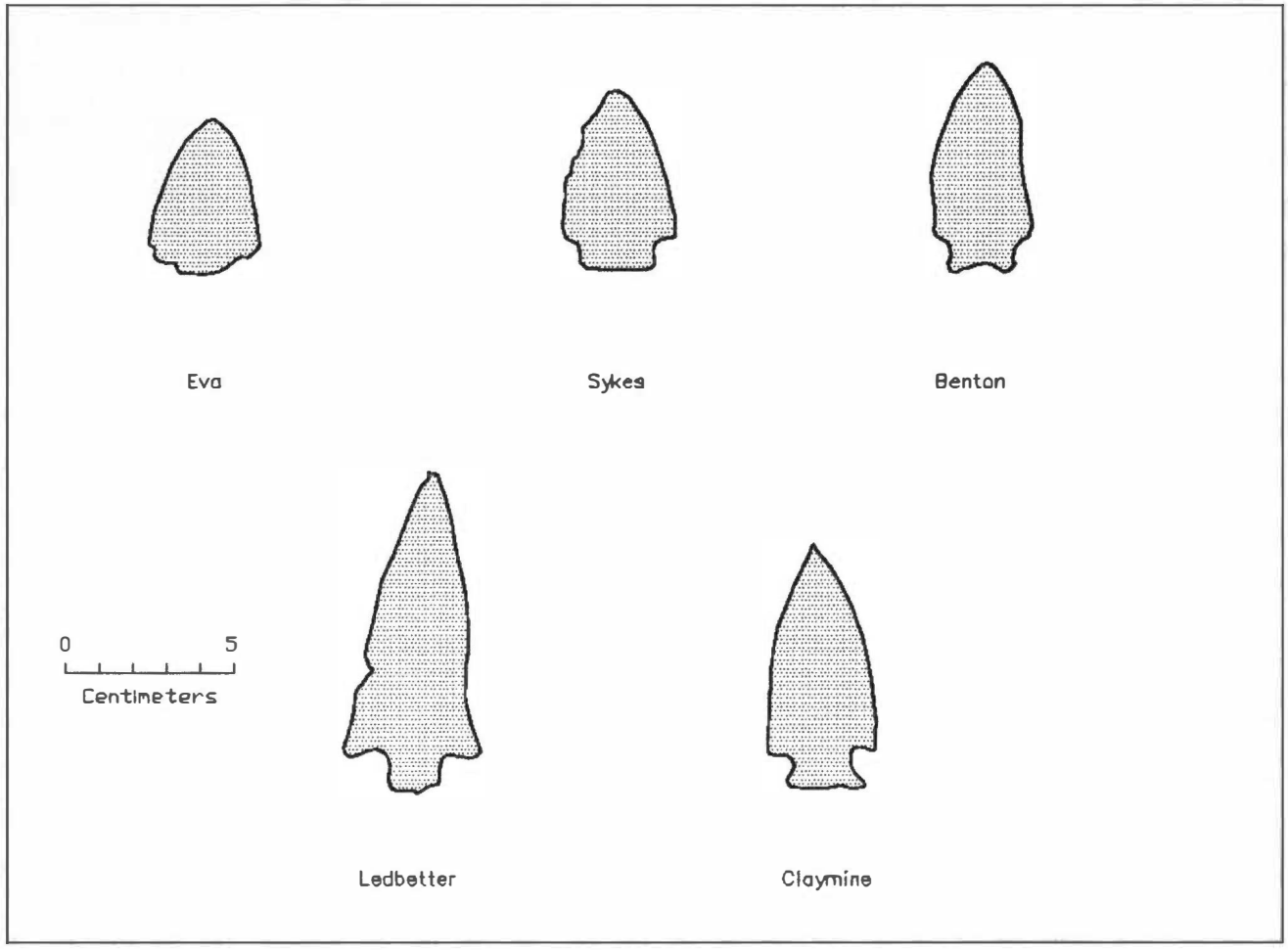


Figure 5.1. Projectile point types used in the analysis.

project area (Hall et al. 1985). This analysis established the type as a temporal marker, later in time and distinct from the Ledbetter type.

Ledbetter. The Ledbetter type was first defined by Kneberg (1956). In its initial formulation the distinguishing attribute of this large, stemmed point type was the asymmetry of the blade and shoulders: "The distinctive feature of the blade is its asymmetry. The side edges are usually recurvate, but the recurvature is reversed on the two side edges" (Kneberg 1956:26). The stem "is usually straight or tapered with a straight basal edge, but it may be tapered with an excurvate basal edge" (Kneberg 1956:26). In practice, a wide variety of stem forms, from expanding through contracting and rounded, was accommodated within the range of variation for the type (Lewis and Kneberg 1959:165: Figure 1,e). The stem shape has come to occupy a more central place in the type definition recently, as the effects of tool maintenance on blade shape has been more fully appreciated (Faulkner and McCollough 1973; Hoffman 1985; Thorne et al. 1981:214).

The Ledbetter type is here used in its' broadest, most encompassing formulation (Hoffman 1985). A vast number of previously defined types are subsumed within the Ledbetter type. Included are Pickwick, Mulberry Creek, Little Bear Creek, Cotaco Creek, and Flint Creek types (Cambron and Hulse 1975). All of these types are considered to be potential outcomes of a use and maintenance trajectory that begins with a common Ledbetter form (Hoffman 1985). All are characterized by a straight to slightly tapering or expanding stem.

A series of five carbon dates from Columbia project Ledbetter contexts fall between 4130 $\pm$ 130 B.P. and 4655 $\pm$ 185 B.P. (Hall et al.

1985). Kneberg's (1956) original suggestion of 2000 B.C. for the type fits comfortably within the Columbia range.

Benton. The Benton Stemmed point type was defined by Kneberg (1956) as a medium to large stemmed Archaic point. The distinguishing attribute of the type was the steeply beveled edges of the broad and short stem (Lewis and Lewis 1961: 34). Cambron and Hulse (1975: 13) note that "the steeply beveled basal edge may be straight or incurvate," and illustrated examples exhibit considerable morphological variability (e.g. Faulkner and McCollough 1973: 257; Thorne et al. 1981: 232). Several sub-types of the Benton have been defined, including the Benton Broad Stemmed (Cambron and Hulse 1975: 12), and the Benton Stemmed Variant (Thorne et al. 1981: 234).

The temporal position of the Benton type has been firmly demonstrated in the Columbia project area with three carbon dates to 5115 ± 185 B.P., 5245 ± 230 B.P., and 5765 ± 200 B.P. (Hall et al. 1985). Six additional carbon dates are available from the Columbia project area on contexts where Benton points were recovered in association with Ledbetter points (2 dates) and with points of the White Springs - Sykes cluster (3 dates). Including these contexts, the Benton type may be dated to between 6160 ± 175 B.P. and 4130 ± 130 B.P. (Hall et al. 1985: Figure 4.3).

White Springs - Sykes. These two types, the White Springs (DeJarnette et al. 1962) and the Sykes (Lewis and Lewis 1961), are so similar morphologically that Faulkner and McCollough (1973) combined them into a single cluster. Cambron and Hulse note that many of the Sykes examples recovered by Lewis and Lewis (1961) at the Eva site "fit into the White Springs type" (Cambron and Hulse 1975:128). The types are characterized by haft modification referred to as "corner removal" (Faulkner and McCollough 1973: 152; Lewis and Lewis 1961:

40) that results in a wide and broad stem (Cambron and Hulse 1975: 128).

In the Columbia project area White Springs - Sykes projectile points were found in isolation from other projectile point types in only two datable contexts. At the Claymine site the lower component yielded a date of 6240 ± 500 B.P., while at the Hayes site a date of 5870 ± 165 B.P. was obtained (Hall et al. 1985). The type was dated three times in contexts that also produced Benton type points, and once in a context with Morrow Mountain type points (Hall et al. 1985). The co-occurrence of the White Springs - Sykes types with Benton (Lewis and Lewis 1961) and Morrow Mountain (DeJarnette et al. 1962) has long been recognized. The seven dates from the Columbia project area span a range from 5370 ± 190 B.P. to 6375 ± 215 B.P. (Hall et al. 1985). For convenience, this class will be referred to as "Sykes" (the first of the two types to be defined) throughout the following analysis.

Eva - Morrow Mountain. These two types were defined in widely disparate portions of the Southeast: the Morrow Mountain type by Coe (1964) in the Piedmont of North Carolina, and the Eva by Kneberg (1956) along the lower Tennessee River in western Tennessee. These two types have frequently been recovered from single contexts in the Midsouth (Faulkner and McCollough 1973; Hofman 1984a; Lewis and Lewis 1961). A consideration of lithic tool maintenance led Hofman (1984a) to suggest that the two types represented stages in the use-life of a single projectile point type, beginning with the Eva type and resulting in the Morrow Mountain type. It is recognized that this conception of the two types as occupying the extremes of a single continuum may be appropriate for middle and western Tennessee only. The end product of the Eva reduction may simply resemble the Morrow Mountain type known in eastern Tennessee and the Carolinas (Hofman

1984a: 170). For this reason, this class will be referred to as "Eva" in the following analysis.

In the Columbia project area six carbon dates for Eva contexts were obtained and range between 6540 ± 110 B.P. and 8885 ± 360 B.P. (Hall et al. 1985). A single date was also derived from a context that yielded both Eva and Sykes type points: 6375 ± 215 B.P. (Hall et al. 1985). The cluster analysis of these dates suggested that the earliest date may have been aberrant (Hall et al. 1985).

Selection of the Type Specimens

Two criteria were used to select the type specimens employed in the discriminant analysis: discovery context and morphological clarity.

It was initially hoped that all specimens used in the analysis would be selected from unambiguous excavation context. These contexts, it was hoped, would have stratigraphic clarity, be single component (e.g. yield only projectile points of the target cluster), and be securely dated. It was possible to meet these criteria for all but the Sykes class. In this case, an insufficient number of excavated specimens meeting the morphological criteria (see below) were available.

It was similarly hoped that the specimens used in the discriminant analysis could be morphologically unambiguous. The aim here was not to use isomorphic specimens, but that the points used would be clear examples of the target cluster.

In order to satisfy the requirement of the analysis that there be at least as many specimens per class as there are classes in the analysis (Tatsuoka 1977), at least six examples of each point cluster were selected for the analysis. The specimens selected were all from five sites investigated as part of the Columbia project. The contexts

from which the analytic specimens were chosen are discussed below by site.

Hayes site. The majority of the points involved in this analysis, 32 of 56 (Table 5.1), came from excavated context at the Hayes site (40ML139), a multi-component Middle and Late Archaic shell midden site located at the confluence of the Duck River and Caney Creek (Figure 5.2). During 1982 and 1983 two trenches were excavated at Hayes, one perpendicular to the river (the 920 trench) and one approximately parallel to it (the 1004 trench: Morey 1988). Both trenches were discontinuous, and the 920 trench was partially excavated by backhoe. The midden at the Hayes site was found to vary from approximately .5 m to over 2 m in depth. In the thickest portion of the midden, adjacent to the 920 trench, a three square meter "block" was excavated (Morey 1988) with considerable attention given to stratigraphic control and the recovery of subsistence remains. All of these investigations indicated that the Hayes site preserved a record of nearly 1500 years of prehistoric utilization of this mixed terrace habitat, from 5870 $\pm$ 165 B.P. to 4270 $\pm$ 155 B.P. (Hall et al. 1985). Three stratigraphically distinguishable components were recognized: Sykes, Benton, and Ledbetter (Morey 1988).

All of the Benton points (n = 11) used in the discriminant analysis were from excavated contexts at Hayes. They were recovered from lower Composite Stratum (CS) III, primarily III D or III E (Morey 1988). These contexts were characterized primarily by Benton projectile points, they include the majority of the shell bearing midden at Hayes, and were dated to between 5140 $\pm$ 185 B.P. and 5660 $\pm$ 190 B.P. (Klippel and Morey 1986; Morey 1988).

All of the Ledbetter points (n = 12) used in the discriminant analysis were from excavated contexts at Hayes. The selected specimens were recovered from upper CS III through CS I, and one was

Table 5.1. Projectile point specimens used in the discriminant analysis.

Type	Specimen	Site	Context
Benton	1	Hayes	Lower CS III A
	2	Hayes	Lower CS II
	3	Hayes	Lower CS III A
	4	Hayes	CS III D/E
	5	Hayes	Lower CS III D
	6	Hayes	Lower CS III D
	7	Hayes	CS III D
	8	Hayes	CS III D
	9	Hayes	CS III B
	10	Hayes	CS III D
Claymine	1	Hayes	CS I/II
	2	Hayes	CS II
	3	Hayes	CS II
	4	Hayes	Lower CS III A
	5	Tom's	Zone 3
	6	Tom's	Zone 3
	7	Tom's	Zone 3
	8	Tom's	Zone 3
Ledbetter	1	Hayes	CS III A
	2	Hayes	CS I
	3	Hayes	Upper CS III A
	4	Hayes	CS II/III A
	5	Hayes	CS II
	6	Hayes	PZ
	7	Hayes	CS II
	8	Hayes	CS I/II
	9	Hayes	CS II/III A
	10	Hayes	CS III A
	11	Hayes	CS III A
Eva	1	Cave Springs	Area B Unit 6
	2	Cave Springs	Area A Unit 5
	3	Cave Springs	Area A Unit 3
	4	Cave Springs	Area B Unit 5
	5	Cave Springs	Area B Unit 2
	6	Cave Springs	Area B Unit 5
	7	Cave Springs	Area B Unit 6
	8	Cave Springs	Area B Unit 2
	9	Cave Springs	Area B Unit 4
	10	Ervin	Feature 6
	11	Ervin	Feature 6
	12	Ervin	Feature 6
	13	Hayes	CS III C

Table 5.1 (cont.)

Type	Specimen	Site	Context
Sykes	1	Pilkington	Surface
	2	Pilkington	Surface
	3	Pilkington	Surface
	4	Pilkington	Surface
	5	Pilkington	Surface
	6	Pilkington	Surface
	7	Pilkington	Surface
	8	Pilkington	Surface
	9	Pilkington	Surface
	10	Hayes	CS IV
	11	Hayes	CS IV
	12	Hayes	CS IV
	13	Hayes	CS IV
	14	Hayes	CS III (?)

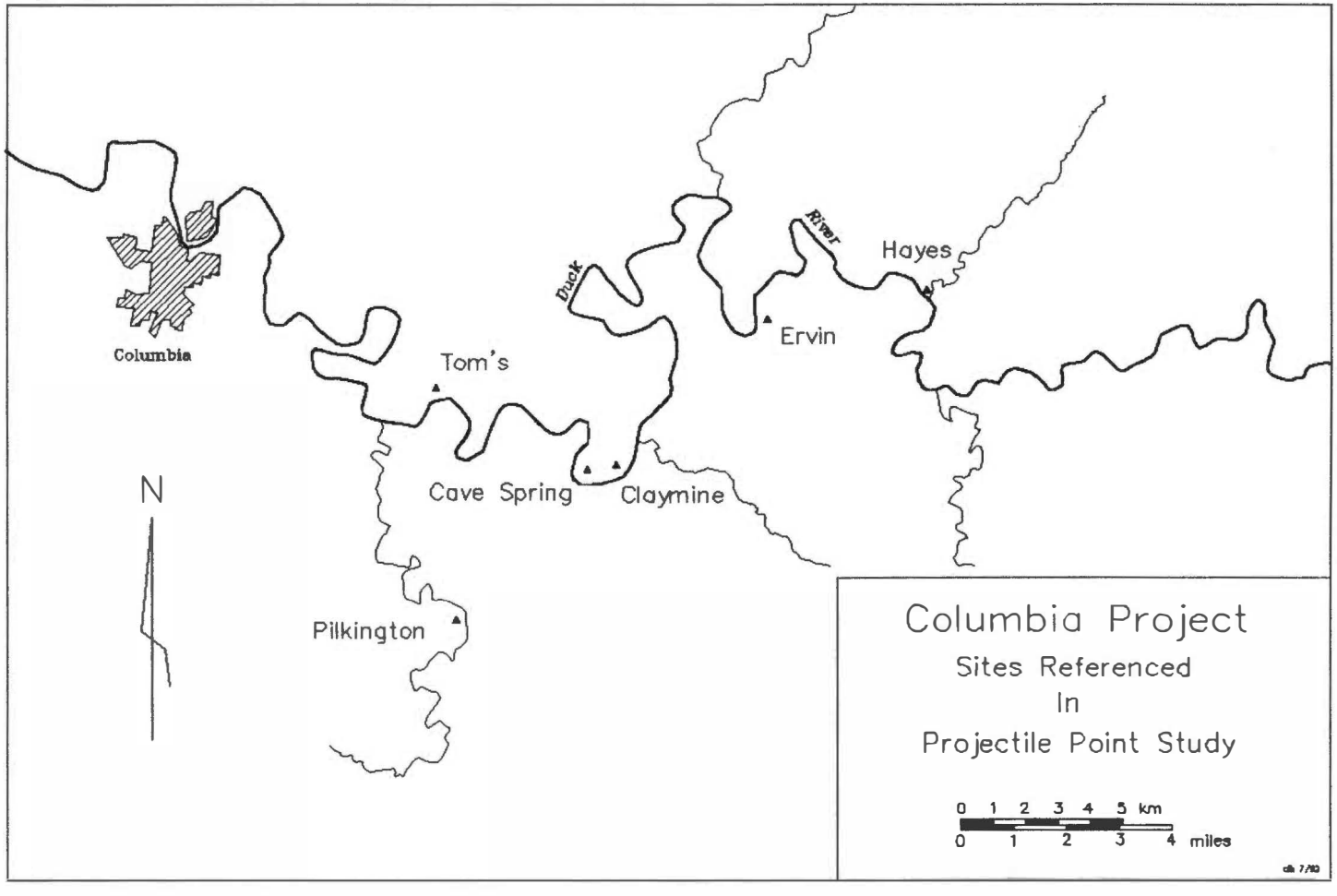


Figure 5.2. Columbia Project sites referenced in the projectile point study.

from the plowzone. These contexts were dated to between 4270 ± 155 B.P. (CS 2) and 5140 ± 185 B.P. (lower CS 3A) (Hall et al. 1985; Morey 1988; Morey and Klippel 1986). Ledbetter projectile points were most abundant in these contexts.

Three of the six Claymine points used in this analysis were excavated from CS II or CS I/II at the Hayes site. Primarily Ledbetter type projectile points were recovered from these contexts.

Of the fourteen Sykes points employed in this analysis, five were recovered from CS IV at the Hayes site near the midden apex. Dates on CSIV vary from 5430 ± 120 B.P. to 6205 ± 245 B.P. (Crites 1987; Morey 1988). Middle Archaic materials, including Sykes and Benton type projectile points, were recovered from this context.

Finally, of the thirteen Eva type points used in this analysis one was recovered from the Hayes site. Fixing the context of this point is difficult, but it was most probably recovered from the lowest portions of CS III or from CS IV.

Cave Spring. The Cave Spring site (40MU141) is located in Cheek Bend (Figure 5.2), and was first identified as an extensive and complex surface scatter of lithic material (Dickson 1976). Investigations in 1980 and 1981 revealed a buried component characterized by projectile points of the Eva cluster (Hofman 1984a). This component dated to between 7250 ± 350 B.P. and 6540 ± 110 B.P. (Hofman 1984a). Nine of the thirteen projectile points of this type were from excavated contexts at the Cave Spring site (Table 5.1).

Pilkington. This site is located on a Pleistocene terrace of Fountain Creek, the largest tributary of the Duck River in the Columbia Project Area (Figure 5.2). The Pilkington (40MU86) site was investigated in 1979 (Turner 1986) as part of a multi-site study aimed at examining the relationship between surface collected and shovel test recovered material. The site yielded a remarkably uniform

projectile point assemblage, with Sykes types overwhelmingly dominant (Turner, personal communication). Because of the rarity of excavated examples of this cluster, nine of the fourteen Sykes points used in this analysis were taken from the surface collected material from the Pilkington site.

Ervin. The Ervin site (40MU174) is a small Archaic shell midden site located on the Duck River (Figure 5.2). The site was surface collected in 1979 and test excavated between 1981 and 1983. The primary occupation of the Ervin site occurred during the Middle Archaic (Hofman 1984b); Eva, Sykes, and Benton components were identified. Four carbon dates from the Ervin site ranged from 5765 ± 200 B.P. to 6645 ± 180 B.P. (Hofman 1984b). Three of the Eva points used in this analysis were recovered from Feature 6, dated to 6645 ± 180 B.P. (Hofman 1984b).

Tom's Rockshelter. Tom's (40MU430) is a small rockshelter located on the Duck River (Figure 5.2) containing stratified deposits spanning more than 5000 years of human utilization (Hall 1985). While numerous projectile points of various types were recovered from the site, with few exceptions the compressed nature of the deposit prevented clear identification of distinct components. One such exception was represented by the recovery of six isomorphic specimens of the Claymine type in unambiguous stratigraphic association. A carbon date of 3205 + 150 B.P. was obtained from this strata (Hall 1985). Three of the Claymine points used in this analysis were taken from the Tom's assemblage (Table 5.1).

The Cannon and Cheek Bend Samples

Once derived, the discriminant analysis will be employed to classify the projectile points recovered from the surfaces of Cheek and Cannon Bend. Defining these assemblages is, in itself, an awesome

task. As has previously been noted, these artifacts have been analyzed two times prior to the current study (Table 5.2). The first analysis was conducted by students under the direction of Bill Turner and included 198 specimens from Cannon Bend and 301 specimens from Cheek Bend (499 total). Turner and Klippel's reanalysis involved only Paleoindian and Archaic material (127 specimens from Cannon Bend, and 385 specimens from Cheek Bend). Significant differences in study assemblages are immediately apparent between these two analyses. The most important difference between these two assemblages is in the omission of much of the Cave Springs site assemblage from the student analysis. During the current analysis 218 projectile points were inventoried from the Cave Springs site; while all of these were presumably available for Turner and Klippel's analysis, the student's analysis included only 25.

In the current reanalysis an attempt was made to inventory all recovered specimens. The following totals were recorded: 191 specimens from Cannon Bend, and 466 specimens from Cheek Bend. Two sub-sets were not available for study. All Paleoindian projectile points (n=16) had been culled from the general collections, and were not available for inspection. The 16 specimens from 40MU409 (Cannon Bend Uplands) had also been removed from the general collections. Minor differences were also encountered (usually no more than one artifact per site difference), and are most probably the result of differences of opinion regarding the minimum requirements for inclusion in the analysis. In all, six hundred and fifty-seven artifacts were included in this reanalysis.

After all recoverable projectile points (657) were photocopied (see Measurement Method, below), initial sorting indicated that 60 were complete, 458 were complete enough for analysis (see "Statement of Inclusion" for criteria), and 139 were too fragmentary for inclusion (Table 5.3). Impressionistic sorting to broad temporal

Table 5.2. Comparison of projectile point assemblages used in analyses.

	Number of Projectile Points Used	
	Cannon Bend	Cheek Bend
Student Analysis	198	301
Turner and Klippel	127	385
Current Analysis	191	466

Table 5.3. Projectile point period by condition, controlling for river bend.

Impressionistic Classes	Cannon Bend Condition[1] 1	2	3	4	sum	Cheek Bend Condition 1	2	3	4	sum	Total
Paleoindian		1			1					0	1
Early Archaic	2	9			11	2	21	6		29	40
Middle Archaic	1	10			11	11	95	21		127	138
Late Archaic	13	54	2		69	10	105	22		137	206
Transition					0		11			11	11
Early Woodland	4	29	5		38	1	17	1		19	57
Middle Woodland	3	28	1	1	33	4	41	5		50	83
Late Wood/Miss.	4	7			11	4	19			23	34
Unclassifed	1	3	3	10	17		8		62	70	87
Total					191					466	657

[1] Condition codes:

1 complete
2 complete enough to identify type, acceptable for analysis
3 complete enough to identify type, not acceptable for analysis
4 not complete enough to identify type, not acceptable for analysis

periods indicated that of the 518 specimens potentially included in the analysis, 1 was identifiable as Paleoindian, 34 were Early Archaic, 161 were Woodland/ Mississippian, and 12 could not be sorted in this manner. One hundred and seventeen were impressionistically identified as Middle Archaic, and 193 were classed as Late Archaic (Table 5.3).

Analysis

Statement of Inclusion

Specimens will be considered complete enough to be included in this analysis if they exhibit both a complete haft element and some portion of the proximal blade. It is essential that one of the shoulders be present and complete. The specimens selected as type specimens for the discriminant analysis, as described above, were chosen in part for their completeness. The inclusion criteria articulated here is more critical for the selection of specimens to be classified.

Lines of Reference

The following lines of reference are defined to aid in the definition of attributes (Figure 5.3).

Blade Baseline. The line connecting the most proximal points of the blade, left and right (the juncture of the lateral blade edge and the shoulder).

Distal Haftline. The line connecting the junctures of the shoulder and lateral haft edge. These junctures are operationalized as the points at which the line bisecting the notches intersects the artifact margin.

Haft Baseline. The line connecting the most proximal points of the neck, left and right (the juncture of the lateral and proximal

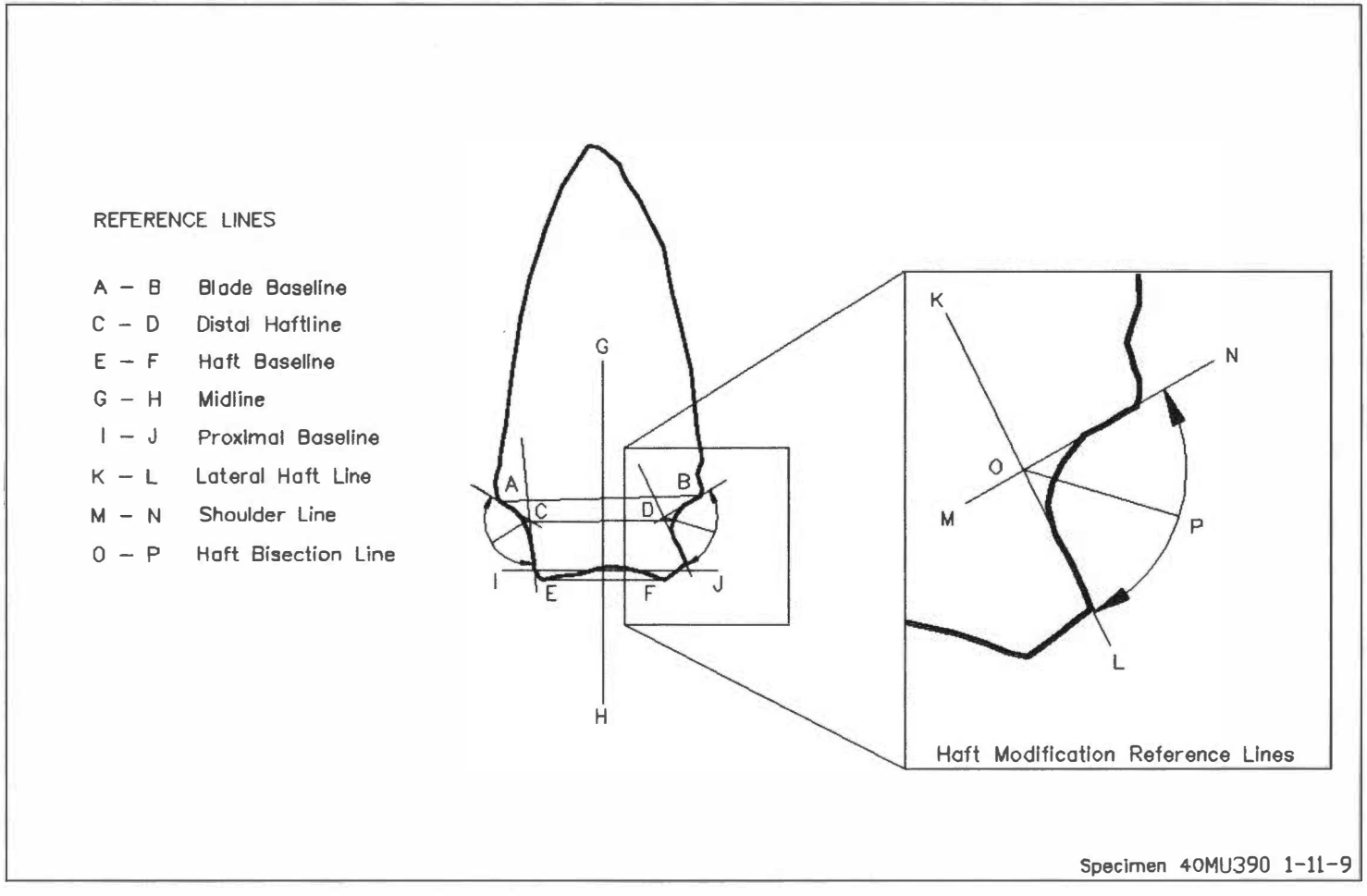


Figure 5.3. Lines of reference used in the projectile point analysis.

haft edges). In cases where distinct lateral and basal haft edges are not defined (i.e. round based points) the Haft Baseline is that line parallel to the Distal Haftline and tangent to the most proximal point of the haft.

Midline. The line perpendicular to and bisecting the Haft Baseline. In cases where the Haft Baseline is defined as parallel to the Distal Haftline and tangent to a rounded base, the Midline is that line perpendicular to and bisecting the Distal Haftline.

Proximal Baseline. A line perpendicular to the midline and tangent to the basal haft edge at the baseline. Note that in specimens lacking distinct lateral and basal haft edges (rounded base points) this line will be isomorphic with the Haft Baseline.

Lateral Haft Line. The straight line best laid along the lateral haft margin, beginning at the juncture between the proximal and lateral haft margin and continuing toward the juncture of the lateral haft margin and the shoulder.

Shoulder Line. The straight line best laid along the shoulder, beginning at the juncture of the lateral blade margin and the shoulder and continuing toward the juncture of the lateral haft margin and the shoulder.

The Variables

The selection of attributes is critical to the success of the intended analysis. The number should be as few as possible to preserve clarity and elegance, yet should include a sufficient number of variables to render accurate discrimination of classes. It is also important that the attributes be universal (present on all specimens) and practical (measurable). The following variables have been selected with these criteria in mind (Figure 5.4).

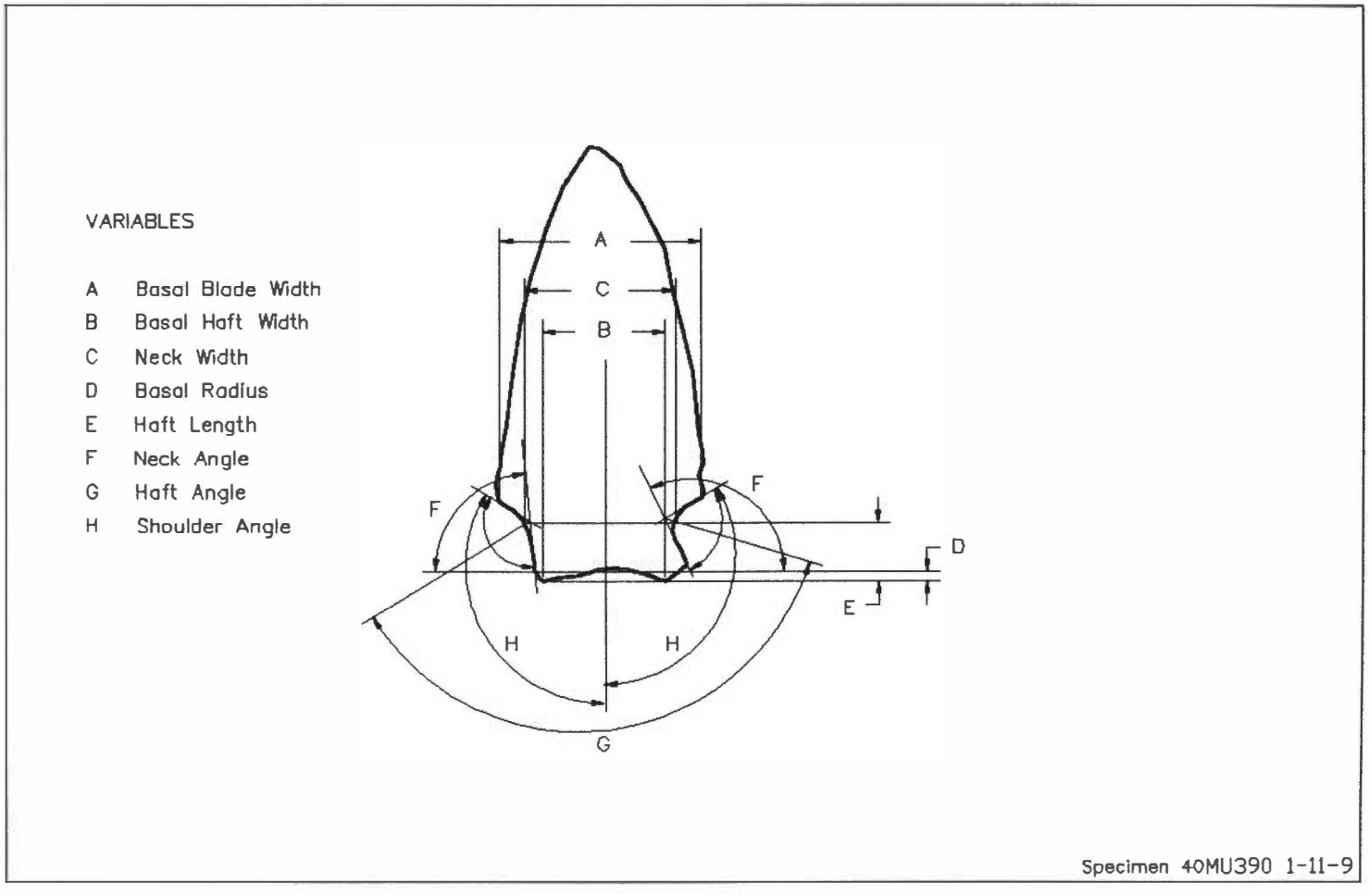


Figure 5.4. Variables used in the projectile point analysis.

Basal Blade Width. Width of the blade measured along the Blade Baseline. (Note that for this measurement and the two widths that follow, an estimate will be made for incomplete specimens using an assumption of symmetry: the distance from the Midline to the margin will be doubled.)

Basal Haft Width. Width of the haft measured along the Haft Baseline. This measure will be zero in artifacts lacking a distinct basal margin (i.e. round-based points).

Neck Width. Width of the neck measured along the Distal Haftline.

Basal Radius (Lucterhand 1970). The distance from the haft baseline to the proximal baseline, measured along the midline. This measure will be positive in excurvate specimens and negative in incurvate specimens.

Haft Length. The distance between the Distal Haftline and the Haft Baseline measured along the Midline.

Neck Angle (Gunn and Prewitt 1975). The outside angle between the proximal baseline and the lateral haft line. This attribute is recorded as two variables: left and right. (Note that for this angle and the Shoulder Angle, an estimate for incomplete specimens will be made using an assumption of symmetry: when only one angle is available, right or left, it will be used as an estimate of the missing angle.)

Haft Angle. "The angle formed by the intersection of lines drawn to bisect the angles defined by the notches which form the haft. The Angle is measured below the intersection" (Johnson 1981: 143). (Note that for incomplete specimens an estimate of the haft angle will

be made using an assumption of symmetry: the angle from the line bisecting the available notch to the Midline will be doubled.)

Shoulder Angle. The inside angle between the midline and the shoulder line. Gunn and Prewitt (1975) referred to this angle as the "neck angle," and Thomas (1979) defined this as the "proximal shoulder angle." This attribute is recorded as two variables: left and right.

Excluded Variables. Several traditionally recorded variables have been excluded from this analysis. Total artifact length, generally defined as the distance from the distal tip to the mid-base, has been dropped for two reasons. First, total length is more commonly estimated than measured, as a large percentage of the projectile points in any assemblage are truncated. While estimates may just as possibly be good as bad, there is no way to assess their accuracy. Secondly, length has commonly been found to be a poor discriminator between projectile point classes. Gunn and Prewitt (1975) and Ahler (1970), both concluded that total length was controlled more by resharpening and material dependant concerns than by class.

Artifact thickness has also been excluded from this analysis. While this variable may be useful in distinguishing point classes, it is not employed here for two reasons. The primary reason for excluding thickness is that it is not measurable on a two dimensional representation of the artifact. As all measurements will be made from either photographs or xerographic images of the artifacts (see Measurement Technique below), it will not be possible to include thickness. In addition, it is expected that thickness is highly correlated with artifact width, and a requirement of discriminate analysis is that the variables be independent.

Measurement Technique

Other attempts to develop automatic classification techniques for projectile points have suffered from a fundamental inability to accurately record the variables specified by the researchers. While calipers are exceptionally precise instruments, measuring dimensions on artifacts in accordance with definitions is often difficult. When variables are defined as measures "perpendicular" or "parallel" to lines of orientation, the analyst is in the unenviable position of "eye-balling" these lines. In addition, the "jaws" of the caliper often have a flat face rendering the accurate measurement of distance between curved surfaces difficult. In the end the measure is approximate notwithstanding the precision of the instrument used. As inhibiting as these difficulties are, they pale in contrast to those visited on the use of protractors in the measurement of angles.

Protractors designed for the measurement of angles on small items are often marked in 5° increments (e.g the reticle of a "pocket comparitor"). Any recording of angles to less than these increments is an approximation. Moreover, the protractor must be oriented by the analyst to the two lines defining the angle. A misalignment of a fraction of the width of the line can result in an inaccurate reading, and this possibility is enhanced by the irregular and curved margins of prehistoric lithic artifacts. In the end, recorded angles are typically at best approximations, with a likely error margin of 10° either side of the actual angle.

These difficulties are sufficient to render attempts at automatic classification hopeless. In the present analysis, measurement precision has been enormously enhanced by the use of Computer Aided Drafting (CAD) technology.

The specimens to be analyzed were placed on a sheet of clear mylar laid over the glass of the photocopying machine, with their flattest side down. Two images were made, one with a dark gray

background and one with a white background. In this way a relatively clear image (essentially a silhouette) was assured regardless of the color of the specimen. Thick or irregular specimens photocopied poorly, however, due to the shadows cast by the intense light of the machine. For these specimens, all lines partially obscured by shadow were highlighted by hand with the original specimen used as a guide. All of the 56 specimens used in the discriminant analysis were photocopied in this manner, as were all projectile points collected from the surfaces of Cheek and Cannon bend.

A millimeter scale was also laid on the mylar with each group of projectile points so that its image was clearly produced on the copy. This scale was used to calibrate the digitizing tablet prior to the recording and measurement of each point. In addition to the primary benefit of producing "scaled" CAD images of the points, this technique also compensated for any distortion introduced into the size of the image due to the photocopying process.

Each point was defined as a separate CAD file. After the outline of the specimen was digitized, the Haft Baseline was defined. The drawing was then rotated until the Haft Baseline was horizontal. Once the other lines of reference were defined, measurements were taken and plotted on the drawing. All linear measurements were made to the nearest tenth of a millimeter, and all angles were made to the nearest hundredth of a degree. All files were saved and plotted. Measured examples of each type are illustrated in Figure 5.5. Measurements were transferred into a database file manually from the plots.

Discussion of the Means

An examination of the variable means (Table 5.4) allows an initial exploration of the differences between the classes under consideration. It is immediately apparent that the Eva class differs

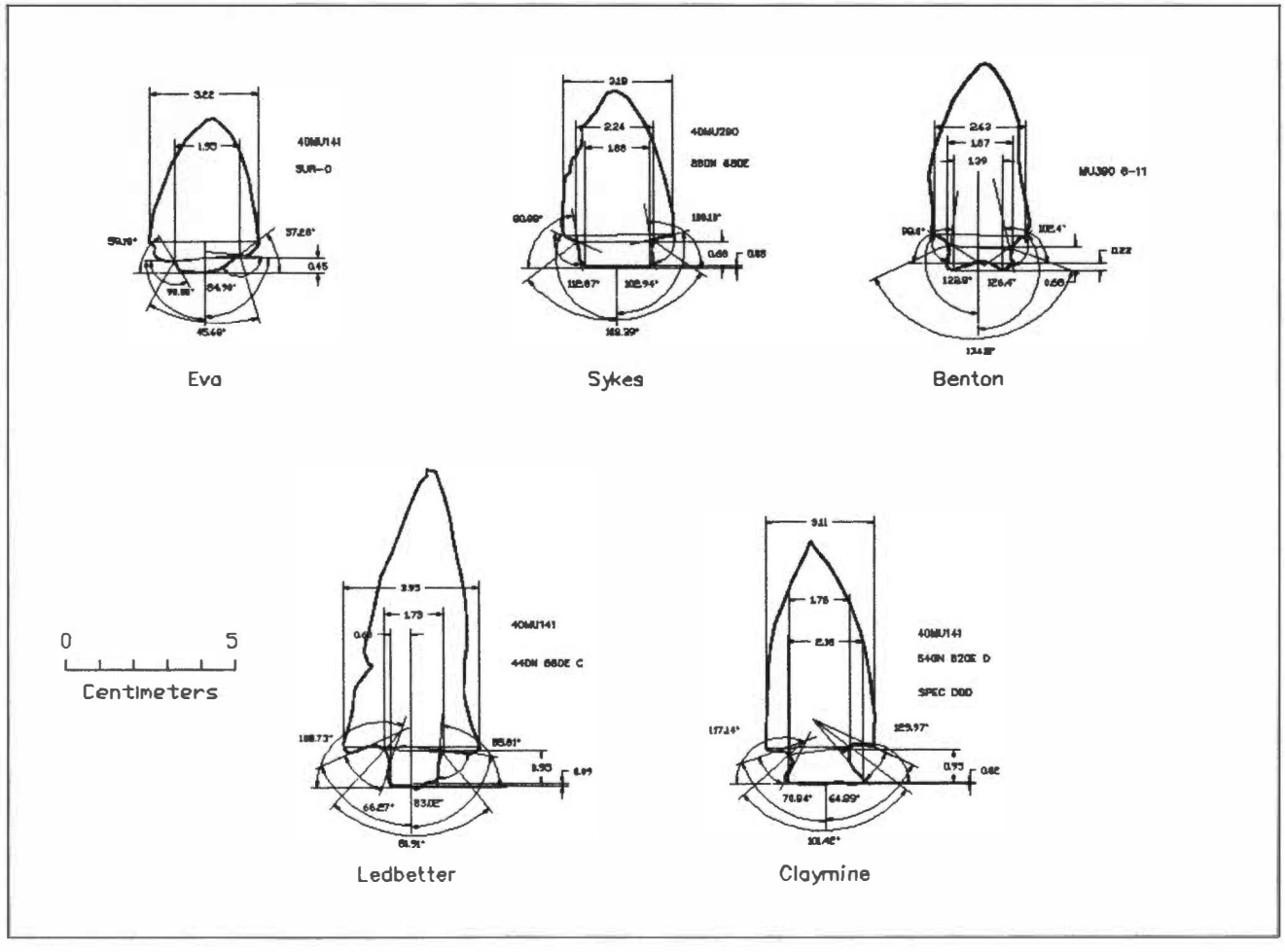


Figure 5.5. CAD measured examples of each projectile point type used in the analysis.

Table 5.4. Variable means and standard deviations for the discriminant classes.

Variable		Class				
		Eva	Sykes	Benton	Ledbetter	Claymine
BBW	Mean	2.74	2.78	2.90	3.45	2.88
	SD	0.33	0.34	0.19	0.35	0.32
NW	Mean	1.70	2.12	2.02	1.91	1.72
	SD	0.24	0.23	0.14	0.13	0.25
BHW	Mean	0.37	2.01	1.56	1.56	1.88
	SD	0.50	0.29	0.23	0.16	0.24
HL	Mean	0.57	0.65	0.97	0.99	0.91
	SD	0.14	0.11	0.16	0.12	0.13
BR	Mean	0.05	0.04	-0.16	0.10	0.05
	SD	0.07	0.07	0.05	0.09	0.08
NAL	Mean	58.90	104.48	95.44	94.12	112.39
	SD	13.15	10.36	6.27	10.23	10.88
NAR	Mean	57.78	102.38	98.85	89.54	111.25
	SD	15.98	14.96	8.81	9.56	10.91
SAL	Mean	75.90	106.84	110.59	86.04	95.94
	SD	17.51	10.86	16.56	15.63	20.03
SAR	Mean	72.11	107.38	101.79	92.41	96.20
	SD	29.50	18.70	18.65	19.22	19.05
HA	Mean	46.30	120.36	113.65	91.26	116.87
	SD	19.25	16.23	20.38	12.97	17.94
count		13	14	10	11	8

from all others in its very small Basal Haft Width (BHW). This is easily explained by the rounded base, which frequently results in a measured BHW of 0. In addition, the Eva class is characterized by a very short haft length. The Sykes class similarly has a very short haft length, but this attribute is coupled with the largest basal haft width recorded for any class. The most distinctive attribute of the Benton class is the negative basal radius; an indication of a characteristically incurvate basal haft margin. The square, straight stems of the Ledbetter class results in neck, shoulder, and haft angles very near 90°. The Claymine class registered the largest neck angles of any class, reflecting the characteristically expanding stem.

Discriminant Results

The BMDP Statistical software program BMDP7M was used to derive the discriminant functions. BMDP7M is a stepwise discriminant which produces "an optimal set of discriminating variables" (Klecka 1980:53). Stepwise discrimination allows the researcher to identify and eliminate those variables that are weak or redundant discriminators of the classes under investigation. Eliminating these poor discriminators enhances the elegance of the analysis, reduces the computational complexity, and the resultant solution is often more powerful than if all variables under consideration are included (use of redundant variables can weaken the discriminating power of the derived functions).

BMDP7M uses a forward stepwise procedure, beginning with the variable that "provides the greatest univariate discrimination" (Klecka 1980:53). The procedure then locates and adds the variable that when combined with the initial variable produces the best pair, then the best triplet, and so on until the addition of variables no longer increases the power of the discriminant functions. The variables were included in the discriminant solution in the following

order: basal haft width, basal radius, haft length, neck width, basal blade width, and haft angle. Shoulder and neck angles were not included in the discriminant solution, possibly as a result of redundancy as both lefts and rights were recorded for these two variables. The results of the analysis are presented in Tables 5.5 - 5.8.

Discriminant analysis may result in up to a maximum of one fewer discriminant functions than there are classes in the analysis, or the number of variables, whichever is fewer (Klecka 1980:16). In the present analysis, with five groups and 10 variables, all four functions contribute significantly, and are retained (Table 5.5). Discriminant functions 1 and 2, however, together account for nearly 88% of the variability among the classes. A plot of these two functions (Figure 5.6) is, therefore, highly indicative of the distinctiveness of the classes and of the importance or role of each function in the discriminant solution. As the figure illustrates, function 1 serves to distinguish Eva from all other point types, and, to a lesser degree, Sykes from Benton and Ledbetter from Claymine. Function two is most important in distinguishing between Sykes - Benton points and Ledbetter -Claymine points.

Table 5.6 presents the standardized discriminant function coefficients. When the sign is ignored, the size of the coefficient is an indication of the weight of each variable in the discriminant function. The largest contributions to function 1 are made by haft angle, basal haft width, and haft length. The importance of these variables to the identification of Eva points is readily apparent; as a result of their rounded base Eva points often have a basal haft width of zero, an extremely small haft angle, and a short haft element (Table 5.4). Sykes points characteristically have short wide haft elements, and Ledbetters have very square stems (Table 5.4). Function 2 loads heavily on basal blade width and neck width. The Ledbetter

Table 5.5. Summary statistics for discriminant analysis.

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	8.5127888	61.57	.94598
2	3.5882996	25.95	.88434
3	1.3777756	9.96	.76121
4	.3475898	2.51	.50787

Table 5.6. Standardized discriminant function coefficients.

Variable	Discriminant Function 1	2	3	4
BHW	0.67116	-0.18111	-0.19048	0.59288
BR	-0.15674	0.57303	-0.76407	-0.16030
HL	0.50429	0.69128	0.36264	-0.00628
NW	-0.11465	-0.86288	-0.16846	-0.91652
BBW	0.07956	0.85137	0.04343	-0.46812
HA	0.68377	0.08696	-0.09369	-0.33521

Table 5.7. F-Matrix for discriminant classes (6,46 degrees of freedom).

Group	Eva	Sykes	Benton	Ledbetter
Sykes	47.11			
Benton	44.87	11.25		
Ledbetter	39.40	24.68	18.96	
Claymine	41.35	11.83	9.2	5.63

Table 5.8. Classification results for discriminant classes (jackknifed classifications in parentheses).

Actual Class	Predicted Class				
	Eva	Sykes	Benton	Ledbetter	Claymine
Eva	13 (13)	0	0	0	0
Sykes	0	14 (14)	0	0	0
Benton	0	0	10 (10)	0	0
Ledbetter	0	0	0 (1)	10 (8)	1 (1)
Claymine	0	0	0	2 (2)	6 (6)

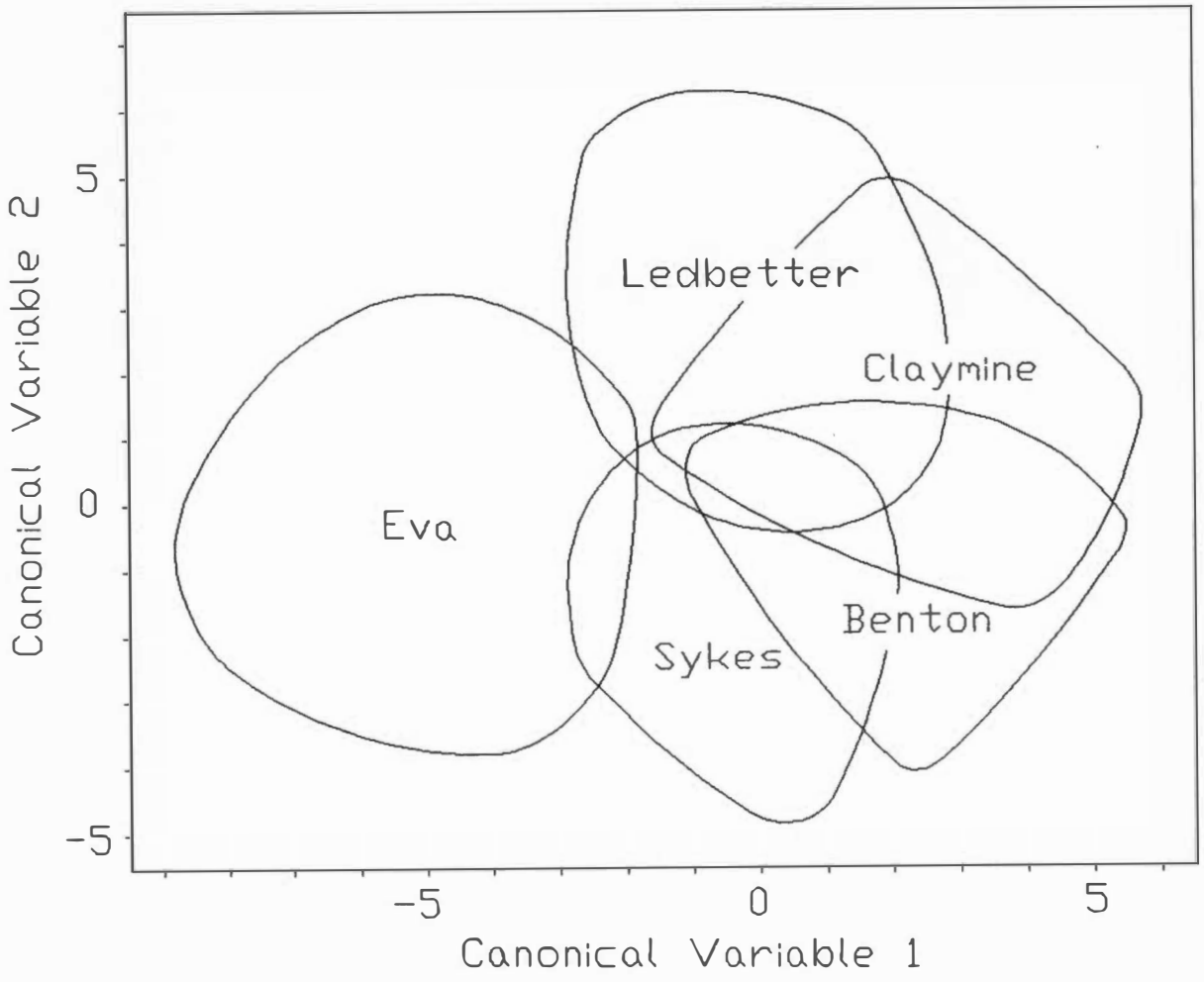


Figure 5.6. Plot of projectile point discriminant analysis cannonical variable 1 by cannonical variable 2.

type has the widest blade while the Claymine has the narrowest neck (Table 5.4).

Function 3 is primarily monitoring basal radius, so we may assume (without its being figured) that it is serving to distinguish the Benton type. Function 4 again emphasizes neck width. It may be that this function contributes to the troublesome distinction between Ledbetter and Claymine types.

Degree of Class Distinctiveness

The reality of the five projectile point types under investigation was a basic premise of this study. The relevant question concerns the ability of the six variables retained by the analysis to discriminate between the five types. Table 5.7 presents the F-matrix based on the distance between class centroids in discriminant space. All measures are significant at the .001 level, with the exception of the Ledbetter-Claymine distance which is significant at the .025 level.

Another measure of the discriminating power of the solution is presented in Table 5.8. This classification matrix illustrates how each of the 55 type specimens was classified by the discriminant solution. In all but three cases the artifacts are correctly classified (94.6%). Significantly, all of the errors are between the Ledbetter and Claymine types, reinforcing the F test results.

One shortcoming of a classification matrix as a test of the success of a discriminant analysis is that each specimen being classified has contributed to the discriminant solution; the analysis is predisposed to recognize the specimen as a member of the class it helped to define (Morrison 1974). To overcome this weakness in the classification matrix, the BMDP7M "jackknife" procedure was employed. In the jackknifed classification the discriminant solution is recalculated without the specimen prior to its being classed. The

jackknifed results are presented in Table 5.6 (in parentheses), and are only slightly less excellent than before; one additional specimen, a Ledbetter, is misclassified as a Benton (92.9% correct classification).

The Classification

The method used by the BMDP7M procedure to classify unknowns relies on the Mahalanobis D^2 (Klecka 1980). In a spatial analogy D^2 may be interpreted as the distance between a given specimen and the centroid for a class. This measure is calculated between each specimen and each class, and the specimen is assigned to the class with the nearest centroid. D^2 is a measure of multidimensional distance that has the same properties as a X^2 with degrees of freedom equal to the number of discriminating variables (Klecka 1980:45), and may be used to calculate a measure of distance probability for class membership.

One significant problem with the present classification is a consequence of the nature of the analytic technique. Discriminant analysis requires that each specimen be a member of one and only one group, and that all possible groups are identified and included in the analysis. In an effort to be as non-judgmental as possible regarding the selection of specimens to be classified, a liberal approach was adopted; all specimens potentially belonging to any of the target types was included. In practice this meant that all broad bladed stemmed points were involved. Some of these artifacts almost certainly belong to types not used in this analysis, yet all specimens will be classified to one of the target types.

The solution to this problem is found in a calculated measure of posterior probability (Klecka 1980:46). Posterior probability of membership is calculated for each group, and their sum is 1.0, and relies on the assumption that each specimen must belong to only one of

the target groups. The advantages of using this measure to evaluate the classification of specimens are obvious. Should a specimen be very distant (e.g. large D^2) from all or several groups, D^2 would be adequate to the task of determining that it should probably not be classified as a member of any group. However, should a specimen be very near several groups D^2 might be impressively small for the nearest group, yet the calculated posterior probability would remain relatively small as it must sum to 1.0 across all groups. The posterior probability measure provides an effective means of eliminating specimens with a large chance of belonging to several groups simultaneously.

The BMDP7M procedure calculates posterior probability for each specimen. For the purposes of the present analysis, a minimum value of 0.9 was used to determine the appropriateness of the classification. Each of the specimens retained may be regarded as having a minimum 90 percent chance of actually belonging to the group to which it has been classified. In addition, each specimen retained has a cumulative probability of not more than 10% of belonging to all other groups.

Of the 657 recovered specimens, 294 projectile points were initially selected for analysis (e.g. broad bladed and stemmed). Summary information for all recovered, employed, and retained specimens is presented in Table 5.9. An initial impressionistic sorting into broad temporal periods indicated that 344 of the collected specimens (60% of those that could be sorted) were referable to the Middle and Late Archaic periods. Selection for analysis resulted in the elimination of all but 10% (n=20) of those points sorted into earlier or later periods (n=226). Three quarters (n=15) of these specimens were found to closely conform to one of the target types, and were retained by the discriminant analysis.

Table 5.9. Summary information for projectile point analysis.

Impressionistic Classes	Total Assemblage		Total Employed		Total Retained	
	Cannon	Cheek	Cannon	Cheek	Cannon	Cheek
Paleo	1					
Early Archaic	11	29	1	8		6
Middle Archaic	11	127	11	89	5	66
Late Archaic	69	137	61	110	37	60
Trans-itional		11		8		6
Early Woodland	38	19		1		1
Middle Woodland	33	50		2		1
Late Woodland/ Mississippian	11	23				
Unclear	17	70		3		1
Total	191	466	73	221	42	141

Tables 5.10 and 5.11 present crosstabulations of the results of initial impressionistic sorting to broad temporal period by the results of the discriminant classification for Cannon Bend and Cheek Bend respectively. The results are gratifying in that there is essential agreement between both classifications (84% agreement).

A comparison between the results of the automatic classification and the summary figures provided by Turner and Klippel (1989:57) is offered as a final check of the reasonableness of the automatic classification (Table 5.12). In addition to demonstrating the utility of the approach developed here, this table is a useful summary of results.

Table 5.10. Crosstabulation of impressionistic sort categories by discriminant type: Cannon Bend.

Impressionistic Classes	Discriminant Types					
	Eva	Sykes	Benton	Ledbetter	Claymine	Total
Paleo						0
Early Archaic						0
Middle Archaic	2	2			1	5
Late Archaic	1	1		27	8	37
Trans-itional						0
Early Woodland						0
Middle Woodland						0
Late Woodland/ Mississippian						0
Unclear						0
Total	3	3	0	27	9	42

Table 5.11. Crosstabulation of impressionistic sort categories by discriminant type: Cheek Bend.

Impressionistic Classes	Discriminant Types					
	Eva	Sykes	Benton	Ledbetter	Claymine	Total
Paleo						0
Early Archaic	1		3	2		6
Middle Archaic	39	14	1	4	8	66
Late Archaic		1		40	19	60
Trans-itional				6		6
Early Woodland					1	1
Middle Woodland					1	1
Late Woodland/ Mississippian						0
Unclear				1		1
Total	40	15	4	53	29	141

Table 5.12. Comparison of present analysis results with summary information from Turner and Klippel (1989).

Date Ranges (BP)		Cannon Bend		Cheek Bend	
		Present Analysis	Turner and Klippel[1]	Present Analysis	Turner and Klippel
7505	Eva	3		40	
6375					
6375	Sykes	3	7	15	120
5370					
6160	Benton	0		4	
4130					
4655	Ledbetter	27		53	
4130			102		185
3215	Claymine	9		29	
3205					

[1] Turner and Klippel's figures are larger than those for the present analysis as their temporal groupings included a greater range of types (e.g. they combined Late Archaic and Early Woodland types), and because they were able to include specimens too fragmentary for inclusion in the present analysis (see Table 5.3).

CHAPTER VI

ANALYTIC UNITS 2: SITES

Archaeology and Sites

The Site Concept

The essential nature of the site concept in archaeological research has been repeatedly discussed (Dunnell and Dancey 1983; Thomas 1975). These researchers have noted the frequency of explicit statements regarding the elemental nature of the site concept (Binford 1964; Hodder and Orton 1976; Hole and Heizer 1969; Thomas 1979; Willey and Phillips 1958), while it is more common to use the site as a basic unit of archaeological research and analysis (e.g. Davis 1986; Dickson 1979; Faulkner and McCollough 1973). Most definitions emphasize the assumed behavioral aspects of the archaeological site: "A site is any place, large or small, where there are to be found traces of ancient occupation or activity" (Hole and Heizer 1973:59). Other definitions stress their contemporary observational character: "The site is a spatial cluster of cultural features or items, or both" (Binford 1964:431).

Non-Site Archaeology: Rejection of the Site Concept

When archaeologists began to think in terms of sites as areas of high artifact density (following from the Binford definition offered above), two logical and troublesome corollaries were necessarily acceptable: areas of low artifact density (e.g. not sites) were also possible, and site boundaries (delimiting high versus low artifact density areas) were analytic rather than observational. These realizations led to the development and articulation of a "non-site archaeology" (Dunnell and Dancey 1983; Foley 1981; Thomas 1975), in which regions rather than sites became the basic unit of spatial investigation and analysis. The premise of this approach was that

artifacts were more or less continuously distributed across landscapes, and that by focusing only on high density areas (e.g. sites) researchers were ignoring a great deal of information. Not only was a focus on sites partially blinding, it was "inessential" or "potentially irrelevant" to the pursuit of the kinds of questions often asked of the archaeological record (Thomas 1975:62). The strength of this argument had a profound impact on the conduct of the Cheek and Cannon Bend surface surveys, and the power of resulting data will be used in testing the models being investigated in the current study.

Settlement Analysis: Sites as Units of Analysis

This dissertation, however, has at its core questions concerning the distribution of past human settlements; many of the tests involve the distribution of sites, not artifacts. As a result it is necessary that sites be defined. This chapter is devoted to the analytic definition of archaeological sites in Cheek and Cannon bends of the Duck River.

Columbia Project Sites

It might reasonably be wondered why it is necessary or appropriate to define sites in an area where they have previously been recorded. In fact, 101 surface sites were defined in the study area (52 in Cannon Bend, and 49 in Cheek Bend, Figures 6.1 and 6.2). It must be remembered that the investigation of these river bends was made necessary by a proposed Federal undertaking with the potential to adversely affect cultural resources (a Tennessee Valley Authority reservoir). Section 106 of the National Historic Preservation Act (16 USC §407f) and attendant regulations (36 CFR 800) mandate and describe a process for considering and minimizing such adverse effects. This "Cultural Resources Management" process is decidedly property based,

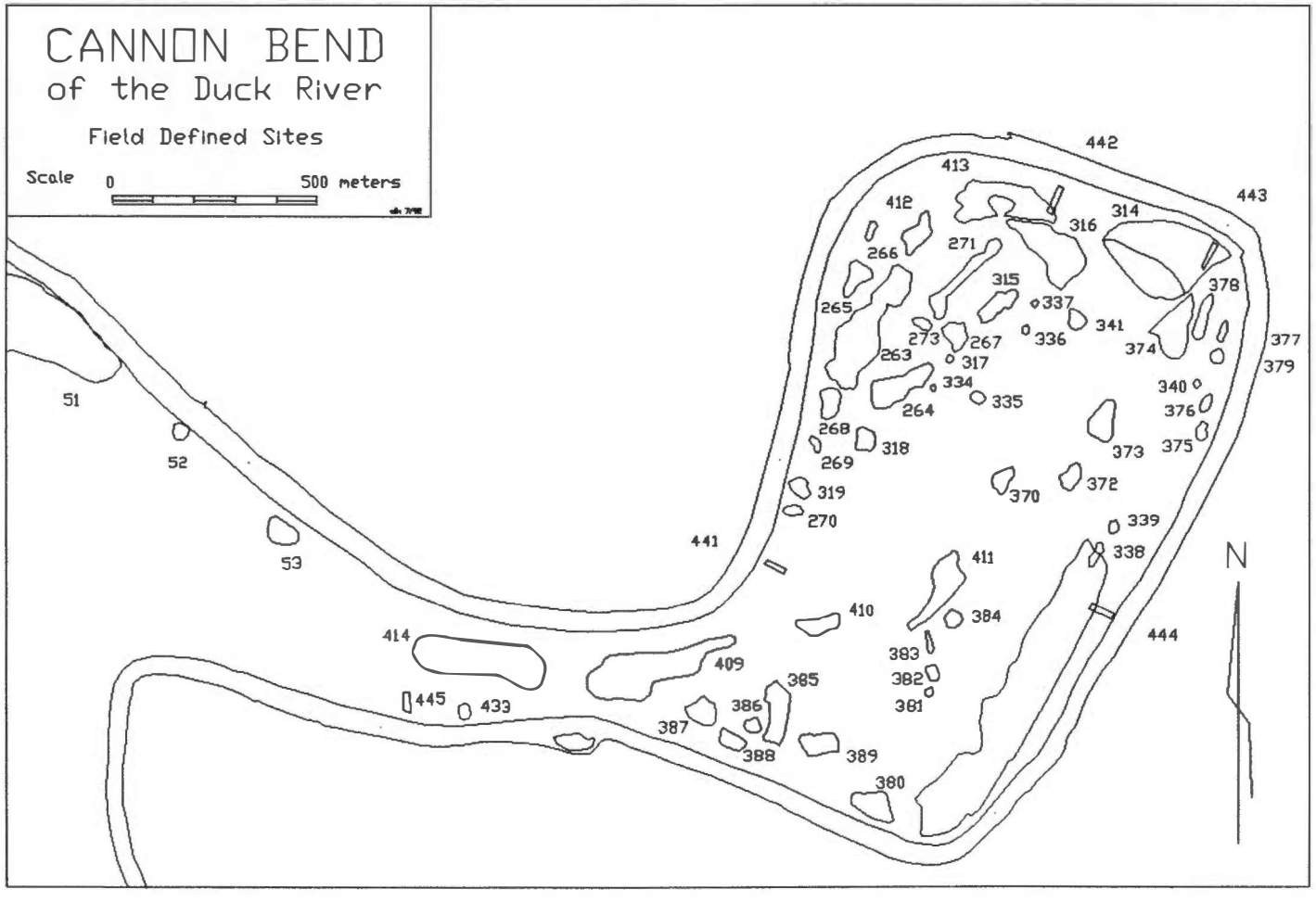


Figure 6.1. Field defined sites in Cannon Bend.

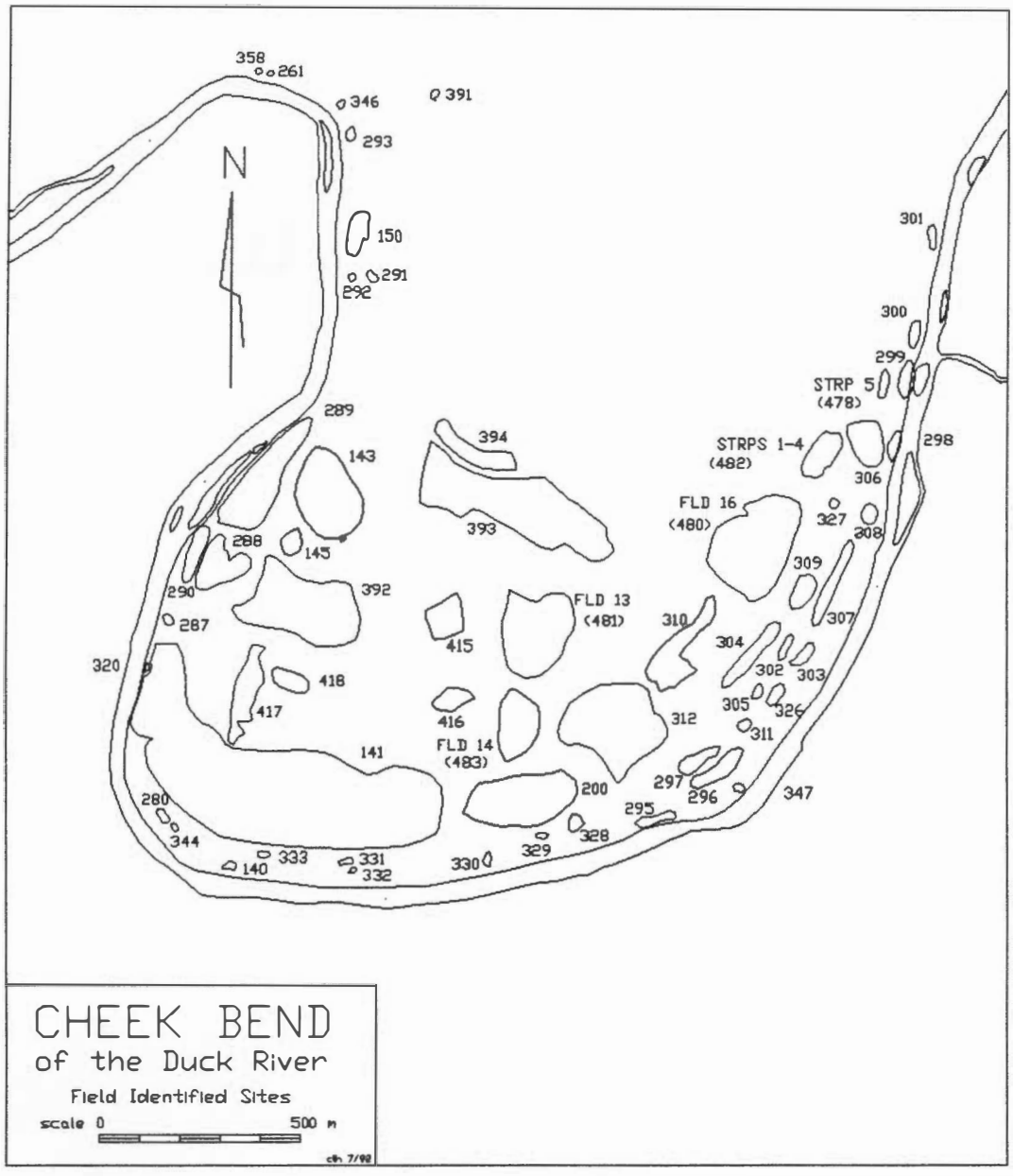


Figure 6.2. Field defined sites in Cheek Bend.

with treatment hinging on the eligibility of each identified resource for inclusion in the National Register of Historic Places. It was, as a result, the primary goal of these investigations to identify and evaluate archaeological sites.

Evolving Strategies

The site survey (1978 - 1980). The initial investigations in Cheek and Cannon bends were site oriented (see Chapter IV). The identification of an artifact during surface survey inevitably led to an intensive effort to place the find in a site context. As few as three artifacts distributed over as much as several hundred square meters often formed the corners of a defined site (e.g. 40MU370 - 40MU375 in Cannon Bend, and 40MU327, 40MU330, and 40MU332 in Cheek Bend). The pattern of sites in the initially surveyed areas of these two river bends generally involves very small sites that may be very near one another.

The whole bend survey (1980 - 1981). As the field investigators became more familiar with the broadly and nearly continuously distributed nature of the archaeological remains in Cheek and Cannon bends, so too did the research orientation of the investigators become more sophisticated. The logic and power of non-site survey dovetailed neatly and fortuitously with the broadly agricultural nature of the project setting: not only was the non-site philosophy appealing, it was also possible in these tightly constrained naturally defined sampling units (river bends). As the gridded whole bend survey strategy evolved and was implemented (Chapter IV), the definition of sites became a side issue: almost a nuisance. In many cases whole fields were defined as sites (e.g. 40MU371, 40MU314, and 40MU263 in Cannon Bend, and 40MU309, 40MU481, 40MU393, and 40MU312 in Cheek Bend) In other cases, fence lines or roads form the boundaries between

defined sites (e.g. 40MU316 - 40MU413 and 40MU314 - 40MU374 in Cannon Bend, and 40MU393 and 40MU394 in Cheek Bend.

The problem of non-equivalent units. These two very different strategies led, of course, to the creation of non-equivalent units. While any degree of perceived discontinuity was taken to represent a site boundary under the site-based early survey work, even large distances between low density clusters of artifacts often did not lead to the definition of site boundaries under the non-site strategy. Table 6.1 provides summary information for recorded sites for Cannon and Cheek bends. The results of the problem introduced above are readily apparent. The average size of sites defined during site-based survey was 1814 sq. m in Cheek Bend and 2589 sq. m in Cannon Bend, while the mean size of those defined during the non-site survey (grid-based) was 32,474 sq. m in Cheek Bend and 18,813 in Cannon Bend. The impact of collection orientation on the size of defined sites may also be seen in the results of "intermediate" methods. In Cannon Bend, a quasi-continuous grid of 25 m2 units was used to collect certain fields in the southern portion of the bend (see Chapter 4). While the collectors were still operating under a site-based model, the near proximity of site areas led them to extend single grids across several sites. By this strategy they were led to the realization that what had been thought of as empty inter-site spaces could be perceived of as extremely low artifact density areas. The end result of this realization was that site areas were extended across what would previously have been defined as "voids", and site size grew. The mean site size for this quasi-contiguous grid collection was 5860 sq. m.

As an end result of these various collection strategies, the defined sites have extremely limited utility. In order to arrive at a standard definition and equivalent units for further analysis, a quantitative density analysis was undertaken to redefine sites in the

Table 6.1. Summary information for recorded sites.

Collection Strategy	Cannon Bend		Cheek Bend	
	Site[1]	Area	Site	Area
5, 10 & 20 m grids	263	22792	141	174060
	265	3189	143	27451
	314	36985	145	2431
	409	24353	200	28623
	412	3731	288	10566
	413	14948	289	23746
	414	25691	290	4525
			310	13844
			312	41044
			392	41219
			417	10654
			418	3846
			480	40153
	n= 7	sum= 131689 mean= 18813	n= 13	sum= 422162 mean= 32474
25 m site-based grids	338	981		
	339	550		
	340	222		
	371	81754		
	372	2084		
	373	4370		
	374	8511		
	375	910		
	376	840		
	377	748		
	378	2558		
	379	820		
	380	4890		
	381	290		
	382	830		
	383	515		
	384	1287		
	385	6357		
	386	1033		
	387	3487		
	388	2007		
	389	3873		
	n= 22	sum= 128917 mean= 5860		

Table 6.1 (cont.)

Collection Strategy	Cannon Bend		Cheek Bend	
	Site	Area	Site	Area
Piece Plot	370	2073	393	58321
	410	3302	394	9089
	411	8890	415	7490
			416	3794
			481	29572
			483	13489
	n= 3	sum= 14265 mean= 4755	n= 6	sum= 121755 mean= 20292
Site-Based	264	7942	140	484
	266	680	280	709
	267	2812	287	505
	268	2858	295	1930
	269	609	296	4955
	271	6266	297	3177
	273	929	298	1587
	296	896	299	2636
	315	3810	302	1093
	316	14240	303	1693
	317	231	304	6185
	318	2073	305	667
	319	1695	306	7880
	334	155	307	5516
	335	754	308	1553
	336	284	309	3793
	337	203	311	764
	341	159	320	146
			326	1423
			327	431
			328	1179
			329	301
			330	488
			331	443
			332	183
			333	371
			344	262
			347	443
	n= 18	sum= 46596 mean= 2589	n= 28	sum= 50797 mean= 1814

[1] site numbers are presented without the "40MU" prefix.

study area. Such a method has been advocated by researchers (e.g. Dunnell and Dancey 1983: Figure 7.2), yet no examples were identified in the literature. It is probable that the reason for this may be found in the method of sampling space in non-site applications; non-site sampling has employed a random stratified sampling unit selection (Nance 1980; Thomas 1975). The dispersed nature of the resultant quadrats, and their frequently very large size (e.g. 500 m quadrats and 200 m quadrats in the above referenced studies, respectively) cannot be used to define sites whose average size would no doubt be less than the size of the quadrats.

The Columbia project data, however, are well suited to the definition of sites. In this case contiguous 5 m, 10 m, 20 m, and 25 m quadrats were collected. As these sizes may safely be assumed to be smaller than average site areas, it should be possible to identify sites using techniques usually only possible at the intrasite level of investigation (e.g. Whallon 1973).

Cheek and Cannon Bend Density Based Site Definition

The Data

A review of the methods involved in the survey of Cannon and Cheek bends has previously been presented in detail (Chapter 4). The initial task of the present analysis was to transform data from the various collection strategies to comparable and usable data. Of the two bends, Cannon clearly presented the greatest challenges for data transformation and standardization.

Cannon Bend. Five separate collection strategies were employed in the surface survey of Cannon Bend: site specific collections (frequently involving 50 m quadrats), piece-plotting of all observed artifacts by agricultural field, 25 m contiguous quadrats in five separate and limited grids, 10 m contiguous quadrats, and 5 m

contiguous quadrats. Tables 4.1 and 4.2 present useful summaries of these strategies. The goal of the present data transformation was correlation of all collection strategies to a single unifying grid, and calculation of a standardized measure of material density.

The seven separate grids established in Cannon Bend are illustrated in Figure 6.3. Their correlation into an a single unifying grid was made possible by Computer Aided Drafting (CAD) technology. It is impossible to overstate the significance of CAD to this endeavor. While the task could have been accomplished with drafting tables, parallel bars, pencils, rulers, etc., there can be no doubt but that CAD rendered it much more approachable. In addition, the CAD results are unquestionably more accurate than those obtainable using conventional drafting equipment. Because CAD was so essential, and as it is a relatively new technology, the method used is briefly sketched below.

Each of the grids was scale drafted as a separate CAD drawing and overlaid on the map of the river bend (Figure 6.3). CAD software allows the user to insert drawings into other drawings in such a manner that they may be obliqued to any specified angle and interactively dragged to any position. These features made possible the very accurate fixing of the grids to the map of the bend. Landscape features, especially wood lines, fence lines, and ponds, were important in determining the extent of the grids when originally mapped and collected in the field. As these features had been accurately digitized into in the CAD bend drawings, they were also used to precisely determine the position of grids on the map.

The uplands grid used to collect sites 40MU409 and 40MU411 was selected as the basis for the unifying whole-bend grid for two reasons. First, by being aligned with magnetic north it provided the promise of simplified calculations. Second, it was the farthest south and west of the established grids, and its origin (hypothetical N0,

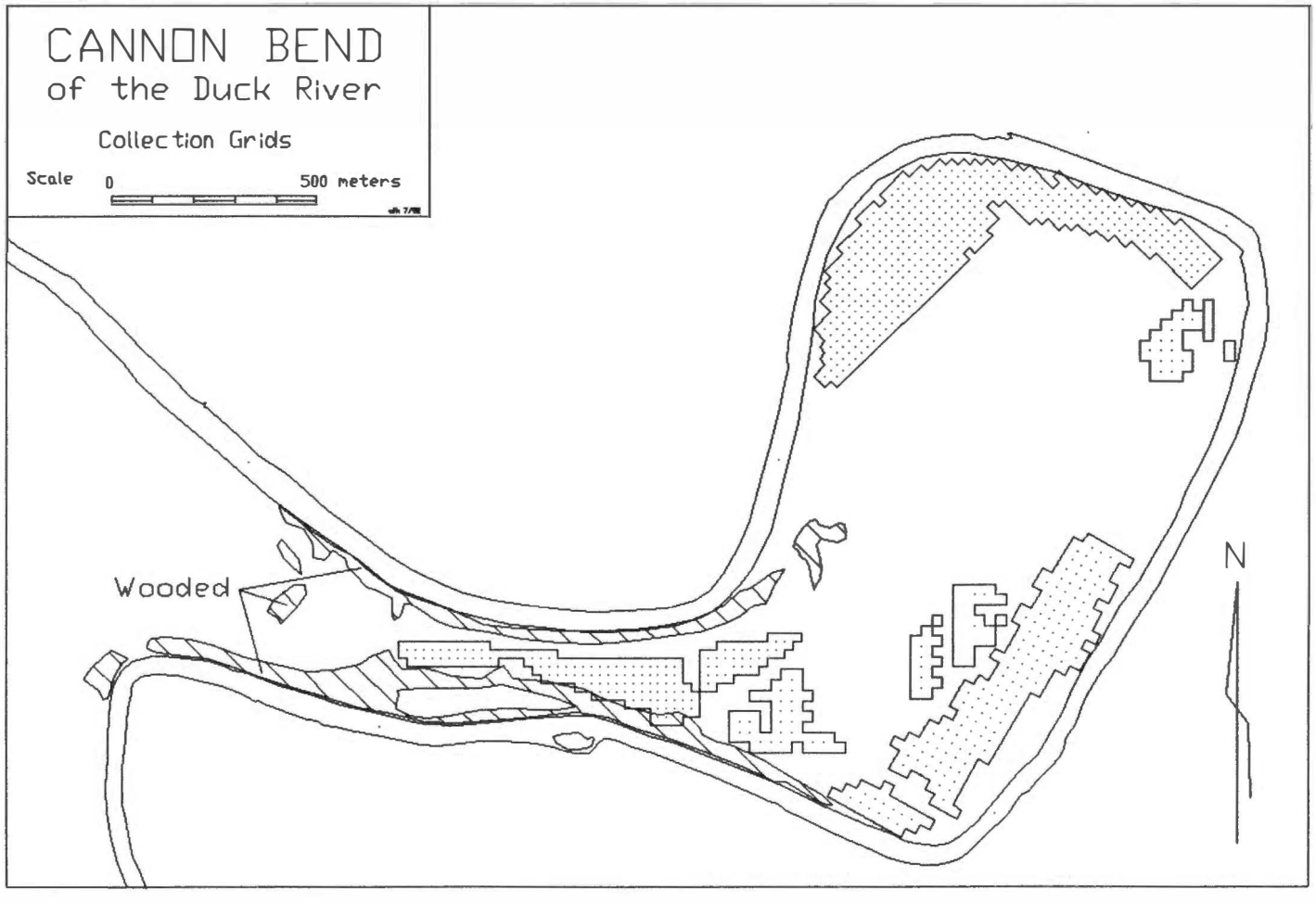


Figure 6.3. Collection grids in Cannon Bend.

E0) was well to the southwest of the entire bend. This grid origin was established as the coordinate origin for the drawing. The absolute coordinates (referenced to the origin of the 40MU409/40MU411 grid) for each point in the other five grids was determined using special functions of the CAD software.

CAD drawings are manipulated by means of a pointer. Objects are drawn, selected, and moved with this pointer, and locations on the drawing are specified by it. The intersection of a horizontal and vertical crosshair on the computer screen indicates the position on the drawing of the pointer, and the pointer is manually controlled by a hand-held device that moves over a "digitizing" tablet. CAD tracks and displays the coordinates of the pointer in drawing scaled units on the screen. As the N0, E0 of the 40MU409/40MU411 grid was specified as the drawing origin, and as the drawing was scaled in meters, the reported coordinates of the pointer corresponded to absolute coordinates of the whole-bend grid. Additional functions of CAD software allow the user to snap the pointer to locations at specified intervals relative to any selected point, and to oblique the crosshairs to any angle. These functions combined to make the task of determining the absolute coordinate of each separate grid point a relatively straight-forward and extremely accurate undertaking.

To determine the absolute coordinates of each grid point, any single point in the grid was selected as a snap reference, the grid interval (5, 10, or 25 m) was selected as the snap interval, and the crosshairs were rotated to the grid orientation. The effect was that when the pointer was moved between points of the grid, it "jumped" to the destination point, landing precisely upon it. The absolute coordinates were noted from the display and recorded.

The material collected from the bend had been washed, sorted, and coded according to the standard Columbia Coding Format (Turner 1986), and the key-punched data were available on a data tape. A SAS

program was written to tabulate the material frequency for each collected unit. This information was entered into a personal computer data base program. The relative grid coordinates were replaced with the absolute coordinates collected in the manner described above.

The selection of a standard measure of material density was a relatively simple matter: of the 3399 grid units actually collected in Cannon Bend, 2350 (69%) were 10 m squares. The number of artifacts per 100 sq. m was therefore selected. In order to simplify data collection, manipulation, and handling, and to comfortably accommodate the 25 m quadrats collected in the bend, control points were selected and recorded on 20 m intervals. In practice this meant using only one in four 10 m sq. units (the southwest quadrat of each 20 m unit, n = 588), or one in sixteen 5 m sq. units (also the southwest quadrat of each 20 m unit, n = 44). For 5 m quadrats (25 sq m), the observed material count was multiplied by four to obtain a density per 100 sq m. All 25 m units were retained (n = 347), and the observed material count was divided by 6.25 to obtain the standard density measure.

Less than 40% (47 hectares) of the surface of Cannon Bend was examined and collected in a gridded manner. The remaining areas were either piece plotted (the location of each observed artifact individually plotted, 8%, 9 hectares), collected in a site-based manner (27%, 32 hectares), or comprised inter-grid spaces between the five semi-contiguous 25 m grids (25%, 30 hectares). The manner selected to convert these data to the absolute grid and standardized density measure is based upon the assumptions that all of the surface was examined, and that all observed artifacts were collected. These assumptions are well grounded. That all of the surface was examined follows from the fact that the entire surface was in agricultural field (excepting minor wooded and pasture areas), and that collection was conducted at times designed to take advantage of agricultural preparation (following recent plowing, discing) and naturally enhanced

artifact visibility (rain, see Turner and Klippel 1989). That all artifacts were collected follows from previous discussion; the site-based collection strategy was characterized by an extreme effort to place all observed artifacts in a site context. Sites defined on the basis of three artifacts are not uncommon in these areas. The acceptance of these assumptions leads to the conclusion that those areas not involved in gridded collections and between defined sites are vacant. By establishing the whole-bend grid units that comprise these vacant areas, and noting their density as zero, fully 57 additional hectares are incorporated into the grid (approximately 1200 zero density grid units).

Field plots for each of the piece plotted fields were digitized into scaled CAD drawings and overlaid on the bend drawing. The whole-bend grid was extended across these fields and the distribution of material observed for each 20 m quadrat involved. The material count was divided by four to standardize the density.

The trickiest, and most problematic, conversion concerned the site-based collections. It has already been argued that intersite areas examined by this strategy may be assumed to have been vacant. The density of artifacts within the defined site areas may be calculated as the assemblage total/site area. CAD was used to calculate the site area for each site as defined on 3 3/4' USGS topographic maps during the course of the field project. Artifact counts were obtained from the project alien tape. This density measure (artifacts/square meter) was standardized through multiplication by 100. The percentage of each whole-bend grid unit that touched a site was determined to the nearest ten percentile, and this figure was used to estimate the standard density for the unit. For example, 219 artifacts were collected from site 40MU271, which was 6266 sq m in area. The standard density for this site is 3.5 artifacts per 100 sq. m [(219/6266)·100]. If 30% of a whole-bend 20 m

quadrat fell within the boundary of this site, its standard density would be 1.05 artifacts per 100 sq. m (3.5*.3). In this manner the standard density of all remaining quadrats was calculated.

A grand total of 2408 control points at 20 m intervals resulted from the selection and calculation methods described above. The location and pattern of all quadrat control points (operationalized as the southwest corner of each unit) is illustrated in Figure 6.4.

Cheek Bend. Unifying and standardizing the collections from Cheek Bend was considerably less trouble than for Cannon Bend. A single grid of 5049 units (305 of which were 20 m sq., having been collected prior to the adoption of the 10 m sq. standard) was collected in Cheek Bend (Figure 6.5). This single grid, oriented N 11° E, represents 59 hectares (43%) of the river bend. An additional 45 hectares (32%) was piece plotted, and 34 hectares (24%) were collected using a site-based strategy. The strategy used to unify and standardize was identical to that described above for Cannon Bend. A grand total of 3344 control points with associated standardized density comprise the data for Cheek Bend. The pattern of these control points is illustrated in Figure 6.6.

The Analysis

Poisson distribution analysis. The Poisson distribution is useful for describing discrete, rare, random occurrences in space (Haggett et al. 1977; Hodder and Orton 1976; Zar 1984:406). The artifacts distributed across the surfaces of Cannon and Cheek bends are quite rare (actual density is low compared to the theoretical maximum density that would result if artifacts were arranged in a continuous mosiac across the surface, see Thomas 1975). There are two ways to use this distribution to assess the degree of randomness of an observed distribution. The first takes advantage of the

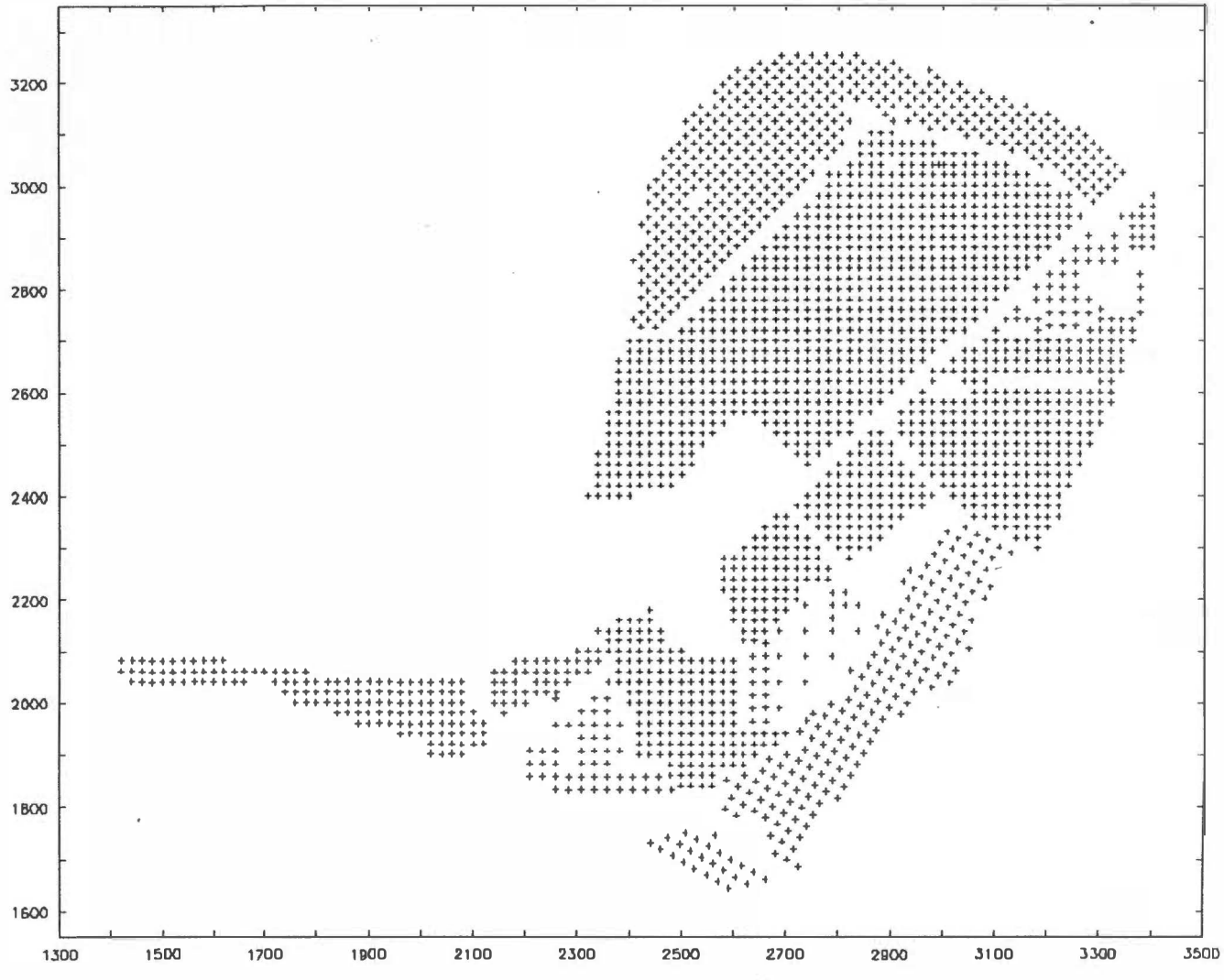


Figure 6.4. Surface II control points defined for Cannon Bend whole-bend grid.

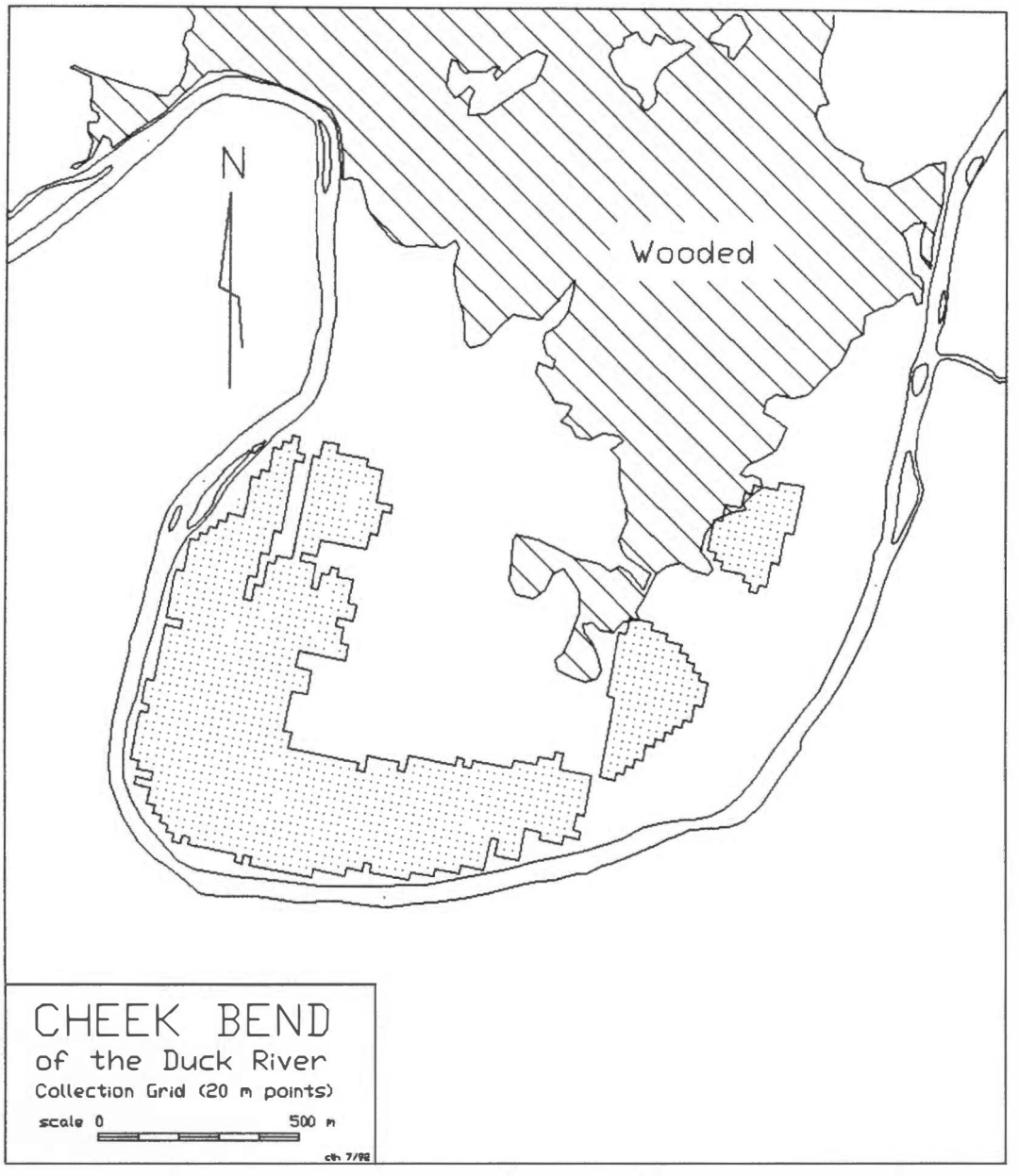


Figure 6.5. Collection grid in Cheek Bend.

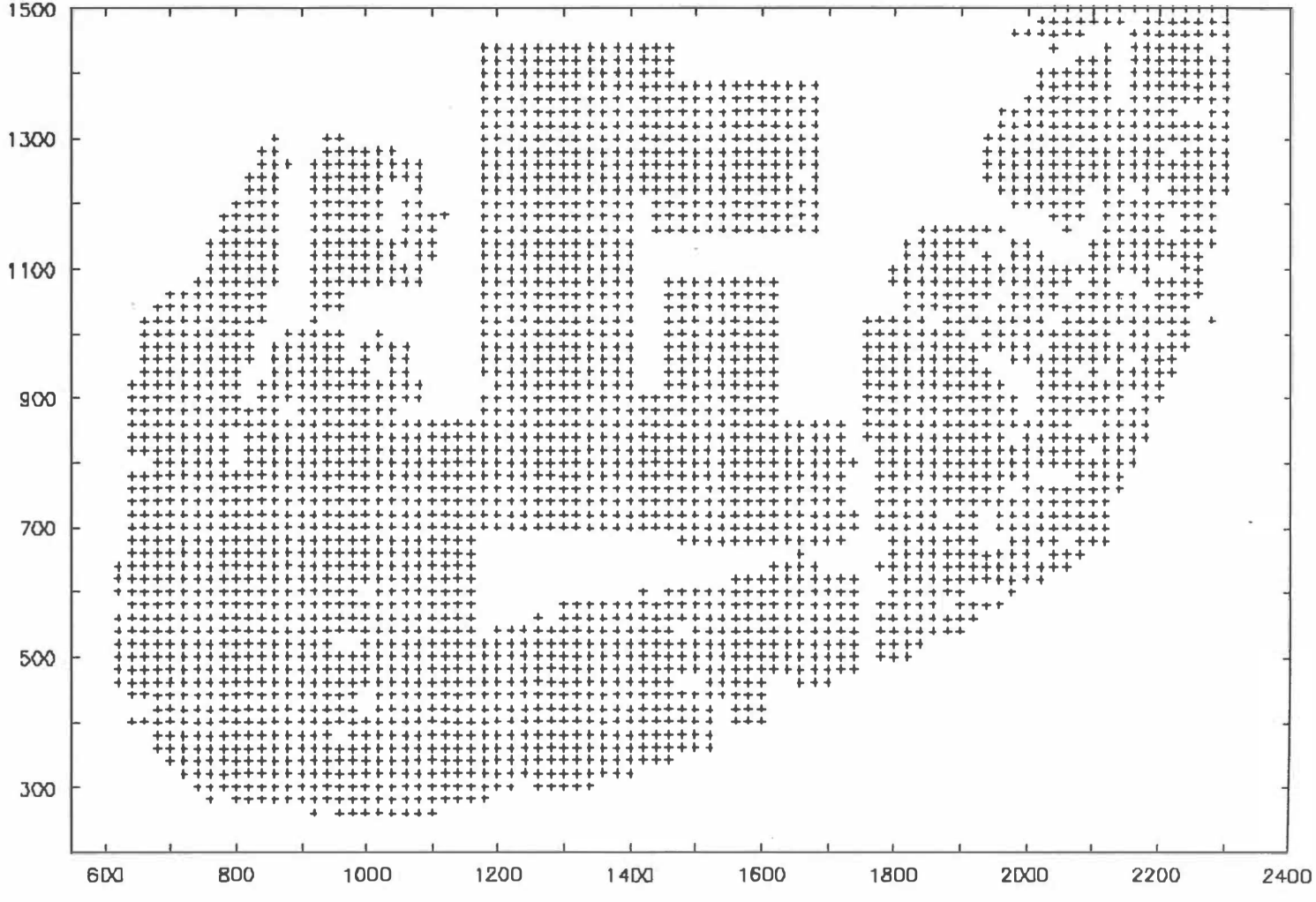


Figure 6.6. Surface II control points defined for Cheek Bend whole-bend grid.

characteristic of the Poisson distribution that the mean and the variance are equal. In a perfect Poisson situation, therefore, the ratio of variance to mean would be 1.0 (Hodder and Orton 1976:34; Thomas 1975:77; Zar 1984:410). The variance/mean ratios for Cannon and Cheek bends are presented in Table 6.2, and neither appears to be near 1.0.

Two questions follow from the observation that the variance/mean ratios for Cannon and Cheek bends are distant from 1.0. The first concerns the importance of the deviation of these ratios from 1.0. An Index of Dispersion (Hodder and Orton 1976:34) may be calculated as $(V/m)\cdot(n-1)$, where V is the variance, m is the mean, and n, in this case, is the number of grid units. This Index of Dispersion is distributed as a X^2 with n-1 degrees of freedom. The variance/mean ratios for both Cannon and Cheek bends are significantly different from 1.0 (Table 6.2).

Given that the distributions of material in Cannon and Cheek bends is non-random (variance and mean for artifacts/quadrat are not equal), the second question concerns the character of the distributions; non-random patterns may be either regular (uniform) or clustered (clumped). As non-random patterns approach uniformity the variance will decrease, resulting in a variance/mean ratio of less than 1.0 (variance will be less than the mean). If the non-random pattern is clumped the variance will increase, resulting in a variance/mean ratio larger than 1.0 (variance will be greater than mean). The non-random distributions of artifacts in both Cannon and Cheek bends both conform to a clustered or clumped pattern (Table 6.2).

Thomas (1975:77) notes that the variance/mean ratio is "little more than an initial attempt to apply the Poisson distribution to grid sampling data." The goodness of fit of the Poisson distribution to an observed distribution may be tested by the chi-square statistic.

Table 6.2. Summary statistics for 20 m whole-bend grid data.

		Density (artifacts/100m^2)					
Bend	Units(n)	Min.	Max.	Mean(m)	Std. Dev.	Var.(V)	V/m
Cannon	2408	0	92	2.32	5.85	34.22	14.75
Cheek	3344	0	449	6.31	19.55	382.20	60.57

Both distributions appear clustered (V/m>1)

Index of Dispersion (V/m)·(n-1) = 35503.25 (Cannon); 202488.58 (Cheek)

$X^2_{0.05,2407}$=2526.2 $X^2_{0.05,3343}$=3483.08

Reject H_o = difference between observed V/m and 1 is significant

The observed frequency of a given discrete density level is compared to the expected frequency as calculated using the Poisson probability. Tail areas are pooled to insure that no expected frequencies are less than zero (Zar 1984). The sum chi-square has degrees of freedom equal to the number of categories after pooling, minus one. Tables 6.3 and 6.4 present the chi-square goodness of fit test for Cannon and Cheek bends, respectively. In both cases, the null hypothesis (observed distribution of artifacts across the surface is random) is rejected.

While both artifact distributions are clustered, the Poisson distribution may still be used to define critical values for artifact density. Beginning with the proposition that "the archaeological record is most usefully conceived as a more or less continuous distribution of artifacts over the land surface with highly variable density characteristics" (Dunnell and Dancey 1983:272), the problem is one of defining the level at which density may be confidently regarded as significantly exceeding random expectations. Using the mean standardized artifact density calculated for each bend to characterize a Poisson distribution, it is possible to identify the critical values above which a random model is unable to account for observed density with a specified level of significance.

The mean density of artifacts associated with each control point in Cannon Bend is 2.32 artifacts/100 sq. m, and 6.31 artifacts/100 sq. m in Cheek Bend. By examining the upper tail area of the frequency distributions of artifact density presented in Tables 6.3 and 6.4, it is apparent that at the $\alpha = 0.05$ level (cumulative Poisson probability of $1-\alpha$) the critical value for Cannon Bend is 4 artifacts/100m^2, and the critical value for Cheek Bend is 10 artifacts/100m^2. Below these critical values the density of artifacts/100m^2 may conform with a random distribution. Densities above the critical values cannot be explained by a random distribution, and will be here taken to represent sites.

Table 6.3. Frequency distribution of artifact density with Poission and Chi Square probabilities: Cannon Bend.

Density (X=arts/100m^2)	observed f_o	Prob. P(X)	Cumulative Prob. ΣP(X)	Expected f_e	Chi Square $(f_o-f_e)^2/f_e$
0	1458	0.098274	0.098274	236.6	6305.20
1	221	0.227994	0.326268	549.0	195.97
2	162	0.264474	0.590742	636.8	354.01
3	113	0.204527	0.795269	492.5	292.43
4	89	0.118625	0.913894	285.6	135.38
5	84	0.055042	0.968936	132.5	17.78
6	38	0.021283	0.990219	51.2	3.42
7	34	0.007054	0.997273	17.0	17.04
8	35	0.002046	0.999319	4.9	183.56
≥9	174	0.000681	1.000000	1.6	18116.87
Total	2408	1.000000		2407.7	25621.66

$X^2_{0.05,8}$=15.5073 Reject H_o = artifacts are not randomly distributed

Table 6.4. Frequency distribution of artifact density with Poission and Chi Square probabilities: Cheek Bend.

Density (X=arts/100m^2)	observed f_o	Prob. P(X)	Cumulative Prob. ΣP(X)	Expected f_e	Chi Square $(f_o-f_e)^2/f_e$
0	1826	0.001818	0.001818	6.1	544844.95
1	302	0.011472	0.013290	38.4	1811.82
2	200	0.036193	0.049483	121.0	51.52
3	111	0.076127	0.125610	254.6	80.97
4	91	0.120091	0.245701	401.6	240.20
5	62	0.151554	0.397255	506.8	390.38
6	71	0.159384	0.566390	533.0	400.44
7	49	0.143673	0.700312	480.4	387.44
8	55	0.113323	0.813635	378.9	276.93
9	44	0.079452	0.893087	265.7	184.97
10	35	0.050134	0.943221	167.6	104.95
11	45	0.028758	0.971979	96.2	27.22
12	22	0.015123	0.987102	50.6	16.14
13	24	0.007340	0.994442	24.5	0.01
14	30	0.003308	0.997750	11.1	32.42
15	16	0.001392	0.999142	4.6	27.65
16	10	0.000549	0.999691	1.8	36.30
≥17	351	0.000309	1.000000	1.0	118448.94
Total	3344	1.000000	3343.9	667363.25	

$X^2_{0.05,18}$=28.8693 Reject H_o = artifacts are not randomly distributed

Density contour mapping. With the critical values identified for each bend it remains only to plot those areas with significant density on the maps. The Surface II Graphics System (Sampson 1975) was used to create contour plots of artifact density. Contour density maps for both bends with density interval set to 1 are presented in Figures 6.7 and 6.8. A second set of maps with contour intervals appropriate for the identified critical values (Cannon interval=4, Cheek interval=10) are presented in Figures 6.9 and 6.10. It is immediately apparent from comparisons of the above contour density maps that the identification and use of the critical values has eliminated a great deal of complexity in the resultant plots. It is intuitively satisfying to find that the Poisson distribution analysis has resulted in a more readily grasped and interpreted model of density structure in the two river bends. The low density patterning may safely be regarded as "noise" for the purposes of site definition.

The spatial structure of artifact density within the mapped sites will be used to identify intrasite patterning that will be useful for proposed point pattern analysis. The highest density area of a site with a single "peak" will be used to define a density-weighted site centroid. Sites with multiple "peaks" will be treated as multiple sites if they are characterized by distinct temporal periods (e.g. different projectile point types), or if the "valley" between them is deep. No statistical significance is associated with this intrasite pattern identification. At this level, the map itself serves as the descriptive model of structure (Jermann and Dunnell 1979).

An examination of Figure 6.9 reveals that Cannon Bend contains 26 significant high density areas. Six of these have internal structure; five are bi-lobed, and a single site has three peaks. Thirty-three potential sites were identified by this analysis.

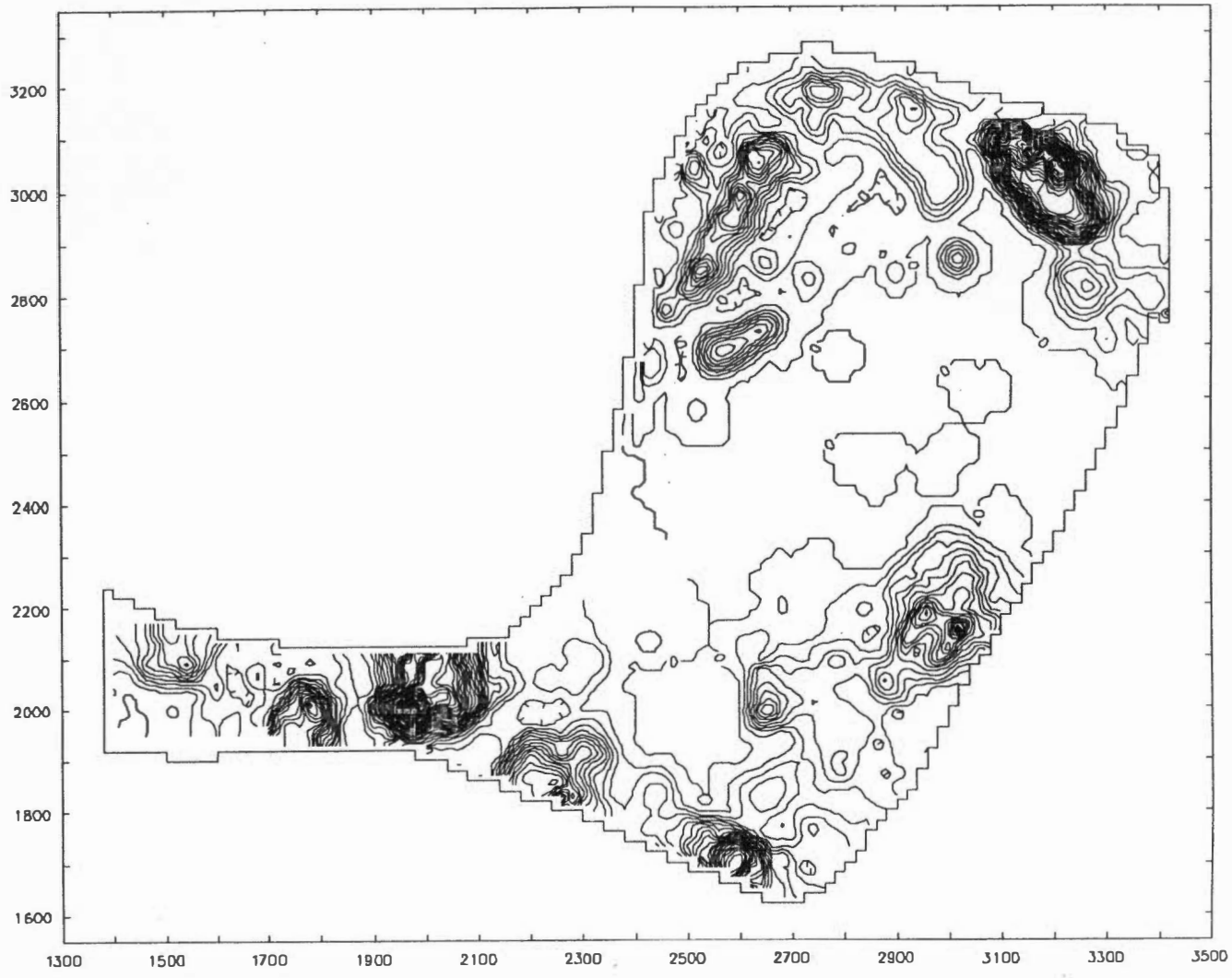


Figure 6.7. Surface II material density contour map of Cannon Bend; interval is 1 artifact:100 m^2.

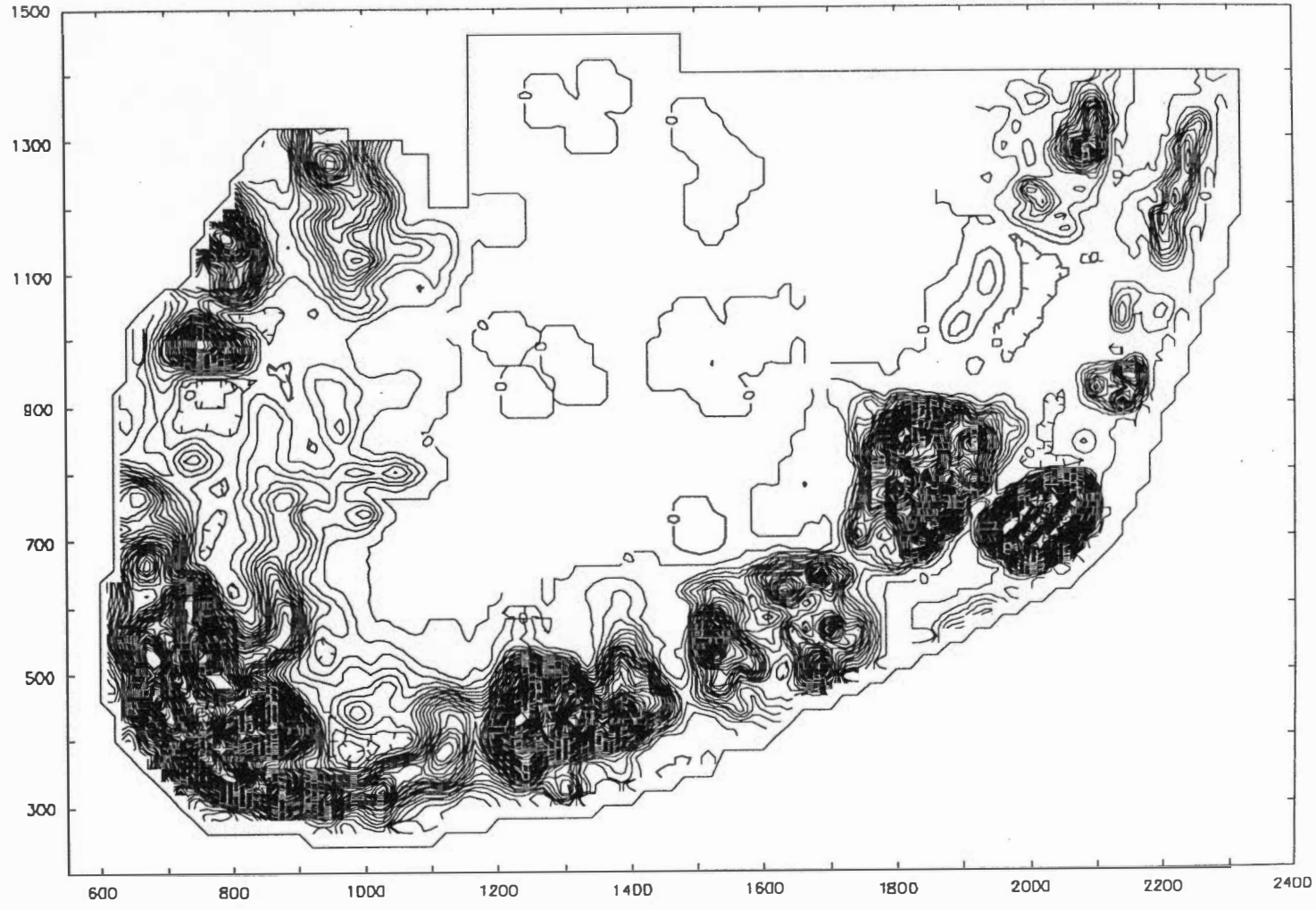


Figure 6.8. Surface II material density contour map of Cheek Bend; interval is 1 artifact:100 m^2.

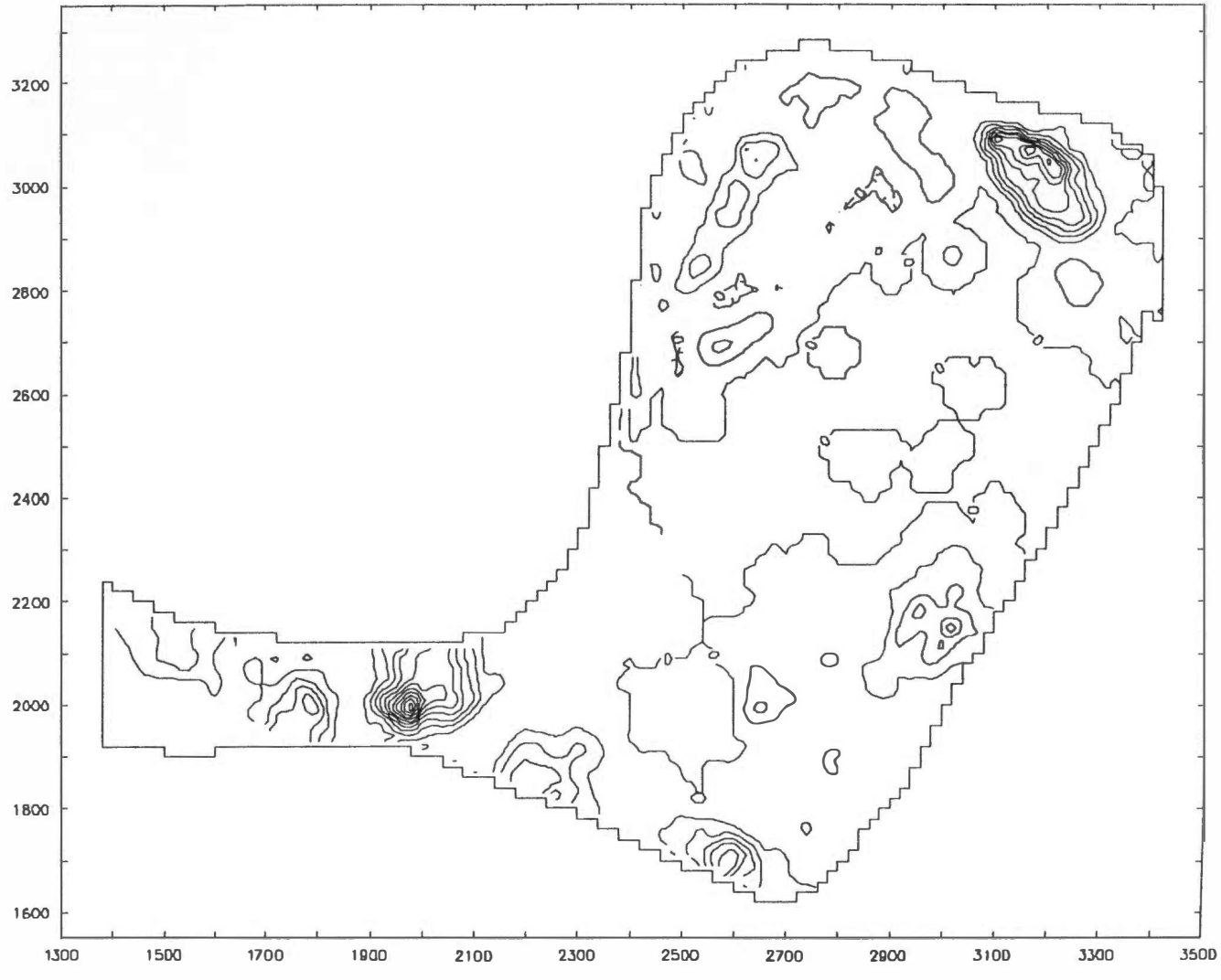


Figure 6.9. Surface II material density contour map of Cannon Bend; interval is 4 artifacts:100 m^2.

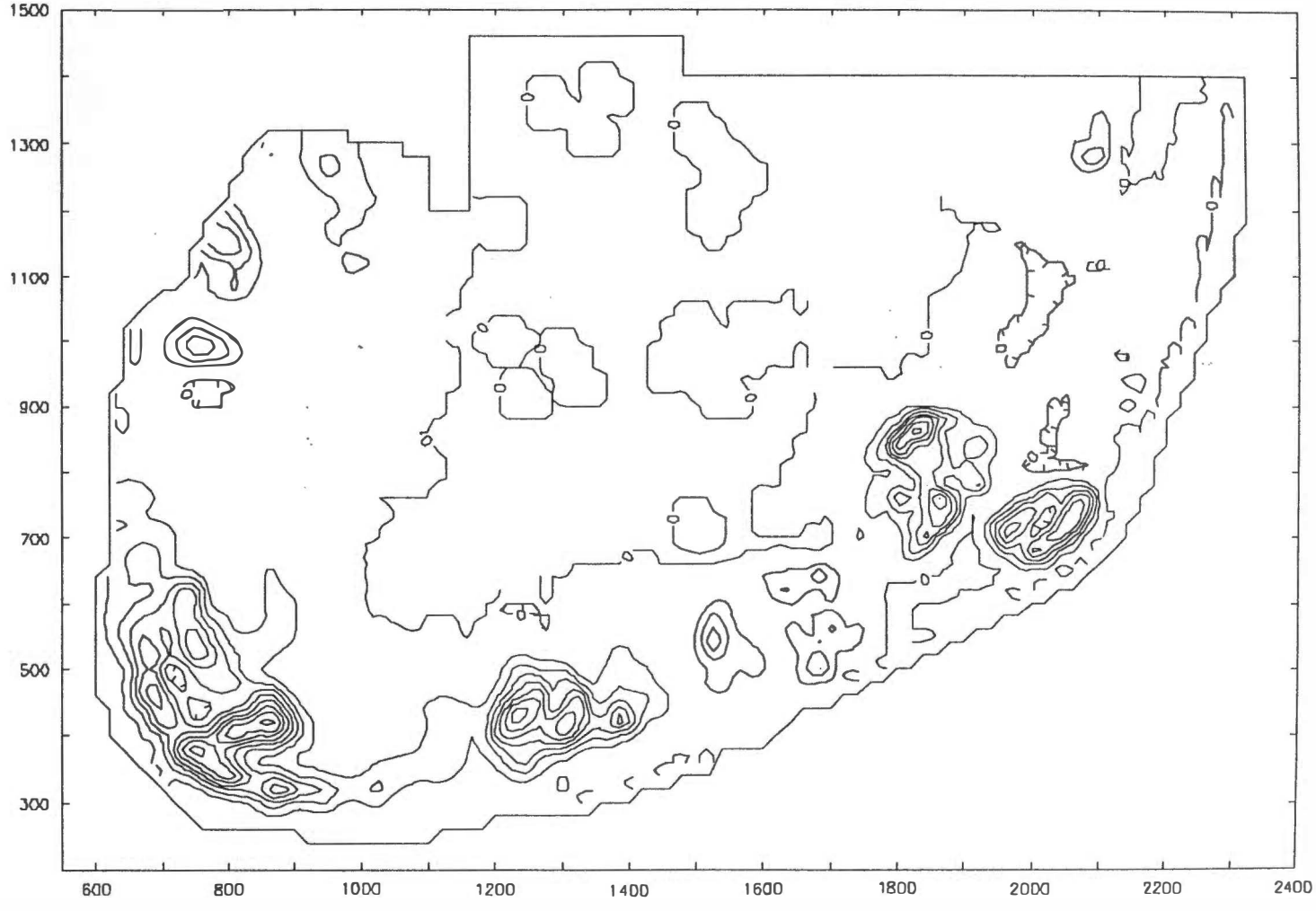


Figure 6.10. Surface II material density contour map of Cheek Bend; interval is 10 artifacts:100 m^2.

Figure 6.10 illustrates 15 significant high density areas within Cheek Bend. Six of these areas have internal structure; three are bi-lobed, one has three peaks, one has six peaks, and the largest defined area has eleven peaks. Thirty-five potential sites were identified by this analysis.

Figures 6.11 and 6.12 illustrate the locations of these analytic sites for Cannon and Cheek Bend, respectively.

Pattern Comparison

Visual comparison of the patterns of site distribution defined analytically and in the field is illustritive both of the evolution of field orientation (as described above), and of the process of archaeological management (Figures 6.13 and 6.14).

Virtually all of the sites defined in the field in the interiors of the two bends were not detected analytically. While artifacts were present, they were present in densities that did not exceeded random expectations. The same is true for many of the sites defined along the lower terraces in both bends under the earlier surveys. In the latter case the predilection to site definition was at least in part a result of the orientation of the investigators; site definition was the goal of the survey. In the former case the collectors were operating under the nonsite orientation, accepting the notion that artifacts should occur in nonsite contexts. Yet sites were defined, often encompassing entire agricultural fields (especially in Cheek Bend). If the density of artifacts was so low in these fields, why did investigators define sites? I suggest that in large part the definition of sites was not dictated by theoretical orientation as much as materials management needs; sites represented the organizing principal of cultural resources management. It was structurally impossible for researchers and managers to handle material that was not attributed to a site. If archaeologists are serious about the

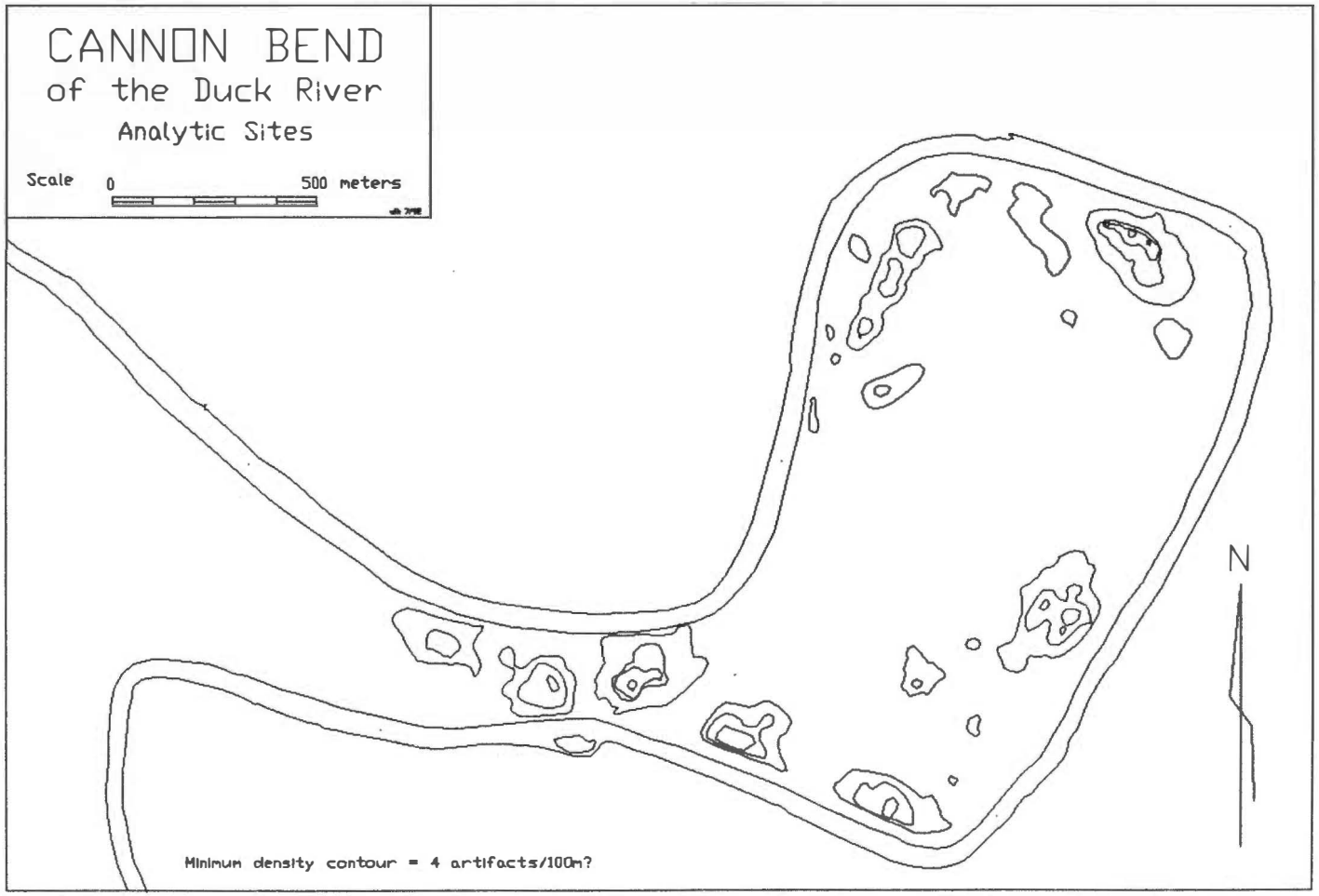


Figure 6.11. Cannon Bend analytic sites.

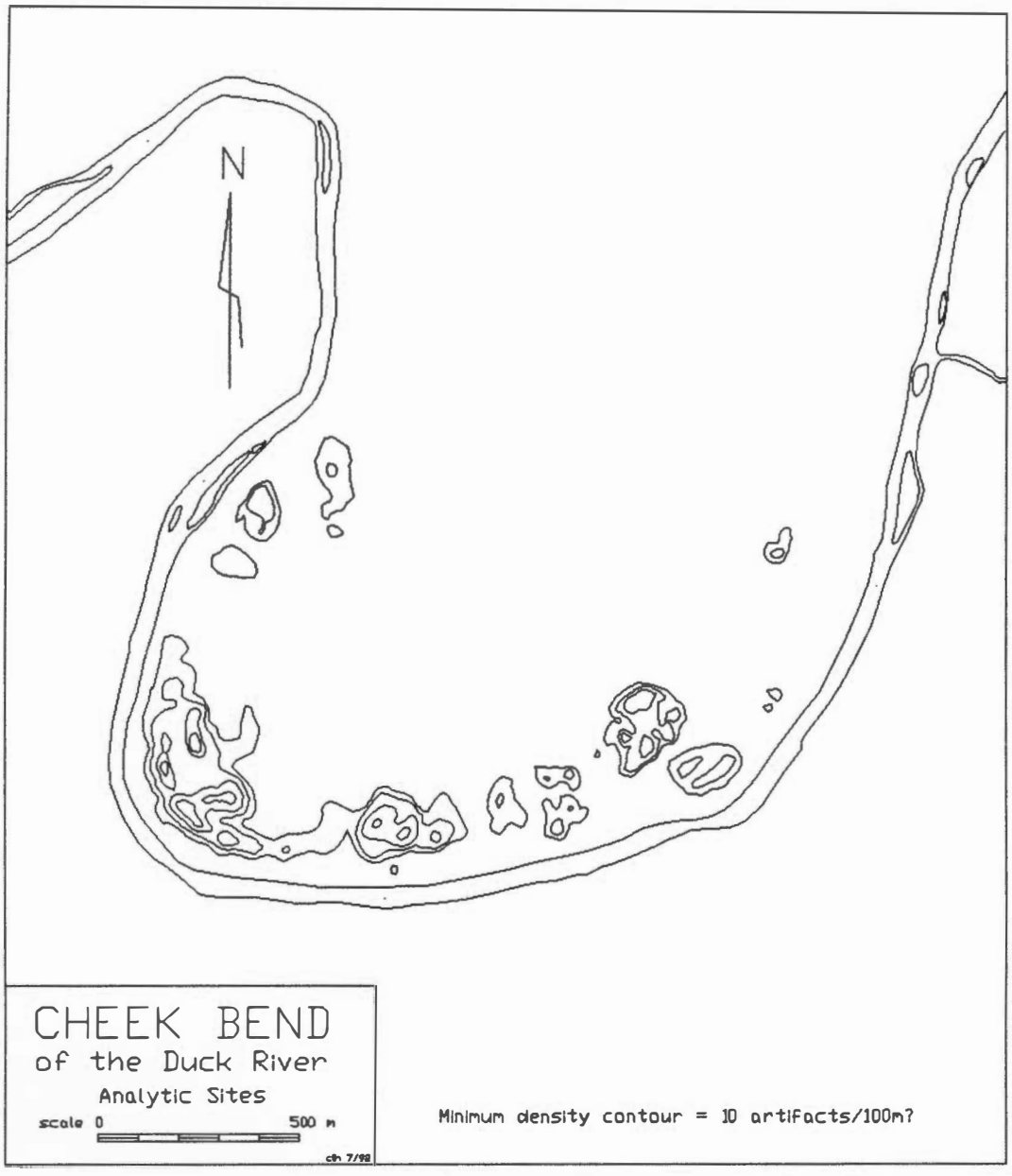


Figure 6.12. Cheek Bend analytic sites.

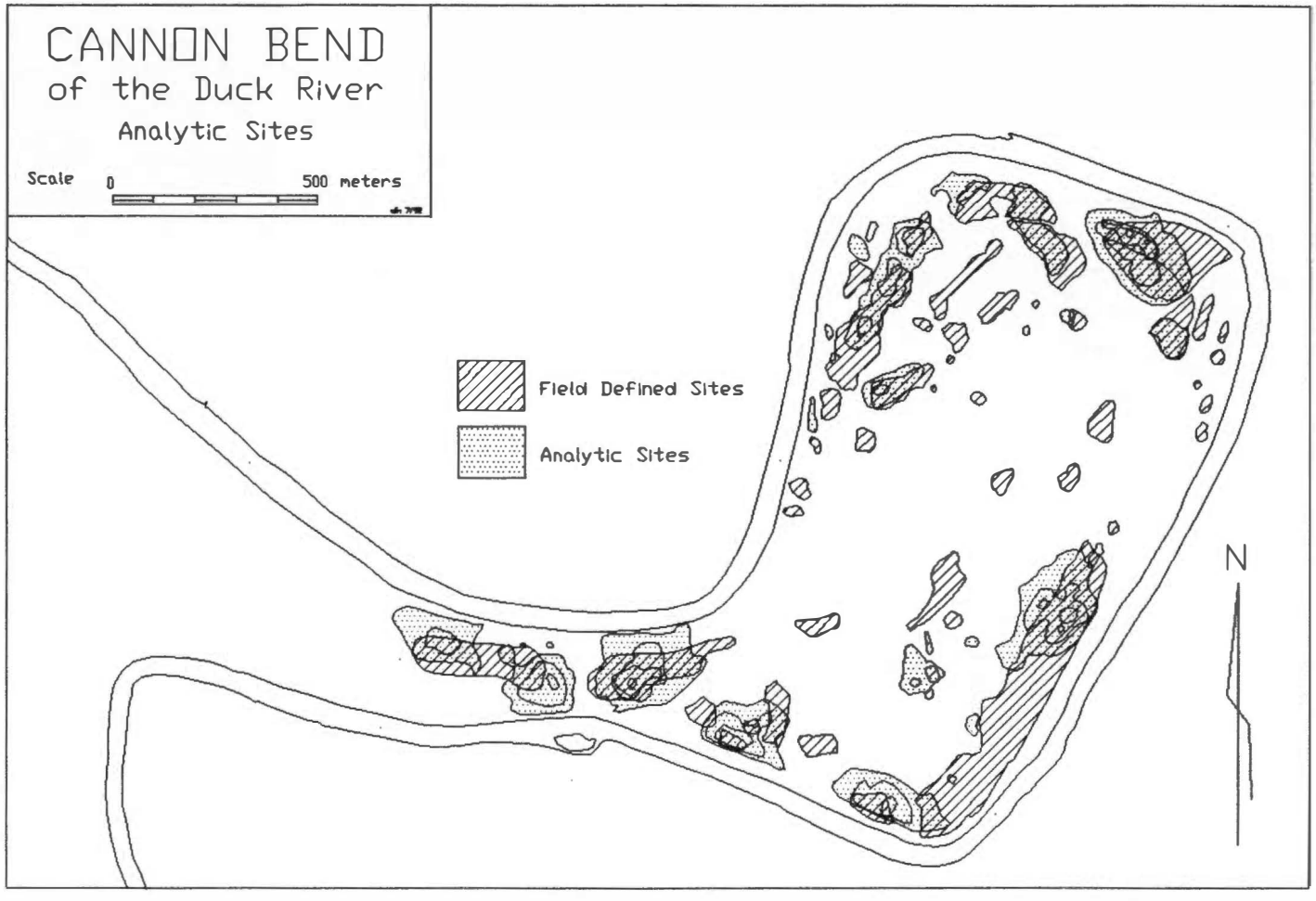


Figure 6.13. Comparison of field defined and analytic sites in Cannon Bend.

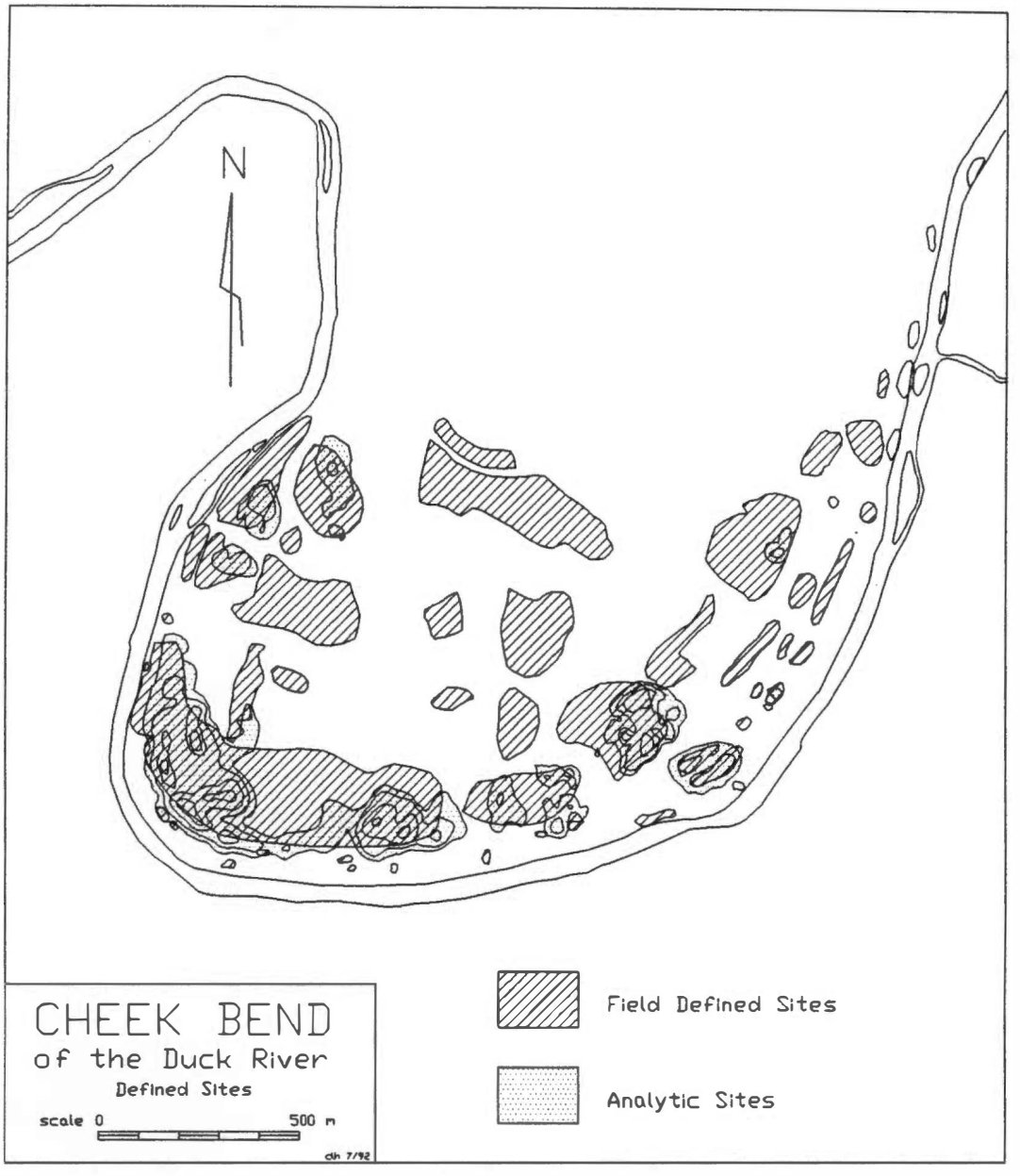


Figure 6.14. Comparison of field defined and analytic sites in Cheek Bend.

value of nonsite material, serious retooling of the management process will be necessary.

Where the analysis did detect a density of artifactual material that exceeded random expectations the field investigators had also generally defined sites. However, the configuration and internal structure of the analytic sites differ considerably from the field defined site patterns. In some cases the analysis definitionally split into multiple sites what had been defined as a single site. More often, however, the analysis was able to detect intrasite areas of spatially distinct high density: multiple density peaks. These areas potentially represent analytically discrete components (if they are characterized by the projectile points of different chronological periods) or settlements within a larger site context (cf. contemporaneous "communities", after Chang 1968). Finally, in some cases the analysis detected density association between what had been defined as separate sites in the field, and combined the sites.

The density analysis was highly successful in the definition of sites. The locations and patterns of defined sites are more informative, meaningful, and useful than those that resulted from the field investigation. The power of subsequent analysis regarding site distributions and patterns will be greatly enhanced because of the analytic nature of the units employed.

CHAPTER VII

CANNON BEND SETTLEMENT

In this chapter the analytic units defined in Chapters V and VI are used to investigate the pattern of material and site distribution across Cannon Bend. Chapter VIII will consider Cheek Bend patterning, and will follow the format developed in somewhat greater detail here. Summarizing from Chapter IV (Table 4.1), 20426 prehistoric artifacts were recovered from 3399 grid units in Cannon Bend. An additional 4910 prehistoric artifacts were recovered in site collection context, bringing the bend total to 25336 artifacts. As the surveyed area in Cannon Bend was approximately 118 ha, the average material density across the bend was equal to 0.0215 artifacts per square meter. This figure compares well with the density of systematically sampled units used in the definition of sites (2.32 artifacts per 100 sq. m, see Table 6.2). All recognized periods of prehistory were represented (see Table 5.3). Projectile points sorted into the Late Archaic group, however, accounted for 40% of the total; the Middle and Late Archaic together accounted for 46% of all classed projectile points. If projectile point proportions accurately reflect the contributions of the various periods to the total assemblage, then any given artifact has a greater potential of having been deposited on the surface of Cannon Bend during a period <u>other than</u> the Late and Middle Archaic (probability of <u>not</u> Middle or Late Archaic = 1 - .46 = .54). As a result, it is not necessary that the observations regarding the character of the surface distribution in Cannon Bend pertain to the target periods for this study. Both the data and the analysis are, however, capable of withstanding this potential liability. It has already been shown that the distribution of materials is not random (Chapter VI), and it is expected that the patterning has meaning.

The following analyses are intended to identify and characterize patterning. Meaning is best left to the realm of theory and to the techniques of logic and science. A theoretical framework based on economic and ecological principles was presented in Chapters I, III, and IV that may help explain the patterning. The expectations derived regarding the Cannon Bend assemblage may be summarized as follows: colonial or clumped spacing of both Middle and Late Archaic settlements is predicted by Horn's optimal spacing model; south facing, level areas near the river vertically and horizontally are predicted to have been disproportionately selected for settlements by general optimization models. The degree of fit between expectations and observations will be taken as a indication of the power of optimization theory to explain the patterning in the archaeological record, and by implication, the past.

Non-Site Pattern

A subjective evaluation of the degree of dispersion or aggregation in a density distribution may be directly gained from inspection of a density contour map (Figures 6.7 and 6.9), but is more readily obtained from a three-dimensional representation of the same data (Figure 7.1). In this oblique transverse view of Cannon Bend, peaks represent areas of high artifact density. Two observations concerning the distribution of artifacts are suggested by the figure; the intrabend area is vacant, and two primary peaks, one in the southwest (left), the other to the northeast (right), are present. The overall impression is one of a relatively clumped artifact distribution, with few widely spaced primary areas of high artifact density. While this impression generally fits the expectation derived from Horn's model, the degree of confidence vested in the conclusion is minimal. The pattern of artifact distribution in Cannon Bend may be more systematically investigated using trend surface analysis.

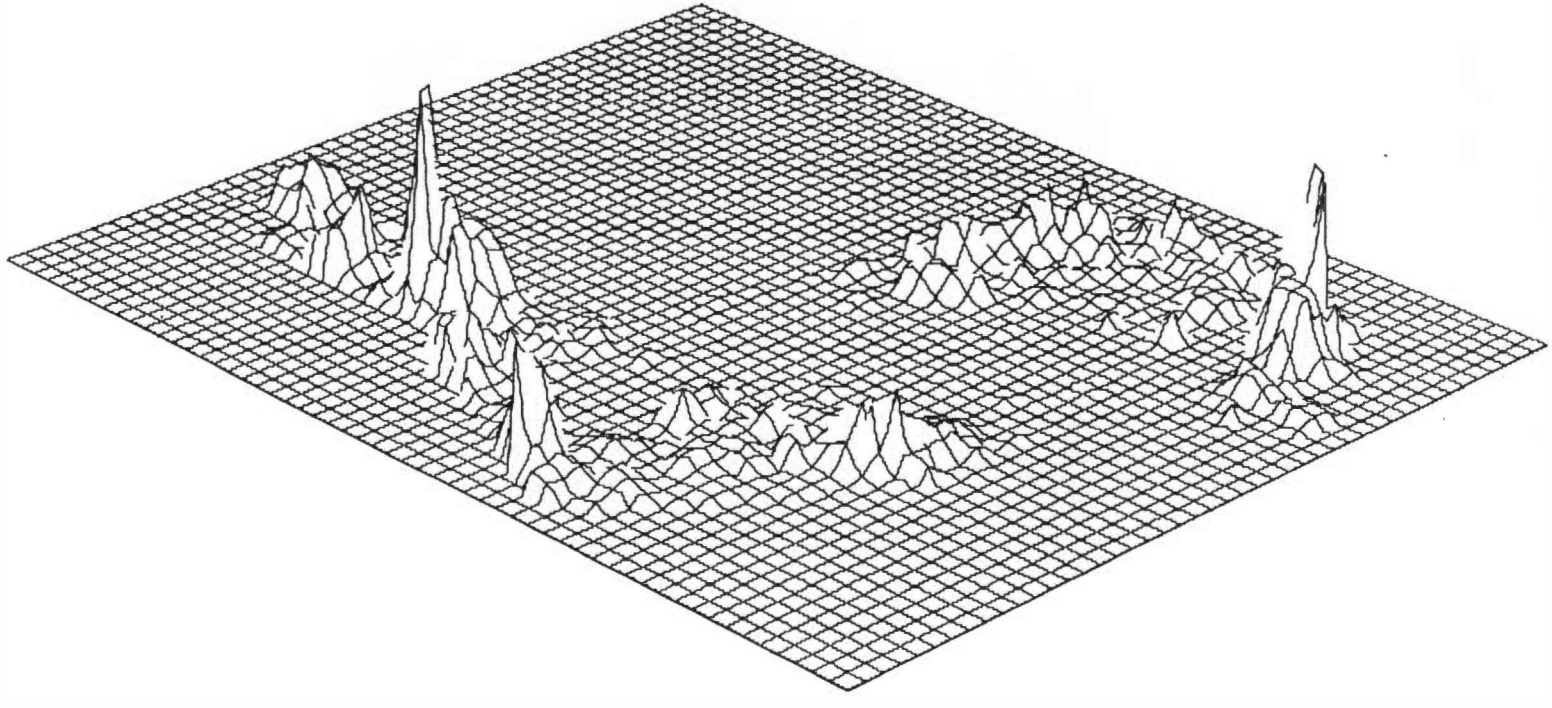


Figure 7.1. Oblique transverse view of mapped artifact density in Cannon Bend, facing northwest.

Trend Surface Characterization of Dispersion

Trend surface analysis is an application of polynomial regression to some mapped variable (Hodder and Orton 1976:155). A mathematical surface is generated by the least squares regression method in which the squared deviations between the points on the actual surface and those on the modeled surface are minimized. By this method the "best" fit is obtained within the framework of the parameters set by the analyst. The primary controlled parameter in trend surface analysis is the number of inflections the modeled surface may incorporate. This number is one less than the order of the model (Haggett et al. 1977:379), such that a first order trend surface has no inflections (a flat surface), a second order trend has a single inflection or bend, a third order may have two inflections, and so on. At lower orders, the trend surface may be seen to characterize the general trends in data, while at higher orders an increasing amount of the local patterning is modeled.

The analysis produces, in fact, two component patterns; the trend and the residuals. The trend is the fitted surface, and may be regarded as a model of the regional character of the mapped variable. The residuals represent the difference between the trend and the actual measures of the mapped variable, and may therefore be regarded as a characterization of local deviations from the regional pattern (Hodder and Orton 1976:155). This aspect of trend surface analysis has been used by at least one archaeologist to extract significant patterning in site data on the regional level (Hanson 1985). The question of interest in the present analysis, however, concerns the degree of complexity of the actual surface. If prehistoric settlement in Cannon Bend was in fact clumped or colonial, then we would expect relatively few but large and spatially distinct peaks in the density distribution of artifacts. It is intuitively clear that a flat surface would be a poor model of such a pattern; numerous "bends" in

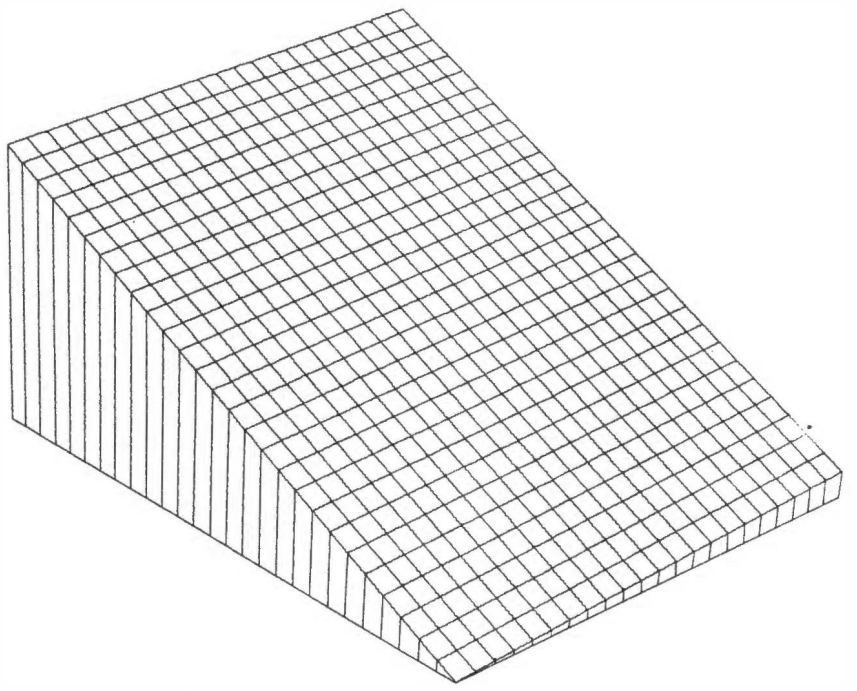
the surface would be required to fit a regression surface to the actual distribution of artifacts.

First through fifth order trend surface analyses were conducted with the data described in Chapter VI using the Surface II program (Sampson 1975). The fitted surfaces and the contoured residuals are presented in Figures 7.2 through 7.6. These are briefly described and discussed below.

The first order trend surface (Figure 7.2 a) increases in altitude generally from east to west. The extremely high density of material observed in the constricted "neck" of Cannon Bend (e.g. site 40MU409, Turner 1986) is largely controlling this trend. Contributing to this trend is the relatively vacant area along the southeastern boundary of the bend. The relatively high density site in the northeast corner of the bend (Figures 6.9 and 7.1), however, has been ignored by the fitted surface, as is indicated by the contour map of residuals.

Table 7.1 presents the Analysis of Variance statistics (Neter et al. 1985) for all five fitted surfaces. The Total Sum of Squares (SSTO) is a measure of the total variation in density among grid units. The Error Sum of Squares (SSE) denotes the variation in density not accounted for by the model (deviations from the surface). The Regression Sum of Squares (SSR) is a measure of the association between the average density and the fitted surface; as SSR increases relative to SSTO the model is accounting for more of the deviation in the actual material density. The significant F statistic for this and all orders of the trend surface indicates that the true parameters of the regression are significantly different from zero (e.g. that the real surface is not flat); not that the fitted models are especially good characterizations of that real surface. A better measure of goodness-of-fit is provided by the coefficient of multiple determination (R^2). This R^2 is a ratio of SSR to SSTO, and measures

(a)



(b)

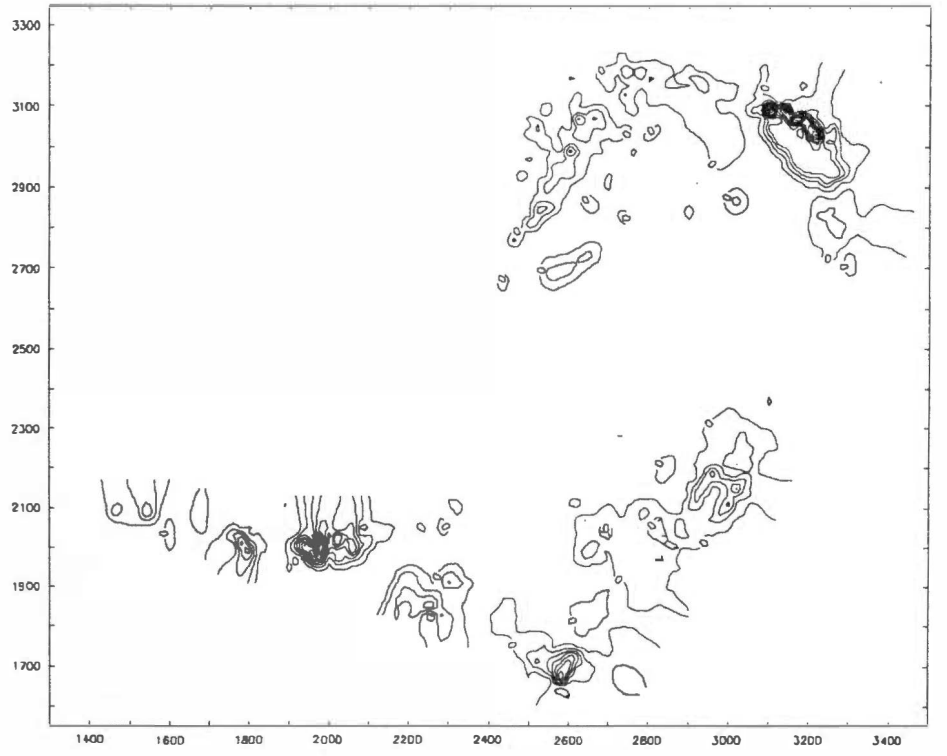
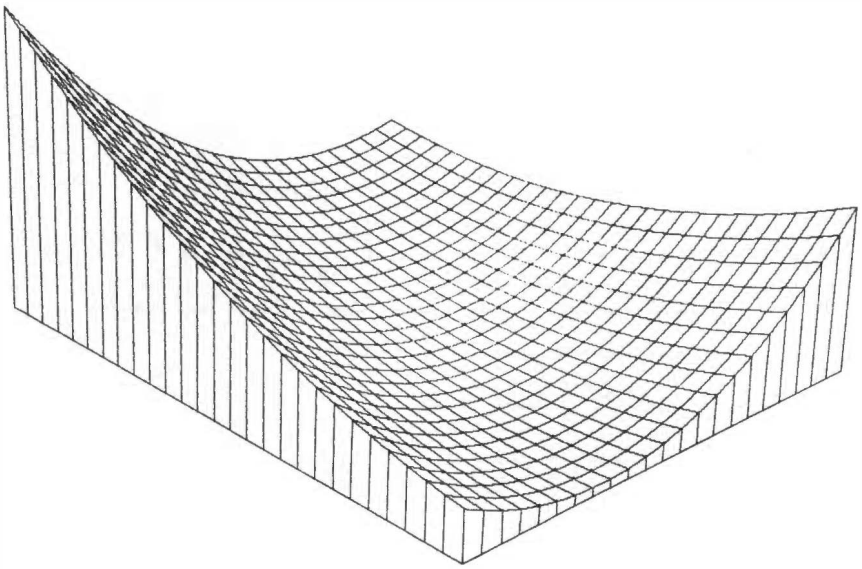


Figure 7.2. First order trend surface of mapped artifact density in Cannon Bend, facing northwest (a), and residuals (b).

(a)



(b)

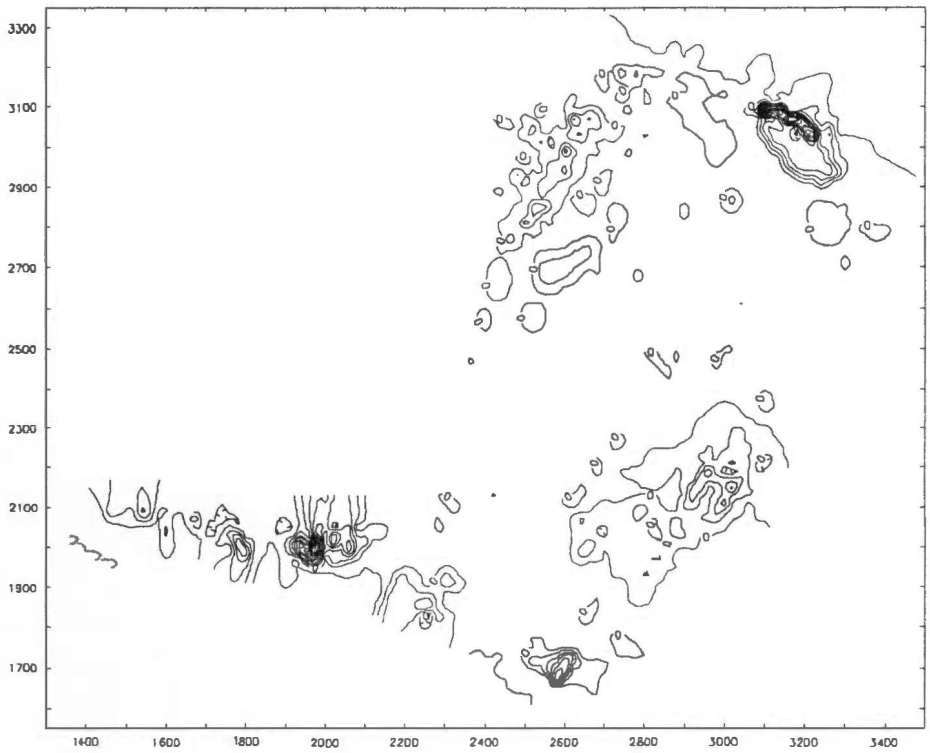
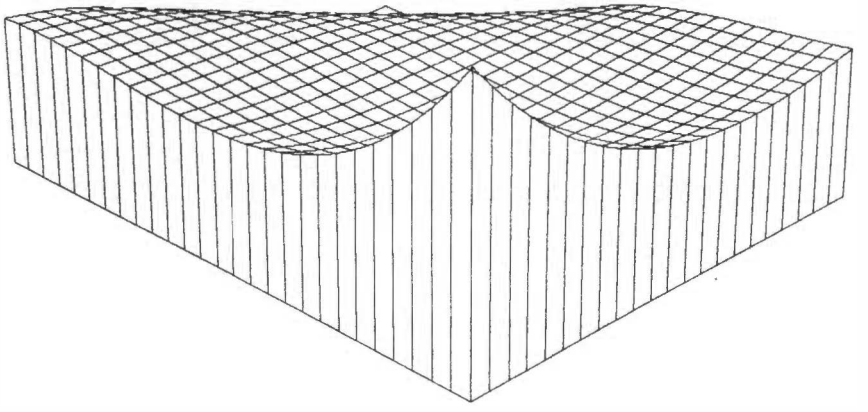


Figure 7.3. Second order trend surface of mapped artifact density in Cannon Bend, facing northwest (a), and residuals (b).

(a)



(b)

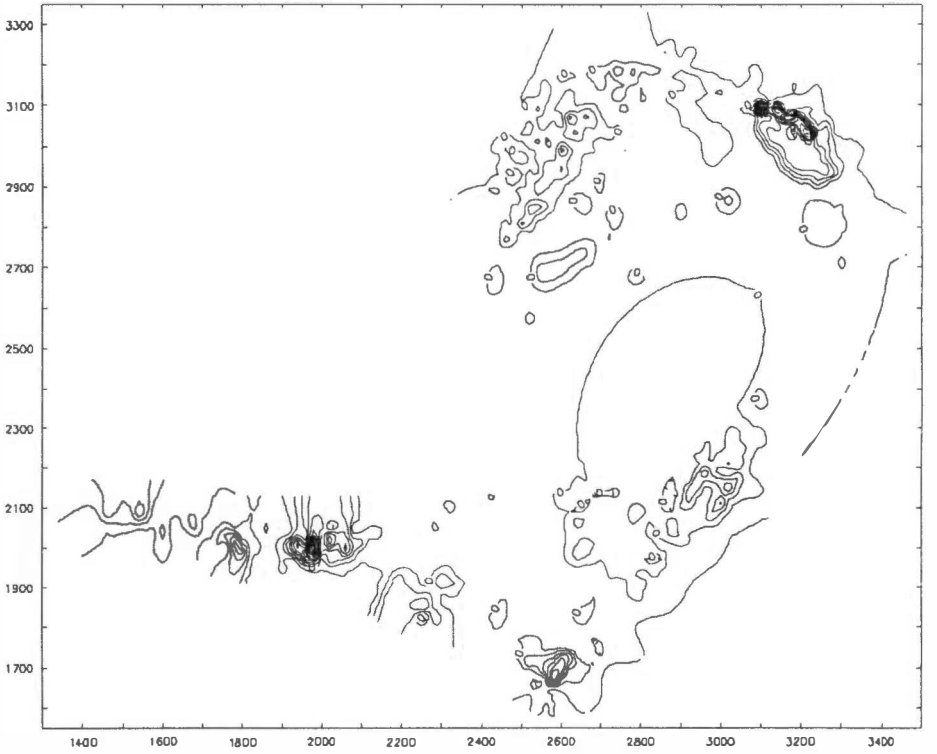
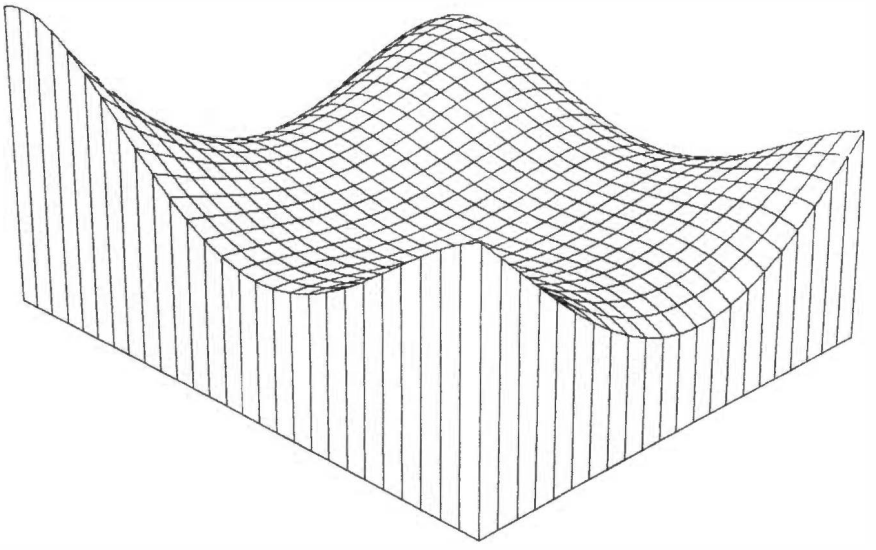


Figure 7.4. Third order trend surface of mapped artifact density in Cannon Bend, facing northwest (a), and residuals (b).

(a)



(b)

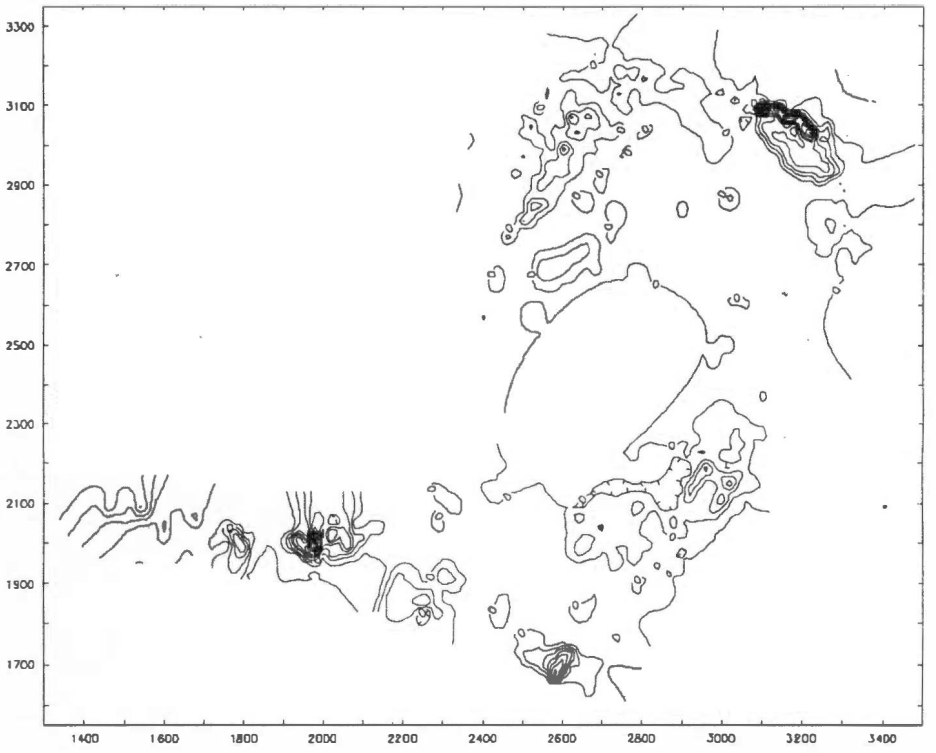
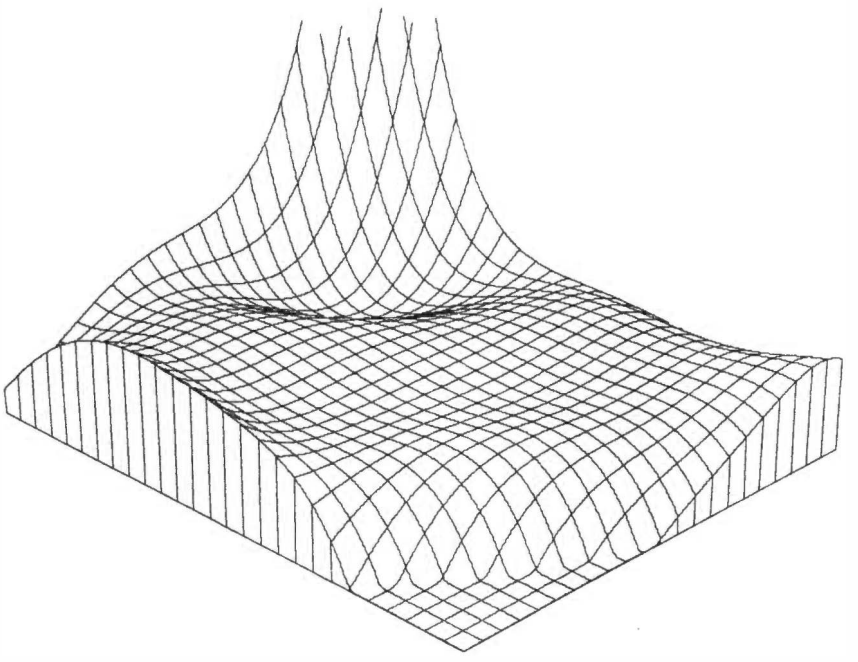


Figure 7.5. Fourth order trend surface of mapped artifact density in Cannon Bend, facing northwest (a), and residuals (b).

(a)



(b)

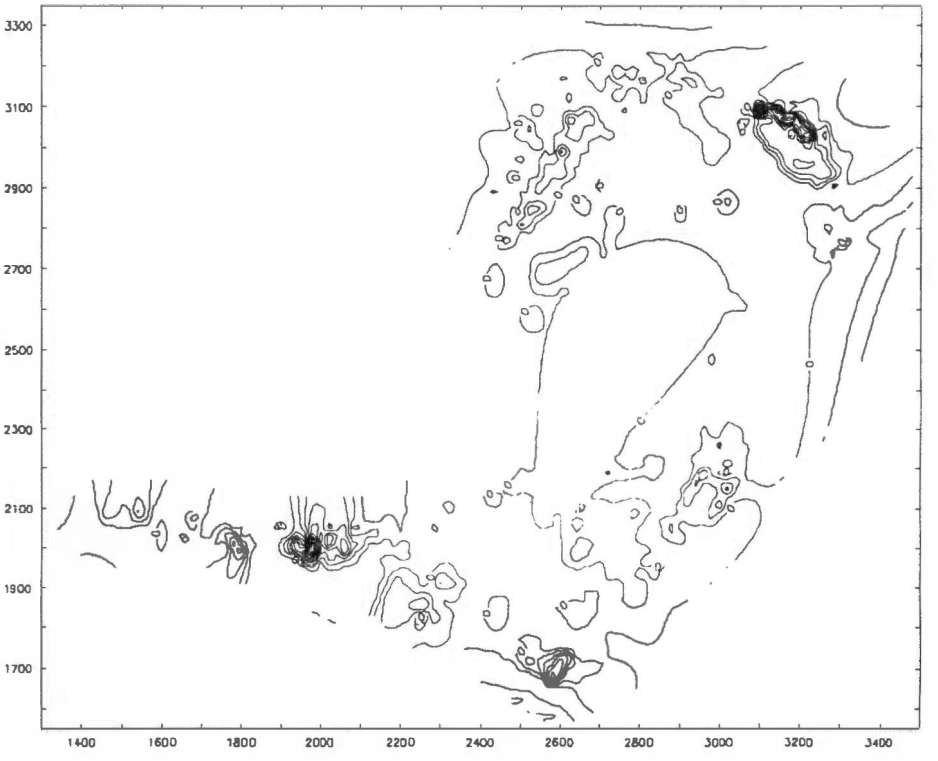


Figure 7.6. Fifth order trend surface of mapped artifact density in Cannon Bend, facing northwest (a), and residuals (b).

Table 7.1. Analysis of variance table for first through fifth polynomial trend surface results: Cannon Bend.

Order	SSTO	SSE	SSR	R^2	F^*	df
1	82377.0	81105.7	1271.3	0.12	18.85	2,2405
2	82377.0	74130.3	8246.7	0.32	53.44	5,2402
3	82377.0	71759.8	10617.2	0.36	39.42	9,2398
4	82377.0	68553.3	13823.7	0.41	34.47	14,2393
5	82377.0	65538.5	16838.5	0.45	30.66	20,2387

* all F values are significant at the 0.001 level.

the proportion of the total variation in artifact density explained by the model. If all true artifact density values fell precisely on the fitted trend surface then R^2 would be 1.0 (a perfect fit); if the fitted surface was completely unrelated to the true distribution of artifacts then R^2 would be 0.0. An R^2 value of 0.12 for the first order trend surface indicates a relatively poor fit.

This first order trend surface analysis is also useful as an independent check of the results obtained from the Poisson analysis presented in Chapter VI. From a non-site perspective, sites may be regarded as areas of local deviation from a regional trend; artifacts are distributed throughout the region with recognizable areas of high density. If the first order trend surface analysis is a model of the regional distribution of artifacts (Hodder and Orton 1976:155), then the residuals, representing significant departures from this background pattern, should represent sites. A comparison of Figures 7.2 (b) and 6.9 indicates substantial similarity, supporting the results of the Poisson analysis.

The second order trend surface and residuals are presented in Figure 7.3. This fitted surface, with a single inflection, bends upward at both the eastern and western ends. In this manner the model has attempted to account for the two primary high density areas to the west (left) and east (right) of the bend. As would be expected, the modeling of this second primary area of high artifact density greatly increases the fit of the trend surface to the real world (R^2 of 0.32, Table 7.1). This is, in fact, the largest proportional increase in R^2 obtained from the overall trend surface analysis.

The third, fourth, and fifth order trend surfaces assume increasingly erratic shapes as the model struggles to explain variability where there is none: beyond the limits of the collected area. This problem with trend surface analysis has been noted by other researchers (Hodder and Orton 1976:163) for cases where data

points do not extend to the edges of the map. The interpretative value of these surfaces is, of course, extremely limited.

In general, it may be concluded that the second order trend surface provided a much better characterization of the real distribution of artifacts across Cannon Bend than did the first order surface. This result is consistent with the intuitive characterization of the density surface offered at the beginning of this chapter, and with the expectations derived from Horn's model.

Trend Surface Characterization of Gravity Effects

Four situational variables were selected for analysis in the present study: elevation, distance to the river, slope, and facing aspect. Each of these is discussed below.

Elevation and distance to the river are the vertical and horizontal components of a single hypothesized determinant of settlement location: proximity to the river. It is suggested that the spatial correlate of energy conservation is distance minimization (Jochim 1976:48). Given that the river would be a source of critical resources (most notably potable water), the efficient forager would locate a settlement as near the river as possible (Hall and Klippel 1988).

Vertical elevation was measured directly from the CAD overlay of analytic sites and topography. Elevation contours, generally 5 foot (1.5 m) with occasional 2.5 foot (.75 m) intervals in areas of low relief, were digitized directly from the 3.75' USGS topographic maps available for the study area. Interpolation based on proportional distance between bounding contours was used to arrive at an elevation determination for each site measured to the nearest 1 foot.

Horizontal distance to the river was operationalized as the shortest straight-line distance between each analytic site and the near bank of the river. Distances were measured directly from the

scaled CAD drawings, providing interactive determination of minimum distance, measured to the nearest meter.

The slope of the terrain in the immediate site vicinity has often been used as a hypothetical determinant of settlement location (Hall and Klippel 1988; Jochim 1976; Kvamme 1985, 1992). It is argued here that slope may be seen as an economic variable (for a contrasting view, see Jochim 1976:51), as less energy is required to render a relatively level area comfortable than is required for a strongly sloped area. Slope was operationalized as the smallest linear distance between the contours separated vertically by 10 feet and bounding the analytic site; the "run" for an elevation change of 10 feet. This distance was measured directly from the CAD drawing to the nearest meter.

Facing aspect has also been frequently used as a determinant of settlement location (Hall and Klippel 1988; Jochim 1976; Kvamme 1985, 1992). It is generally assumed that facing aspect affects the suitability of an area for settlement due to factors of exposure; essentially south facing aspect maximizes solar warming (Kvamme 1992:26). Hall and Klippel (1988) have argued that south facing aspect would maximize protection from prevailing storm patterns in the study area. Aspect was operationalized as declination of a down-slope line placed perpendicular to the topographic contour line passing nearest the analytic site center, and was measured as degrees east of north. All activities associated with measuring aspect were performed in CAD.

Trend surfaces do indicate a tendency for settlement in areas minimizing slope. The first and second order surfaces peak in those portions of Cannon Bend where local relief is minimized: the topographic maximum (in the neck of the bend) and minimum (the broadest part of the lower terraces, Figure 2.3). Surprisingly, a trend toward minimizing distance to river both horizontally and

vertically is not indicated by the analysis. It will be suggested (see Summary, below) that the unique character of the location provided by the bend neck had an unanticipated effect on Cannon Bend settlement.

Site Distribution

The pattern of analytic site distribution in Cannon Bend may also be analyzed as a point pattern. Summary information for the analytic sites, including grid coordinates, is provided in Table 7.2. This analysis has the benefit of enhanced temporal control; the chronological affiliation of each defined site may be investigated by the co-occurrence of projectile point types and high artifact density.

Figures 7.7 and 7.8 illustrate the pattern of Late and Middle Archaic projectile point types overlaid on analytic sites. As can be seen, many projectile points occur in non-site context. This is to be expected, as many of the activities associated with the tools (e.g. hunting) should most frequently occur away from the settlement (Thomas 1975). The low numbers of Middle Archaic and Claymine points precludes meaningful definition of site patterns at the type level, but clear patterns are evident at the period level (Figures 7.9 and 7.10).

Comparisons of observed patterns to randomly generated patterns can provide an important check of analyses of pattern. For this reason a sample of random points equal in number to defined analytic sites was selected using a table of random numbers. Figure 7.11 illustrates the location of these random points, and summary information regarding them is presented in Table 7.3.

Nearest Neighbor Analysis

The distribution of sites may be explored by the nearest neighbor statistic (Hodder and Orton 1976; Whallon 1974). By

Table 7.2. Situational variables data for Cannon Bend analytic sites.

Number	LA Num.[1]	MA Num.[2]	Elevation	Slope[3]	Dist. to River	Aspect[4]	East	North
1	1		621	203	121	142	2295	1921
2	2		598	84	60	177	2587	1712
3	3		600	40	331	142	2654	2009
4	4		595	80	164	124	2881	2070
5	5	2	592	83	171	121	2925	2160
6	6		585	45	92	121	2998	2133
7	7		584	36	94	124	3017	2169
8	8		595	72	168	91	3253	2838
9	9	3	579	97	87	11	3163	3086
10	10		577	253	163	324	2643	3078
11	11		575	140	51	328	2512	3055
12	12		583	119	177	287	2571	2710
13		1	621	167	58	200	2219	1876
14		4	578	213	157	301	2600	2911
mean			592	115	135	178		

[1] cross reference to numbers used in Figure 7.9.
[2] cross reference to numbers used in Figure 7.10.
[3] meters run for elevation change of 3 meters.
[4] facing aspect in degrees east of north.

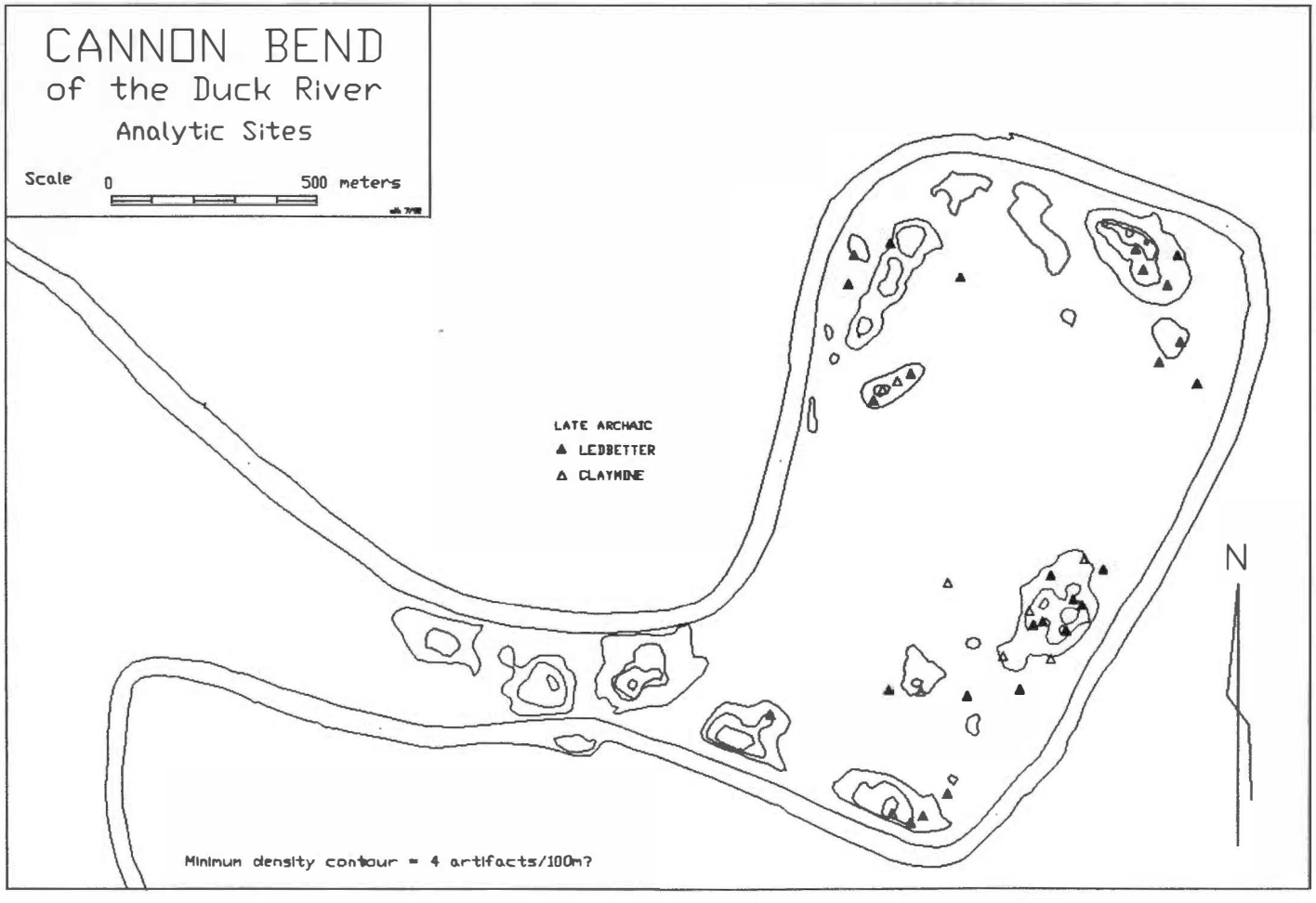


Figure 7.7. Location of Late Archaic projectile points overlaid on analytic sites in Cannon Bend.

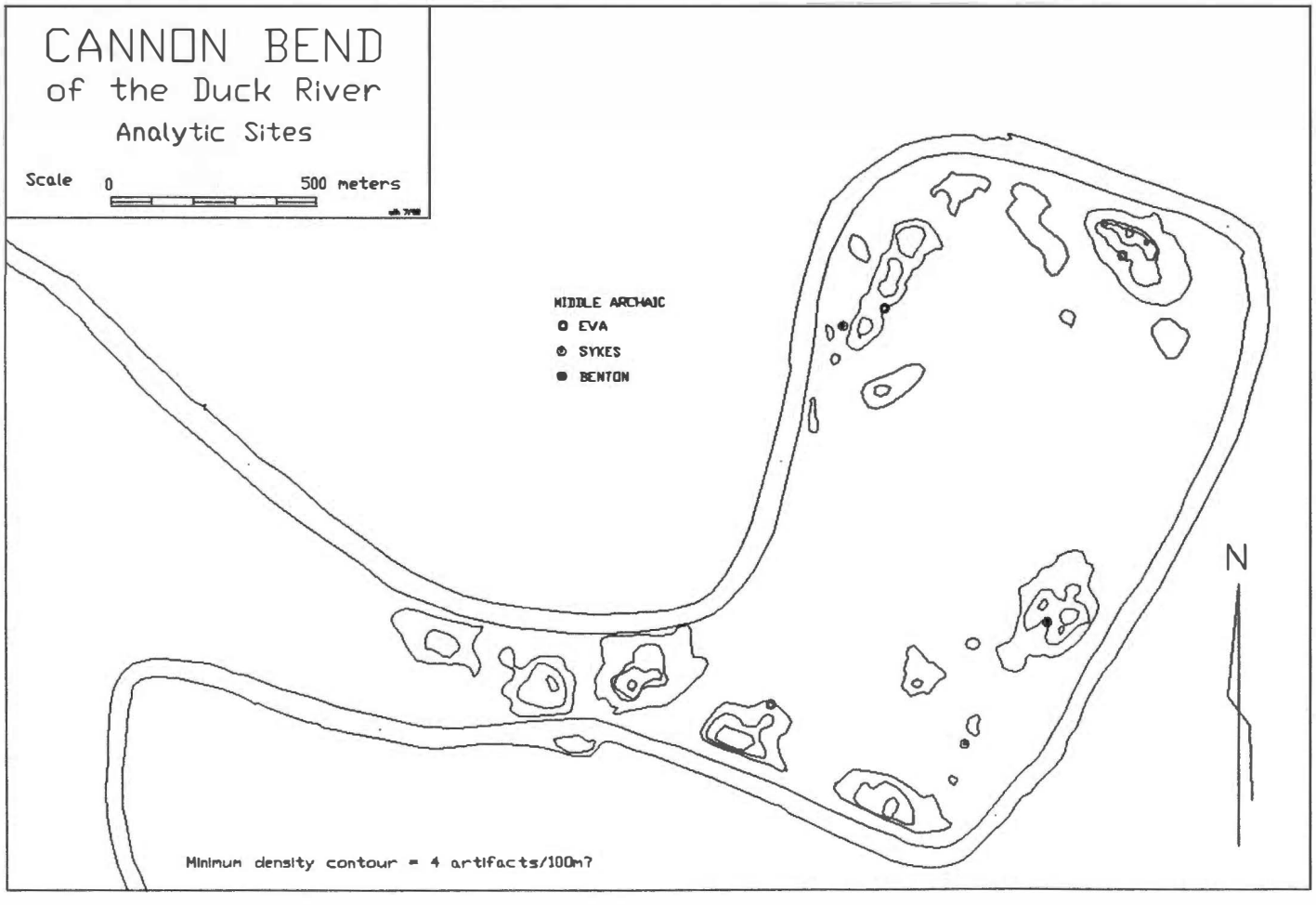


Figure 7.8. Location of Middle Archaic projectile points overlaid on analytic sites in Cannon Bend.

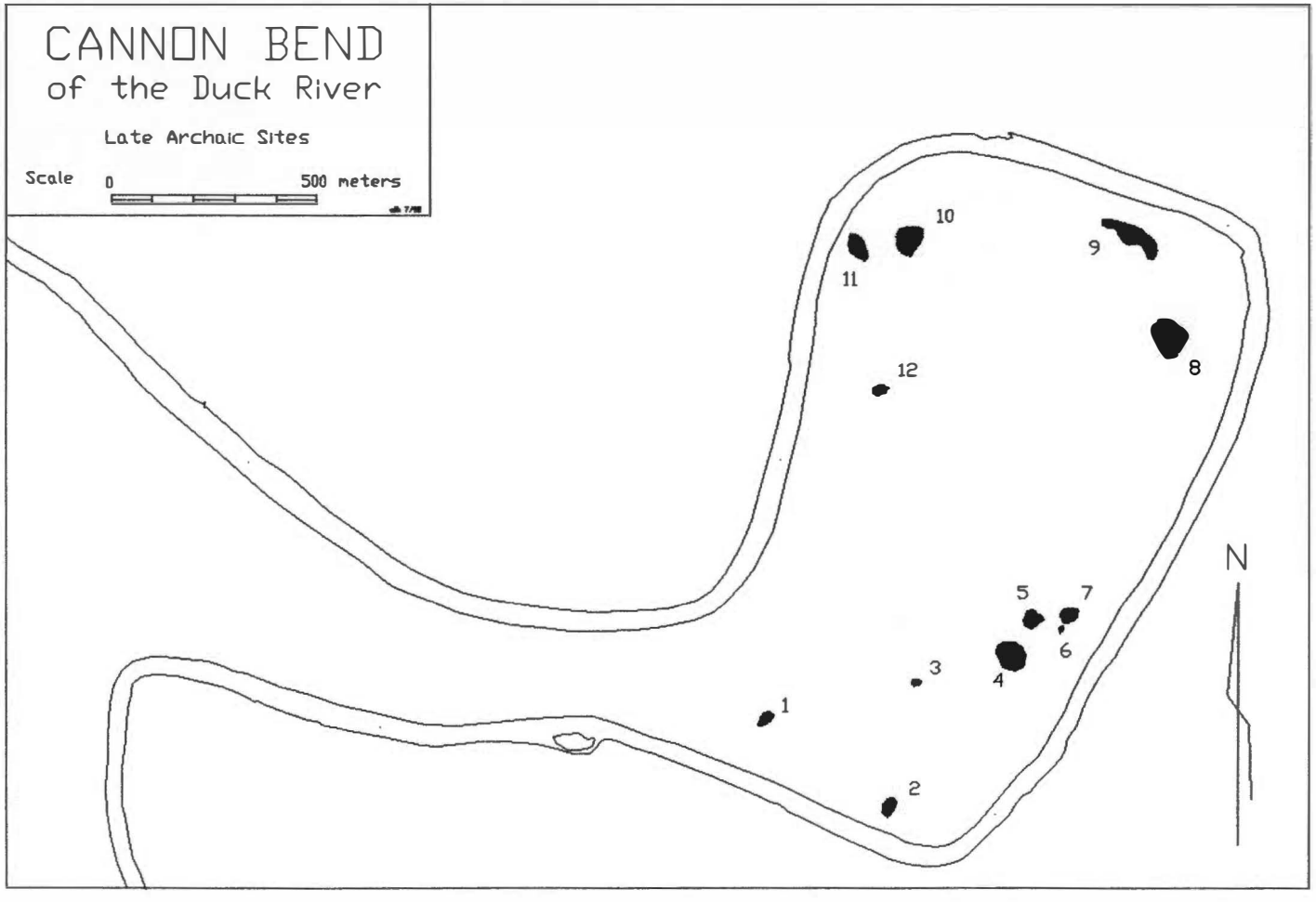


Figure 7.9. Late Archaic analytic sites in Cannon Bend.

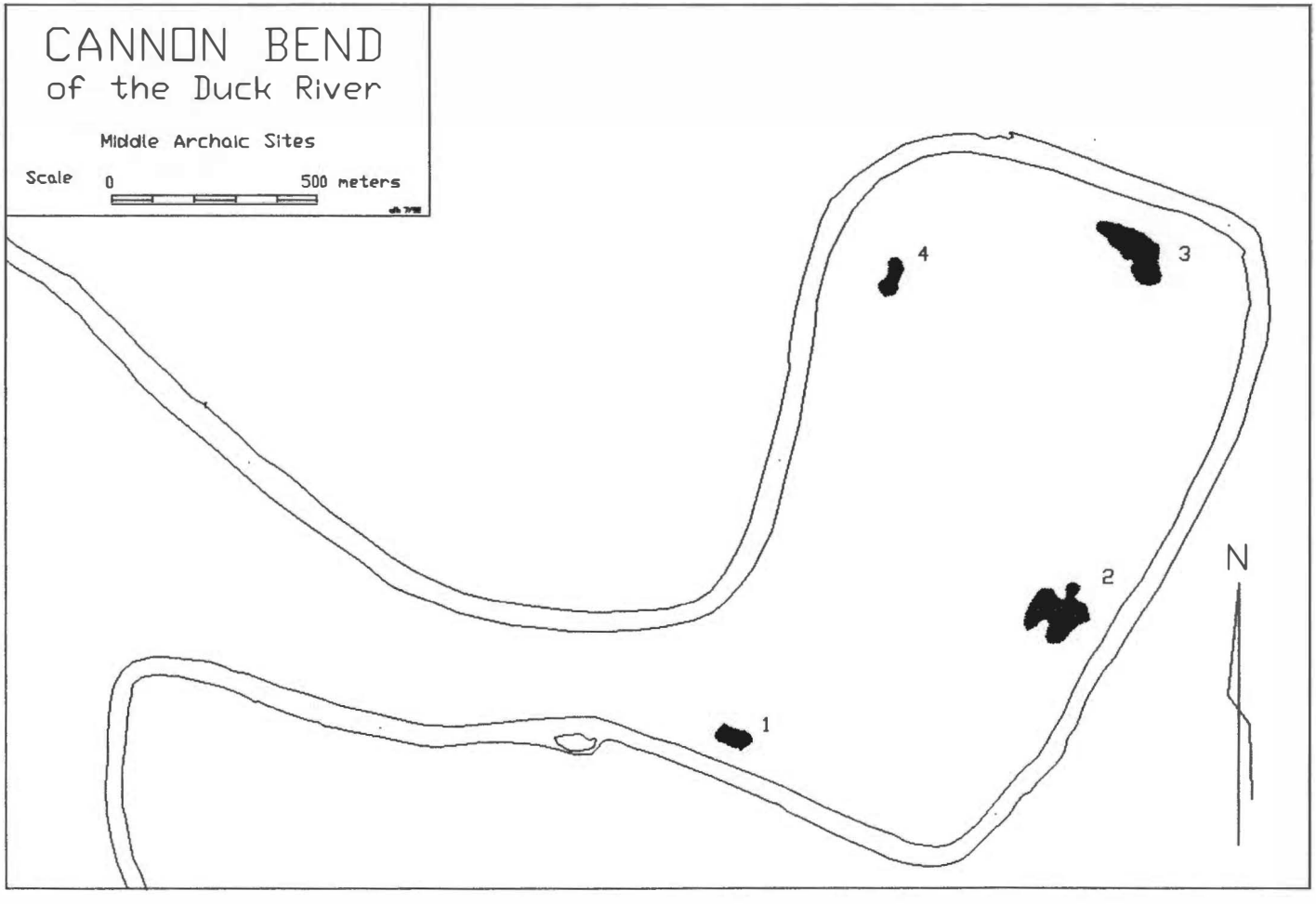


Figure 7.10. Middle Archaic analytic sites in Cannon Bend.

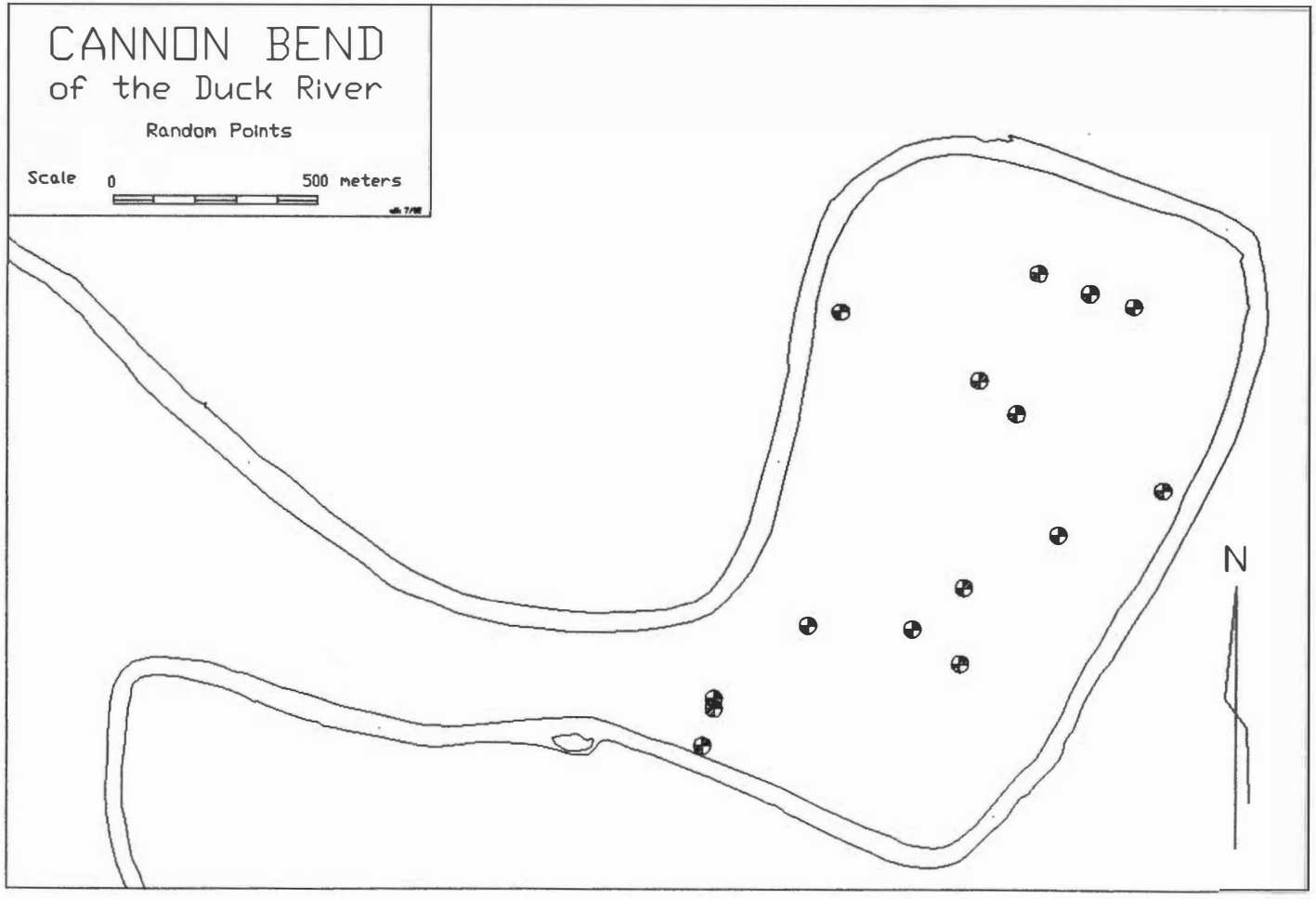


Figure 7.11. Distribution of selected random points in Cannon Bend.

Table 7.3. Situational variables data for selected random points in Cannon Bend.

Number	Elevation	Slope[1]	Dist. to River	Aspect[2]	East	North
1	600	11	17	193	2150	1860
2	625	21	115	52	2179	1946
3	615	26	134	47	2179	1970
4	624	40	194	111	2401	2145
5	604	128	402	137	2648	2138
6	588	81	279	130	2761	2057
7	597	95	345	125	2771	2241
8	594	25	215	134	2994	2364
9	578	93	54	116	3239	2494
10	615	94	438	105	2895	2657
11	612	65	413	344	2802	2742
12	580	65	261	332	3169	2915
13	590	41	240	19	3062	2948
14	591	81	246	20	2944	2995
15	575	169	57	284	2482	2911
means	601	62	239	133		

[1] meters run for elevation change of 3 meters.
[2] facing aspect in degrees east of north.

calculating the area over which a distribution is observed, and dividing the number of observations by this area, a density figure is obtained. The expected mean distance between points in an area is directly related to this density figure (Hodder and Orton 1976:40), and may easily be calculated as $1/(2\sqrt{\text{density}})$. The ratio (R) of the mean observed nearest neighbor distance to this expected mean nearest neighbor distance will vary between 0 (all points in the observed distribution are maximally clustered) and 2.29 (the observed pattern is perfectly regular with no variation in the nearest neighbor distance). An R value of 1 indicates that the observed nearest neighbor distance and the expected random nearest neighbor distance are equal; the observed point pattern is random. The significance of departures from R = 1 may be examined with the test statistic C, the "standard normal deviate" (Whallon 1974). C follows the standard normal distribution, allowing the specification of a critical value (α = 0.05) of 1.96. If the calculated R exceeds the critical value, the departure from random is significant.

Table 7.4 presents the nearest neighbor statistics for Cannon Bend sites and random places. While minor deviations from random patterning are detected, only the distribution of Middle Archaic sites is significantly different from random. The R of 2.2 for Middle Archaic sites indicates a near perfectly regular distribution of these locations (Figure 7.10). Extreme caution must be used in interpreting this result, however, due to the very low number of Middle Archaic sites in Cannon Bend. It is suggested that the pattern of Middle Archaic site distribution in Cannon Bend reflects the highly optimal character of a very few locations more than an optimal spacing response.

Table 7.4. Nearest Neighbor statistics for Cannon Bend sites.

	Late Archaic	Middle Archaic	All Sites	Random Places
Area	1419769	1419769	1419769	1419769
Number	12	4	14	14
Density	.000008	.000003	.00001	.00001
Mean Observeded Dist. (r_o)	191.8	666.0	149.2	139.3
Mean Expected Dist. (r_e)	172.0	297.9	159.2	159.2
Ratio r_o:r_e (R)	1.1153	2.23567	.9369	.8750
Standard Normal Deviate (C)	.7639	4.7278*	-.4513	-.8947

* Significant Values of C (α = .05) > 1.96

Kolmogorov-Smirnov Analysis

The character of the specific locations is further explored using the Kolmogorov-Smirnov statistic (Hodder and Orton 1976:226; Kellogg 1987; Kvamme 1985). This technique takes advantage of the quantitative and ordered nature of the variables hypothesized to have a role in determining the location of settlements. Cumulative frequency graphs are prepared for each variable (Figure 7.12), and the maximum deflection of the observed line from one representing a random distribution is measured (D). The significance of D may be estimated using theoretical distributions published as statistical tables. Table 7.5 presents the Kolmogorov-Smirnov D and associated significance level for each of the situational variables.

As is readily apparent from the cumulative graphs (Figure 7.12) elevation, slope and distance to the river all act in the manner expected; sites are lower in elevation than random places, are located in more level settings than random places (greater "run" for 10' change in elevation), and are closer to the river than random places. Aspect is more difficult to interpret from the cumulative graph. The slope of the cumulative graph for sites is greater in the initial segments than the random cumulative frequency line, indicating a tendency for sites to be located in settings with east and south facing aspect. The differences between site locations and random places on these variables, however, is significant at the $\alpha = 0.05$ level only once (Table 7.5). Only the horizontal distance to the river may be said to be significantly different from random, and the direction of the departure is in the manner expected; sites are nearer the river than would be expected if the distribution was random.

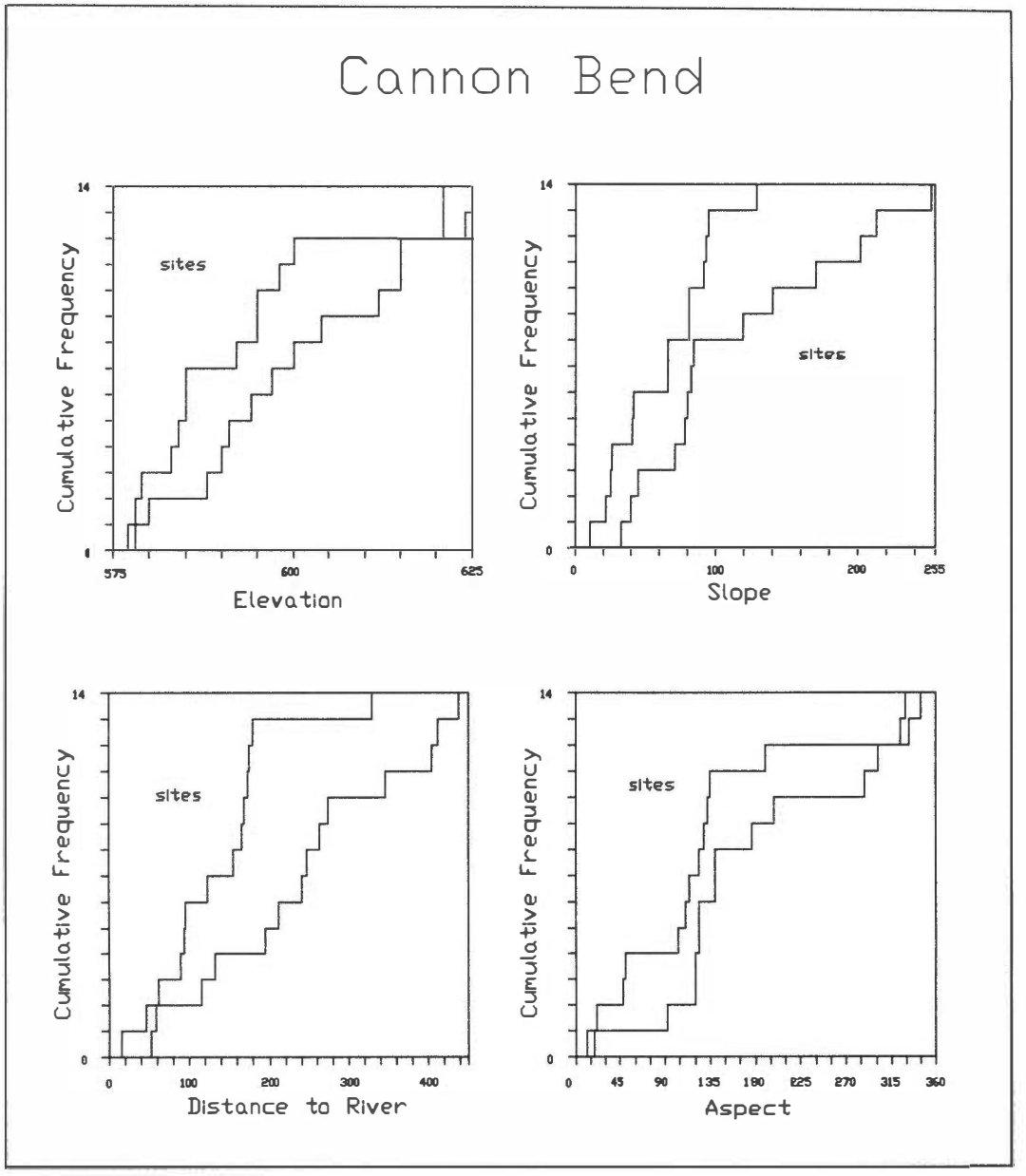


Figure 7.12. Cumulative frequency graphs of situational variables for Middle and Late Archaic sites and random points in Cannon Bend.

Table 7.5. Kolmogorov-Smirnov statistics for two sample comparison of situational variables at Cannon Bend sites and selected random points.

Variable	D	α
Elevation	0.357143	0.33300000
Slope	0.357143	0.33300000
Distance to River	0.642857	0.00614223
Aspect	0.357143	0.33300000

Summary

At an impressionistic level, all expectations have been met for the distribution of Cannon Bend sites. Statistical significance of some of the tendencies, however, is lacking. The distribution of sites appears to be clumped or clustered, with few sites dispersed along the river margin. Two sites appear as dominant features of the prehistoric landscape, and are located at extreme distance from one another. The importance of these locations was demonstrated by the trend surface analysis, which first accounted for the site located in the bend neck (40MU409), and then the site at the extreme northeast end of the bend (analytic site 9, Table 7.2).

While all of the situational variables appear to respond as expected, only horizontal distance to the river is statistically significant. It is suggested that this lack of significance may be in part due to the lack of environmental variability in Cannon Bend on the attributes selected for investigation. While topographic relief is marked, the proportion of area characterized as "bottoms" or alluvial terraces is quite large. High relief is restricted to the area of the bend constriction, or neck. Excluding this area for the moment, it is possible to envision an area that was relatively undifferentiated with respect to slope or elevation in the minds of prehistoric hunter-gatherers.

Turner (1986:16-18) has noted that site 40MU409 "manifests an unusual topographic situation. Elevation of this central isthmus exceeds 35 meters above the river at a constriction where only a few hundred meters separate the sharply curving banks as the river loops inward at the bend head." Such a setting would not be predicted based upon the situational variables included in this study: it is vertically so far above the river as to render it a very difficult location to inhabit given the assumed importance of nearness to

potable water. Jochim (1976:51, 55) has suggested that view would have been very important to hunter-gatherers, and may have played a central role in influencing the selection of locations for settlement. Sites that afforded good views may have been valued as places from which to watch for game (Jochim 1976), while they may also have been important for "social, defensive, or aesthetic reasons" (Kvamme 1992:26). It would be interesting to know if site 40MU409 functioned as a base camp or a "hunting stand" (Binford 1978b). An examination of the 40MU409 artifact assemblage would prove very interesting, but is beyond the scope of this study.

CHAPTER VIII

CHEEK BEND SETTLEMENT

In this chapter the analytic units defined in Chapters V and VI are used to investigate the pattern of material and site distribution across Cheek Bend. Minimal discussion of the techniques is presented here, and the interested reader is referred to Chapter VII where somewhat greater detail is provided. Summarizing from Chapter IV (Table 4.2), 52732 prehistoric artifacts were recovered from 5049 grid units in Cheek Bend. An additional 8864 prehistoric artifacts were recovered in site collection context, bringing the bend total to 61596 artifacts. As the surveyed area in Cheek Bend was approximately 139 ha, the average material density across the bend was equal to 0.0443 artifacts per square meter. This figure is somewhat lower than the density of systematically sampled units used in the definition of sites (6.31 artifacts per 100 sq. m, see Table 6.2). The high variance around the mean for the sampled units (Table 6.2), however, suggests that the difference may be due to sampling error. All recognized periods of prehistory were represented (see Table 5.3). Projectile points sorted into the Middle and Late Archaic groups together accounted for 60% of all classed projectile points. If projectile point proportions accurately reflect the contributions of the various periods to the total assemblage, then any given artifact has a greater potential of having been deposited on the surface of Cheek Bend during the Late and Middle Archaic than all other periods combined (probability of Middle or Late Archaic = .60). It has already been shown that the distribution of materials is not random (Chapter VI), and it is expected that the patterning has meaning.

The expectations derived regarding the Cheek Bend assemblage may be summarized as follows: dispersed spacing of both Middle and Late Archaic settlements is predicted by Horn's optimal spacing model,

while an even greater tendency toward dispersion is expected during the Middle Archaic; south facing, level areas near the river vertically and horizontally are predicted to have been disproportionately selected for settlements by general optimization models. The degree of fit between expectations and observations will be taken as a indication of the power of optimization theory to explain the patterning in the archaeological record, and by implication, the past.

Non-Site Pattern

A subjective evaluation of the degree of dispersion or aggregation in a density distribution may be directly gained from inspection of a density contour map (Figures 6.8 and 6.10), but is more readily obtained from a three-dimensional representation of the same data (Figure 8.1). In this oblique transverse view of Cheek Bend, peaks represent areas of high artifact density. Several observations concerning the distribution of artifacts are suggested by the figure: the intrabend area is vacant (as was also noted for Cannon Bend); a near continuous "range" of high artifact density peaks is apparent along the river. The overall impression is one of a relatively even artifact distribution along the river, incorporating several areas of high artifact density. While this impression generally fits the expectation derived from Horn's model, the degree of confidence vested in the conclusion is minimal. The pattern of artifact distribution in Cheek Bend may be more systematically investigated using trend surface analysis.

Trend Surface Characterization of Dispersion

The question of interest in the present analysis concerns the degree of complexity of the actual density surface. If prehistoric settlement in Cheek Bend was in fact dispersed, then we would expect

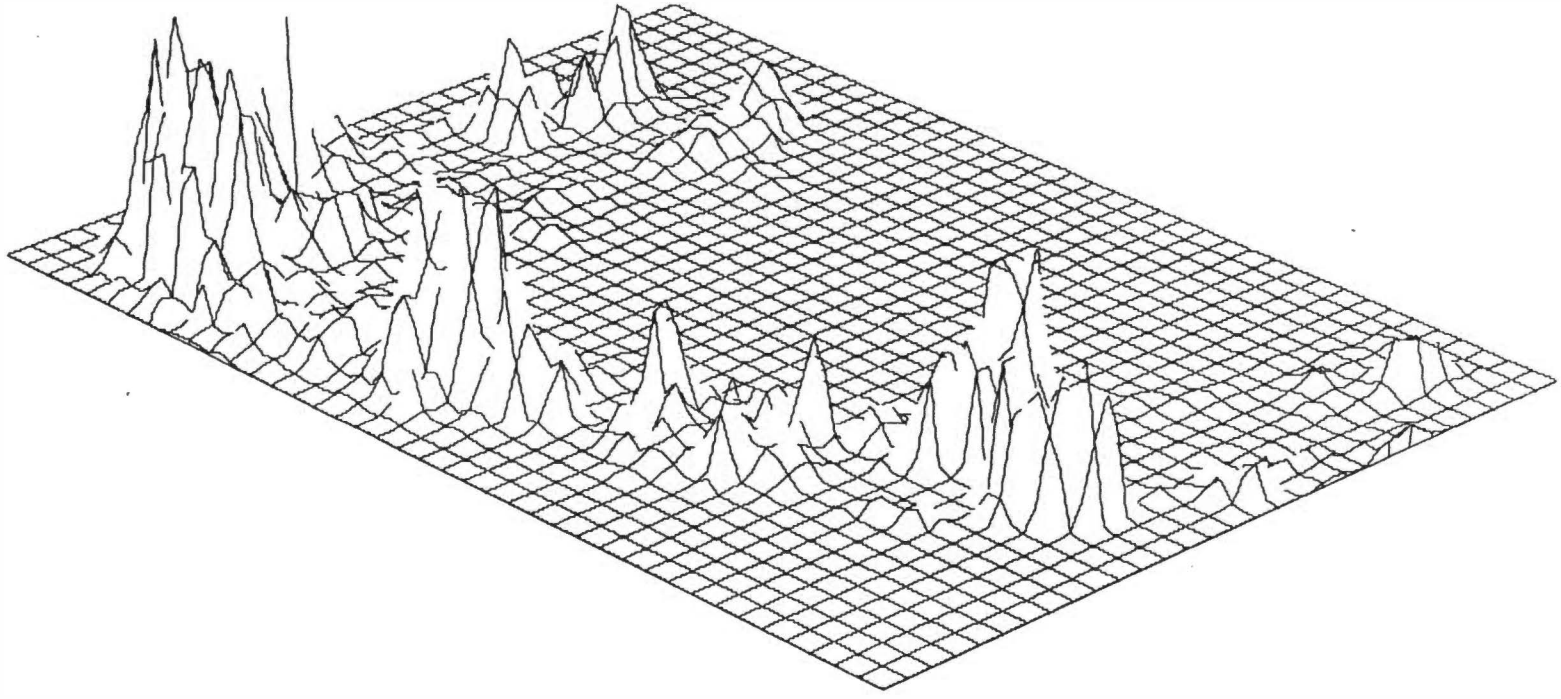


Figure 8.1. Oblique transverse view of mapped artifact density in Cheek Bend, facing northwest.

numerous peaks in the density distribution of artifacts broadly spaced across the bend. A flat surface (first order trend surface) should be a relatively good model of such a pattern.

First through fifth order trend surface analyses were conducted with the data described in Chapter VI using the Surface II program (Sampson 1975). The fitted surfaces and the contoured residuals are presented in Figures 8.2 through 8.6. These are briefly described and discussed below.

The first order trend surface (Figure 8.2 a) increases in altitude generally from north to south. The chain of extremely high density peaks along the river margin is largely controlling this trend. Contributing to this trend is the relatively vacant area in the center or northern portion of the bend.

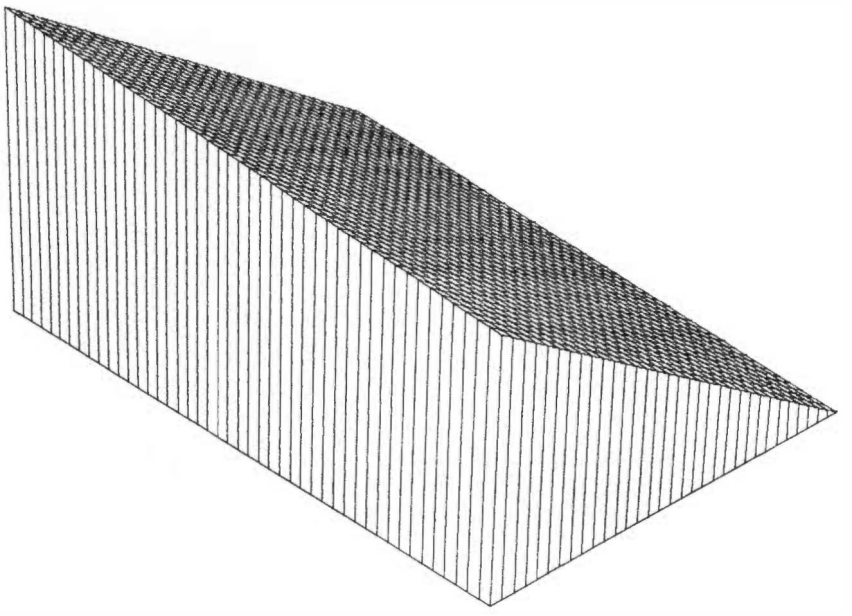
Table 8.1 presents the Analysis of Variance statistics (Neter et al. 1985) for all five fitted surfaces. An R^2 value of 0.30 for the first order trend surface indicates a relatively good fit (especially compared to $R^2 = 0.12$ for Cannon Bend first order trend surface).

This first order trend surface analysis is also useful as an independent check of the results obtained from the Poisson analysis used to define analytic sites presented in Chapter VI. A comparison of Figures 8.2 (b) and 6.10 indicates substantial similarity, supporting the results of the Poisson analysis.

The second through fifth order trend surfaces assume increasingly erratic shapes as the model struggles to explain variability where there is none: beyond the limits of the collected area. This problem with trend surface analysis has been noted by other researchers (Hodder and Orton 1976:163) for cases where data points do not extend to the edges of the map. The interpretative value of these surfaces is, of course, extremely limited.

In general, it may be concluded that the first order trend surface provides a reasonably good characterization of the real

(a)



(b)

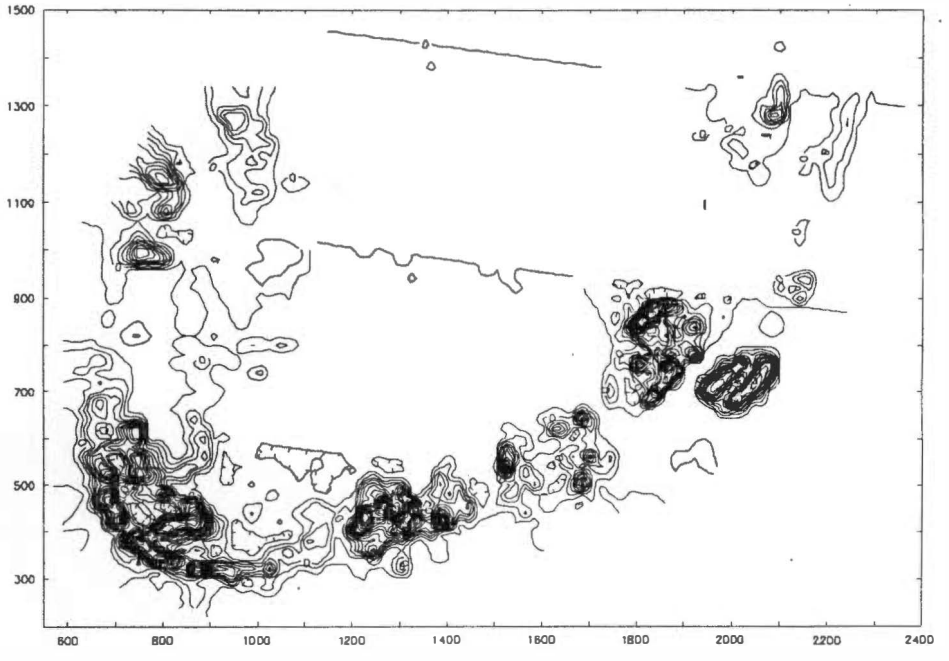
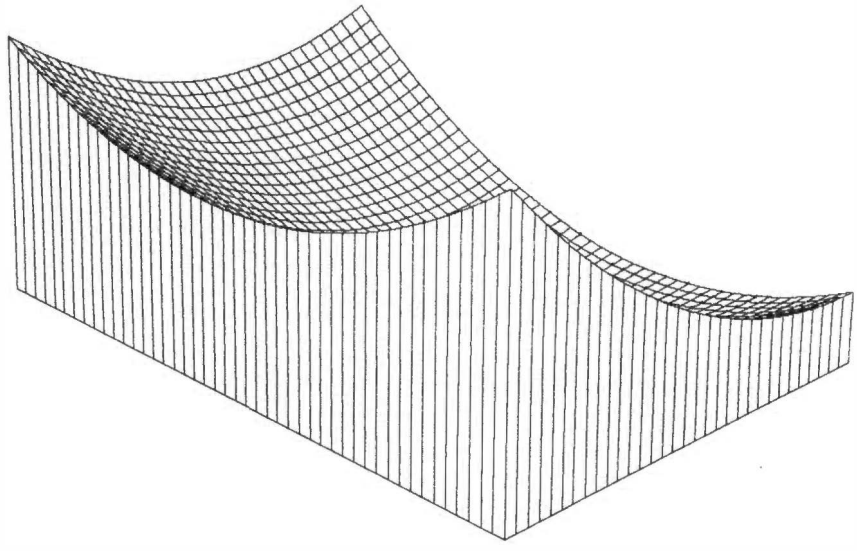


Figure 8.2. First order trend surface of mapped artifact density in Cheek Bend, facing northwest (a), and residuals (b).

(a)



(b)

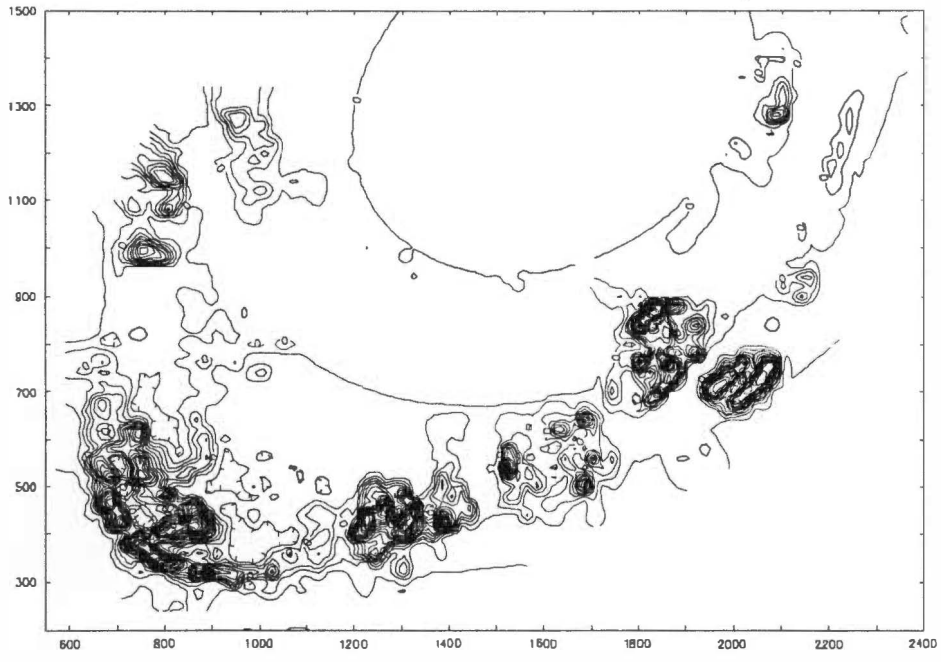
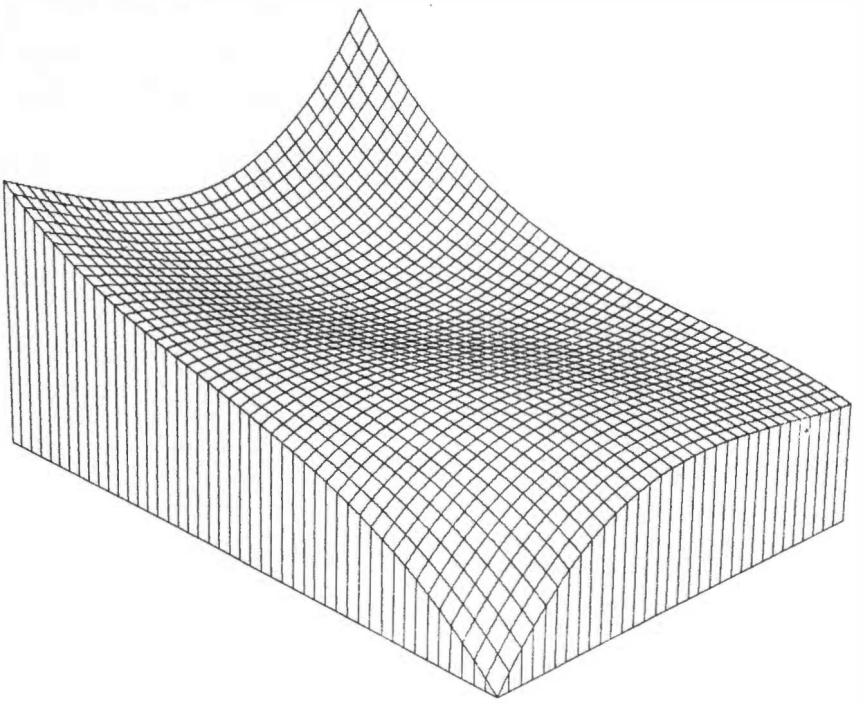


Figure 8.3. Second order trend surface of mapped artifact density in Cheek Bend, facing northwest (a), and residuals (b).

(a)



(b)

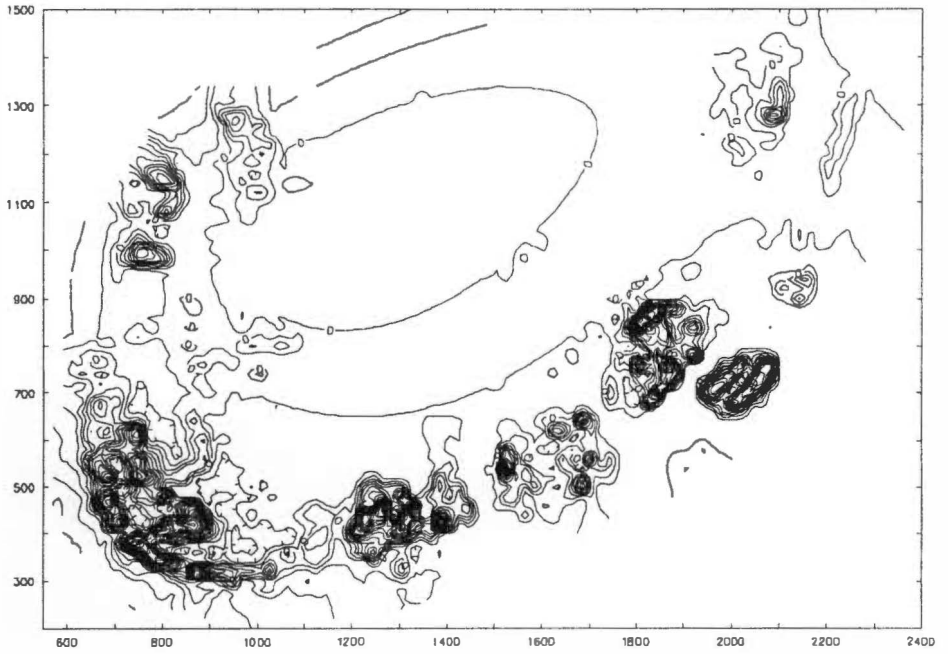
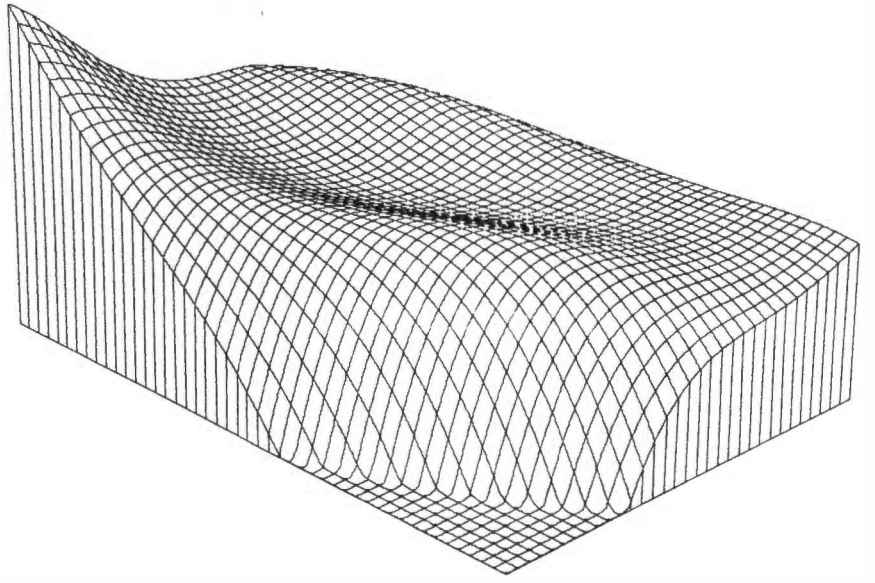


Figure 8.4. Third order trend surface of mapped artifact density in Cheek Bend, facing northwest (a), and residuals (b).

(a)



(b)

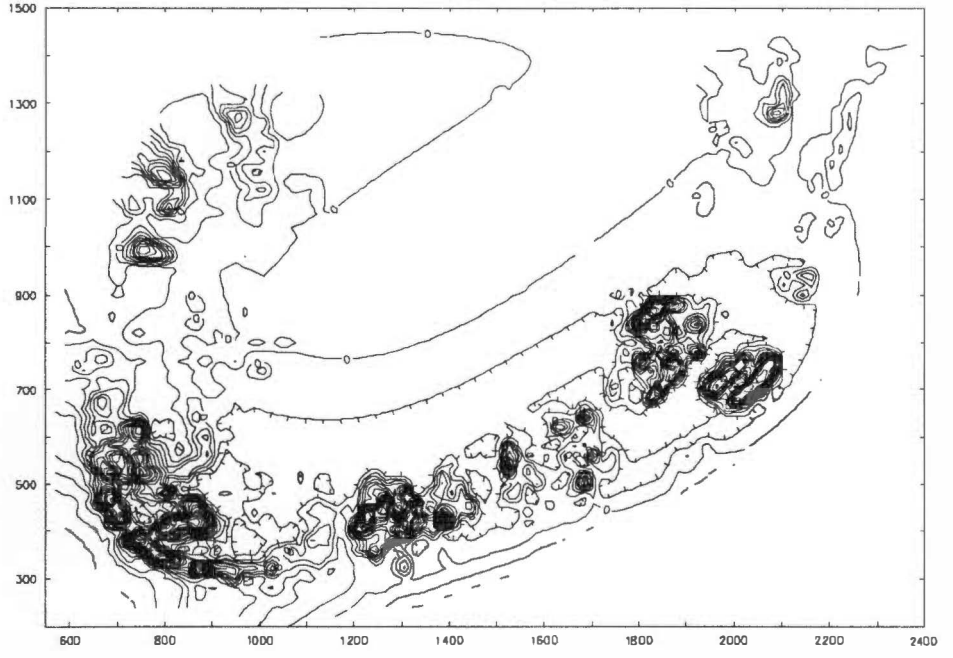
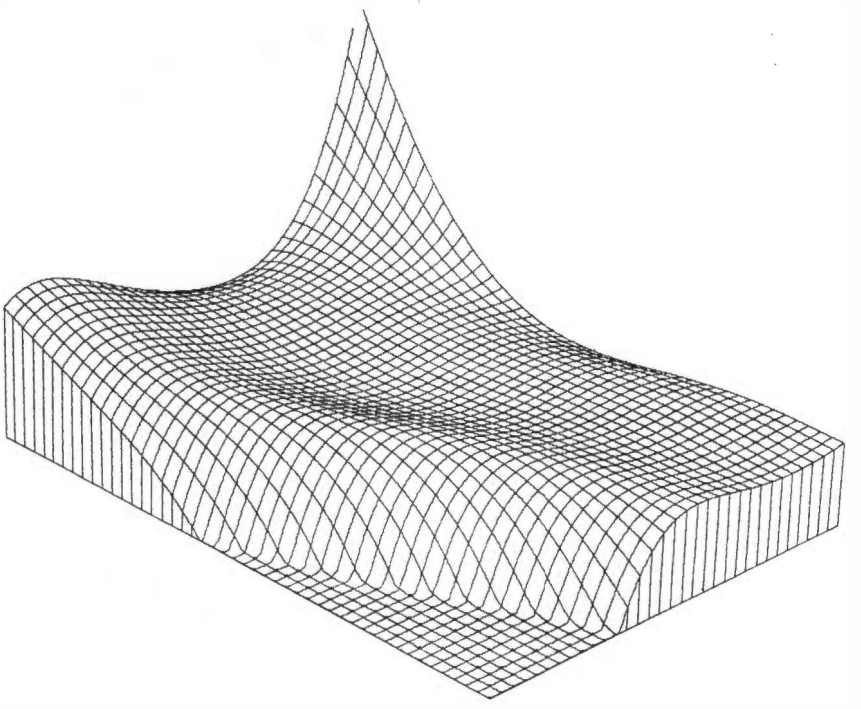


Figure 8.5. Fourth order trend surface of mapped artifact density in Cheek Bend, facing northwest (a), and residuals (b).

(a)



(b)

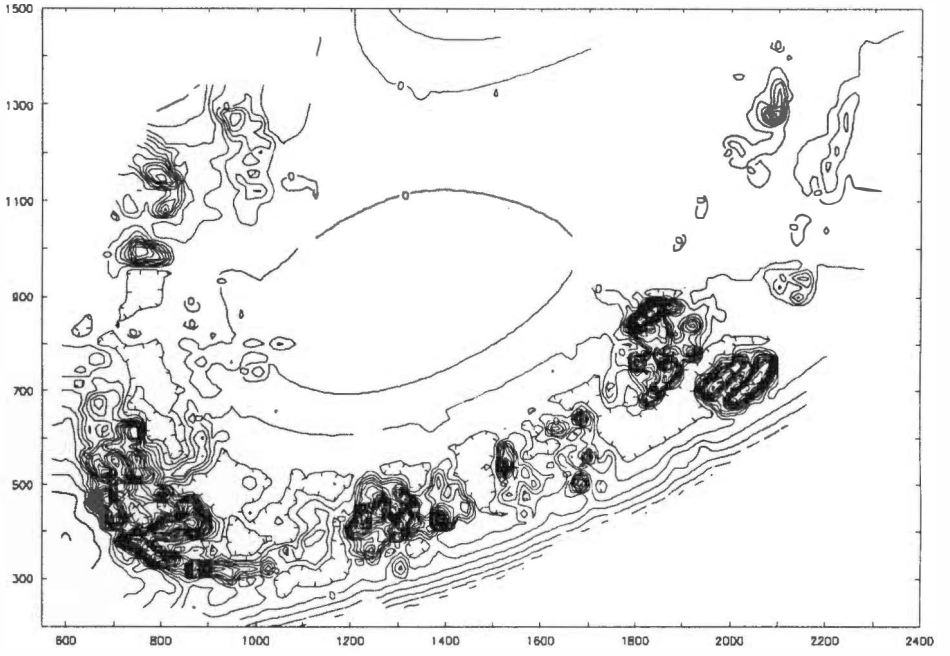


Figure 8.6. Fifth order trend surface of mapped artifact density in Cheek Bend, facing northwest (a), and residuals (b).

Table 8.1. Analysis of variance table for first through fifth polynomial trend surface results: Cheek Bend.

Order	SSTO	SSE	SSR	R^2	F^*	df
1	683572.2	619210.0	64362.2	0.30	173.64	2,3341
2	683572.2	578461.2	105111.0	0.39	121.31	5,3338
3	683572.2	555155.0	128417.2	0.43	85.69	9,3334
4	683572.2	532070.2	151502.0	0.47	67.71	14,3329
5	683572.2	516240.18	167332.0	0.49	53.86	20,3323

* all F values are significant at the 0.001 level.

distribution of artifacts across Cheek Bend. This result is consistent with the intuitive characterization of the density surface offered at the beginning of this chapter, and with the expectations derived from Horn's model.

Trend Surface Characterization of Gravity Effects

The trend surface analysis does indicate a tendency for settlement in areas minimizing slope. The first order surface slopes toward that portion of Cheek Bend where local relief is minimized: the river edge (see Figure 2.4). In addition, a trend toward minimizing distance to the river both horizontally and vertically is also indicated by the analysis.

Site Distribution

The pattern of analytic site distribution in Cheek Bend may also be analyzed as a point pattern. Summary information for the analytic sites, including grid coordinates, is provided in Table 8.2. This analysis has the benefit of enhanced temporal control; the chronological affiliation of each defined site may be investigated by the co-occurrence of projectile point types and high artifact density.

Figures 8.7 and 8.8 illustrate the pattern of Late and Middle Archaic projectile point types overlaid on analytic sites. As can be seen, many projectile points occur in non-site context. This is to be expected, as many of the activities associated with the tools (e.g. hunting) should most frequently occur away from the settlement (Thomas 1975). While several "pure" components are identified by this analysis, most sites are characterized by more than one type of the same period (e.g. Middle or Late Archaic) or both periods. It will be suggested that this may indicate that the site patterning may be responding to the situational variables more than the overall hypothesized distributional pattern (e.g. not so much "dispersed" as

Table 8.2. Situational variables data for Cheek Bend analytic sites.

Number	LA Num.[1]	MA Num.[2]	Elevation	Slope[3]	Dist. to River	Aspect[4]	East	North
1	1	1	645	153	150	60	960	1265
2	2	2	600	151	95	20	803	1146
3	5	3	598	93	85	266	677	660
4	6	4	624	90	289	193	878	621
5	9	5	605	140	188	210	862	421
6	10	6	597	92	97	221	759	370
7	11	7	595	108	92	196	875	323
8		8	599	112	82	193	1025	323
9		9	620	79	230	144	1239	510
10	16	10	612	56	170	143	1530	545
11		11	617	81	196	9	1634	621
12	19	12	633	112	300	162	1828	847
13		13	621	49	226	186	1810	754
14	20	14	617	47	197	161	1866	749
15	21	15	605	132	123	168	1973	711
16		16	600	88	84	164	2045	715
17		17	605	170	78	128	2155	933
18	23	18	645	102	233	125	2092	1274
19	3		605	102	125	292	765	992
20	4		597	93	62	273	658	762
21	7		607	121	173	233	752	536
22	8		598	75	102	256	690	468
23	12		612	57	157	179	1236	434
24	13		597	107	40	177	1298	327
25	14		605	62	123	172	1308	417
26	15		612	67	196	140	1389	519
27	17		605	136	131	180	1653	553
28	18		606	210	191	106	1684	643
29	22		605	135	126	136	1976	711
mean			610	104	150	168		

[1] cross reference to numbers used in Figure 8.9.
[2] cross reference to numbers used in Figure 8.10.
[3] meters run for elevation change of 3 meters.
[4] facing aspect in degrees east of north.

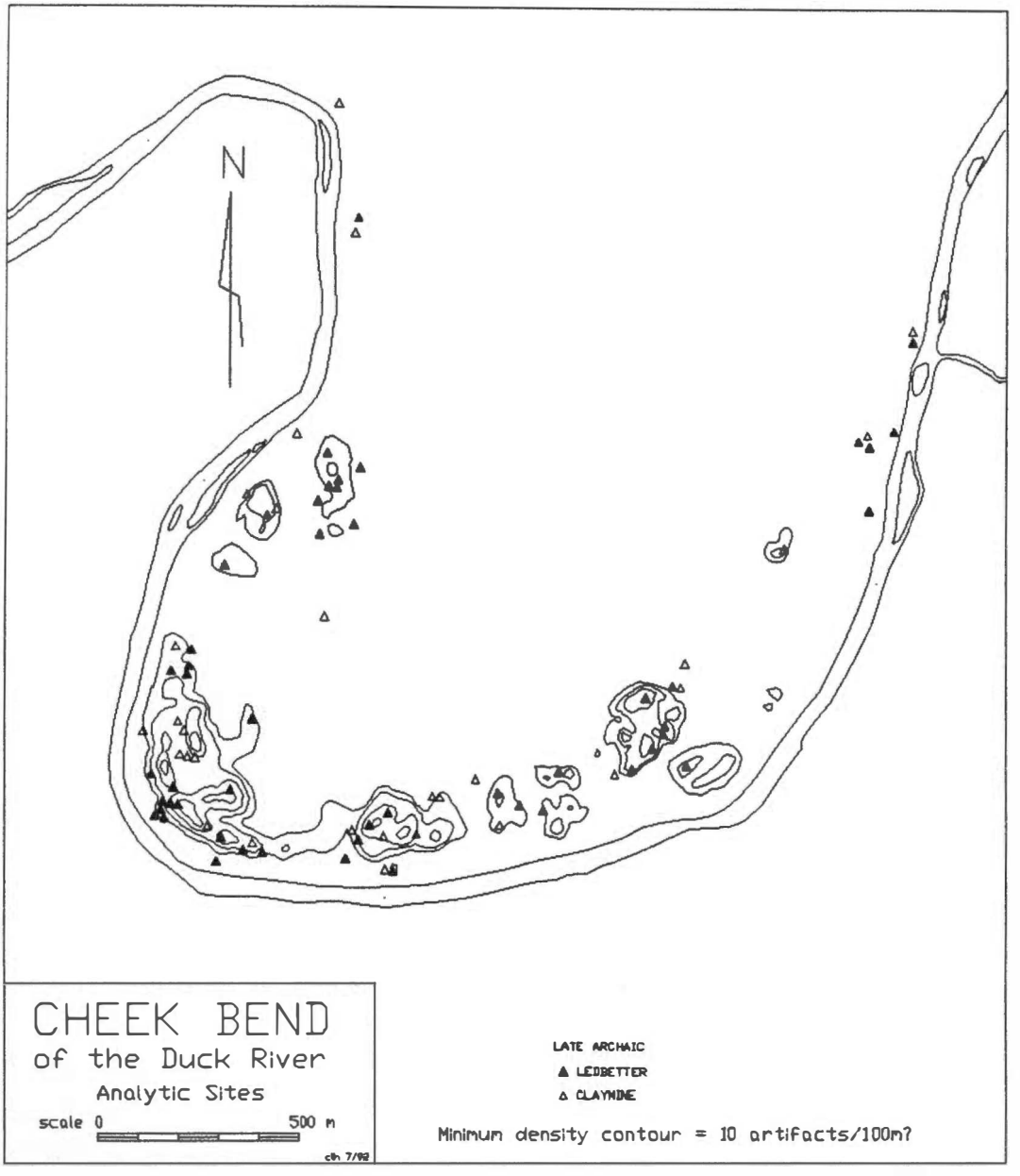


Figure 8.7. Location of Late Archaic projectile points overlaid on analytic sites in Cheek Bend.

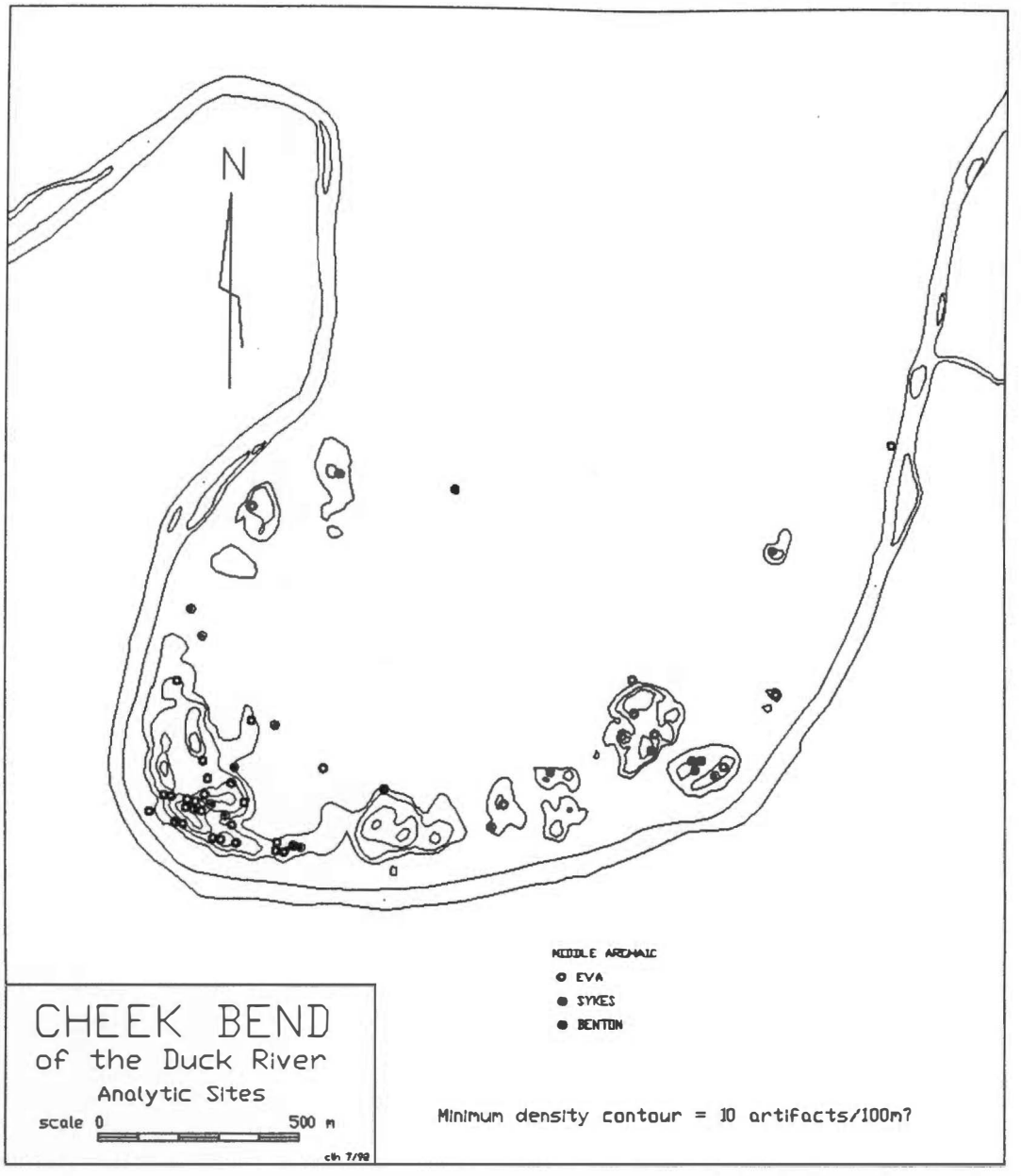


Figure 8.8. Location of Middle Archaic projectile points overlaid on analytic sites in Cheek Bend.

attracted to the river, see Summary below). Clear patterns are evident at the period level (Figures 8.9 and 8.10).

Comparisons of observed patterns to randomly generated patterns can provide an important check of analyses of pattern. For this reason a sample of random points was selected using a table of random numbers. Figure 8.11 illustrates the location of these random points, and summary information regarding them is presented in Table 8.3.

Nearest Neighbor Analysis

Table 8.4 presents the nearest neighbor statistics for Cheek Bend sites and random places. While minor deviations from random patterning are detected, none is significantly different from random. It is suggested that the importance of this analysis lies in demonstrating a lack of significant clustering. This conclusion is in keeping with the expectation derived from Horn's model.

Kolmogorov-Smirnov Analysis

Cumulative frequency graphs were prepared for each variable (Figure 8.12), and the maximum deflection of the observed line from one representing a random distribution was measured (D). Table 8.5 presents the Kolmogorov-Smirnov D and associated significance level for each of the situational variables. As is readily apparent from the cumulative graphs (Figure 8.12) elevation, slope and distance to the river all act in the manner expected; sites are lower in elevation than random places, are located in more level settings than random places (greater "run" for 10' change in elevation), and are closer to the river than random places. Aspect appears to be distributed in nearly an identical manner for sites and random places. The differences between site locations and random places on these variables are highly significant at the $\alpha > 0.05$ level (Table 8.5). Only aspect was random.

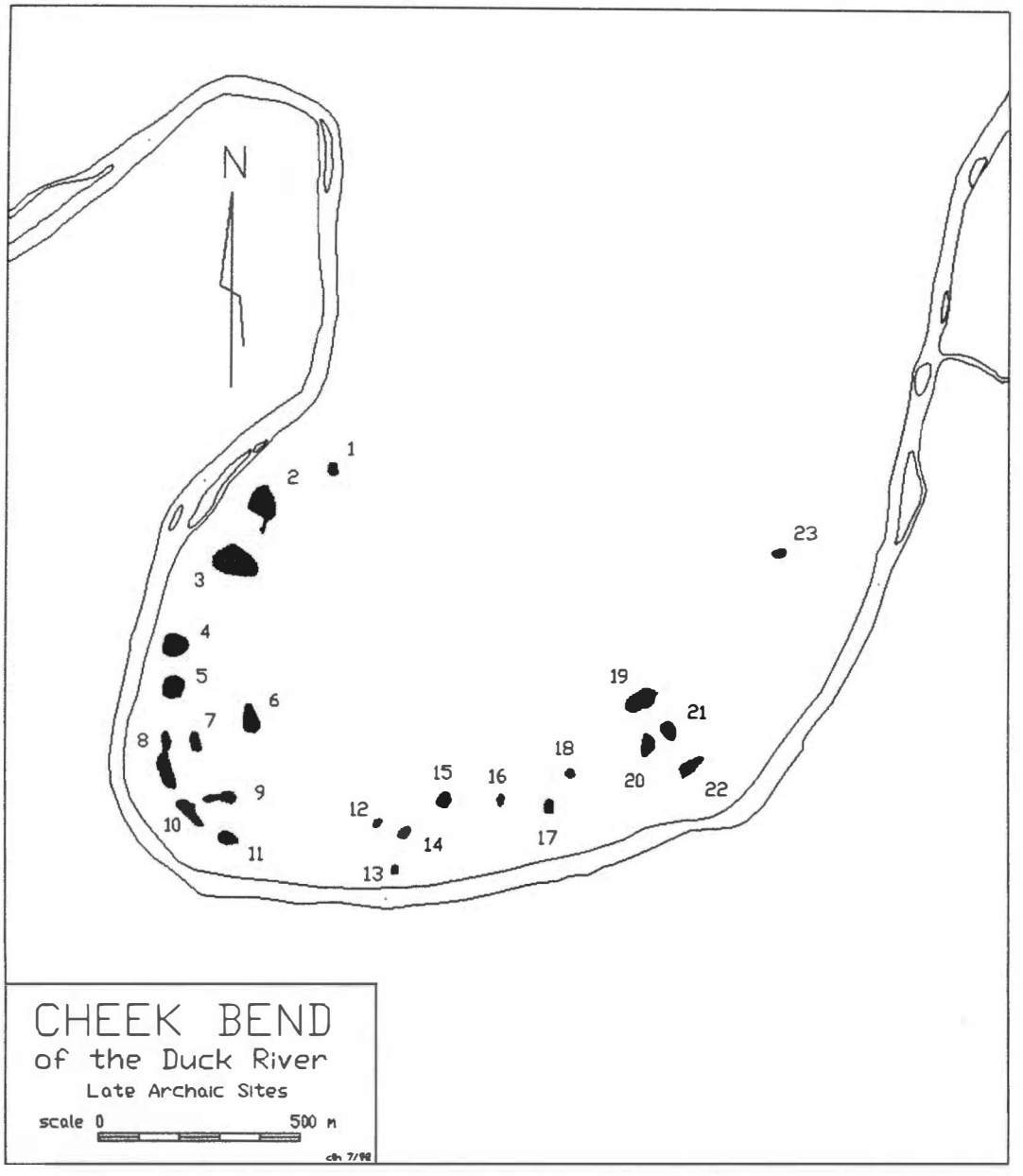


Figure 8.9. Late Archaic analytic sites in Cheek Bend.

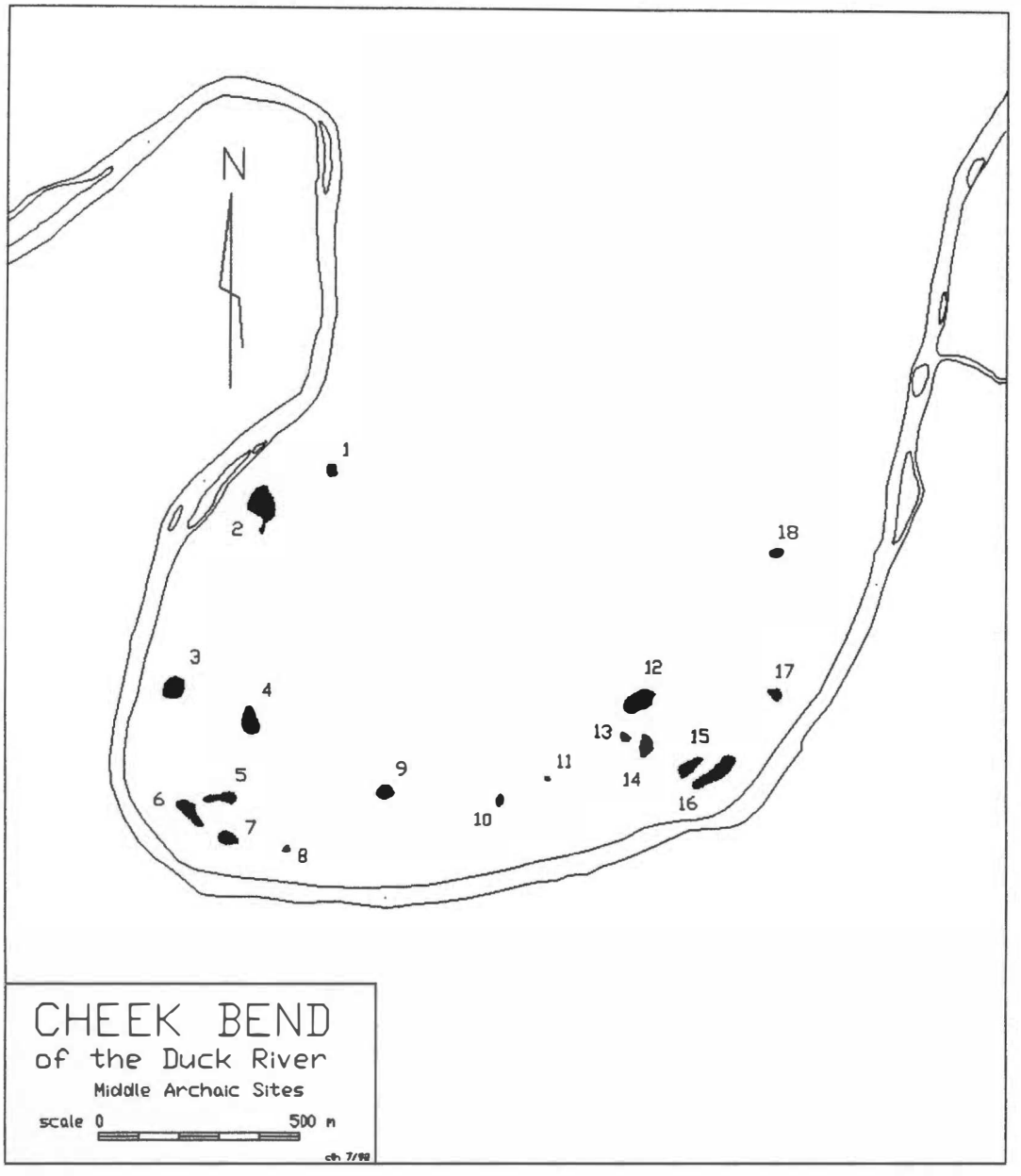


Figure 8.10. Middle Archaic analytic sites in Cheek Bend.

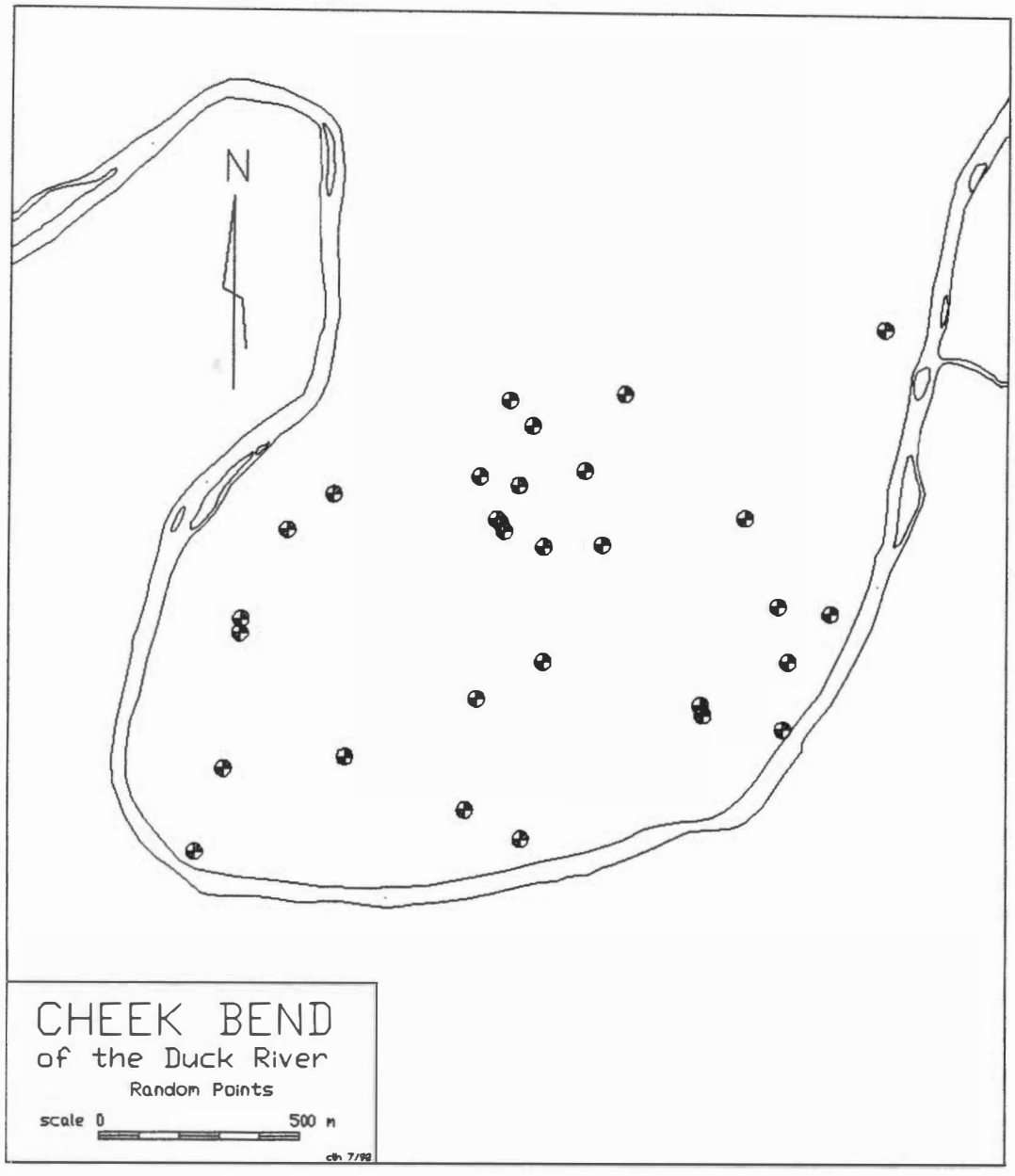


Figure 8.11. Distribution of selected random points in Cheek Bend.

Table 8.3. Situational variables data for selected random points in Cheek Bend.

Number	Elevation	Slope[1]	Dist. to River	Aspect[2]	East	North
1	595	121	32	194	796	272
2	621	32	201	204	804	823
3	625	20	196	281	798	857
4	608	140	223	210	825	484
5	622	235	32	179	867	1099
6	647	136	199	336	968	1208
7	627	31	324	187	1121	575
8	656	28	432	153	1417	779
9	605	136	165	140	1442	505
10	595	104	66	156	1592	461
11	642	26	478	142	1562	897
12	608	58	199	130	1984	850
13	610	46	217	142	1975	871
14	590	12	18	143	2185	853
15	605	154	104	121	2166	105
16	610	39	191	110	2112	1143
17	602	148	59	98	2248	1152
18	635	61	334	104	1993	1352
19	600	49	106	86	2239	1873
20	651	107	664	136	1508	1180
21	665	108	563	158	1403	1199
22	655	26	527	304	1382	1224
23	653	54	647	66	1657	1213
24	650	47	535	314	1419	1320
25	637	96	446	297	1316	1323
26	650	72	671	127	1573	1386
27	650	24	535	154	1423	1470
28	650	102	453	206	1354	1522
29	660	14	697	230	1637	1594
means	628	70	326	104		

[1] meters run for elevation change of 3 meters.
[2] facing aspect in degrees east of north.

Table 8.4. Nearest Neighbor statistics for Cheek Bend sites.

	Late Archaic	Middle Archaic	All Sites	Random Places
Area	2010757	2010757	2010757	2010757
Number	23	18	29	29
Density	.000014	.000009	.000014	.000014
Mean Observeded Dist. (r_o)	120.5	152.6	108.3	148.8
Mean Expected Dist. (r_e)	147.8	167.1	131.7	131.7
Ratio r_o:r_e (R)	.8149	.9129	.8828	1.1332
Standard Normal Deviate* (C)	-1.6977	-.7065	-1.8253	1.3432

* Significant Values of C (α = .05) > 1.96

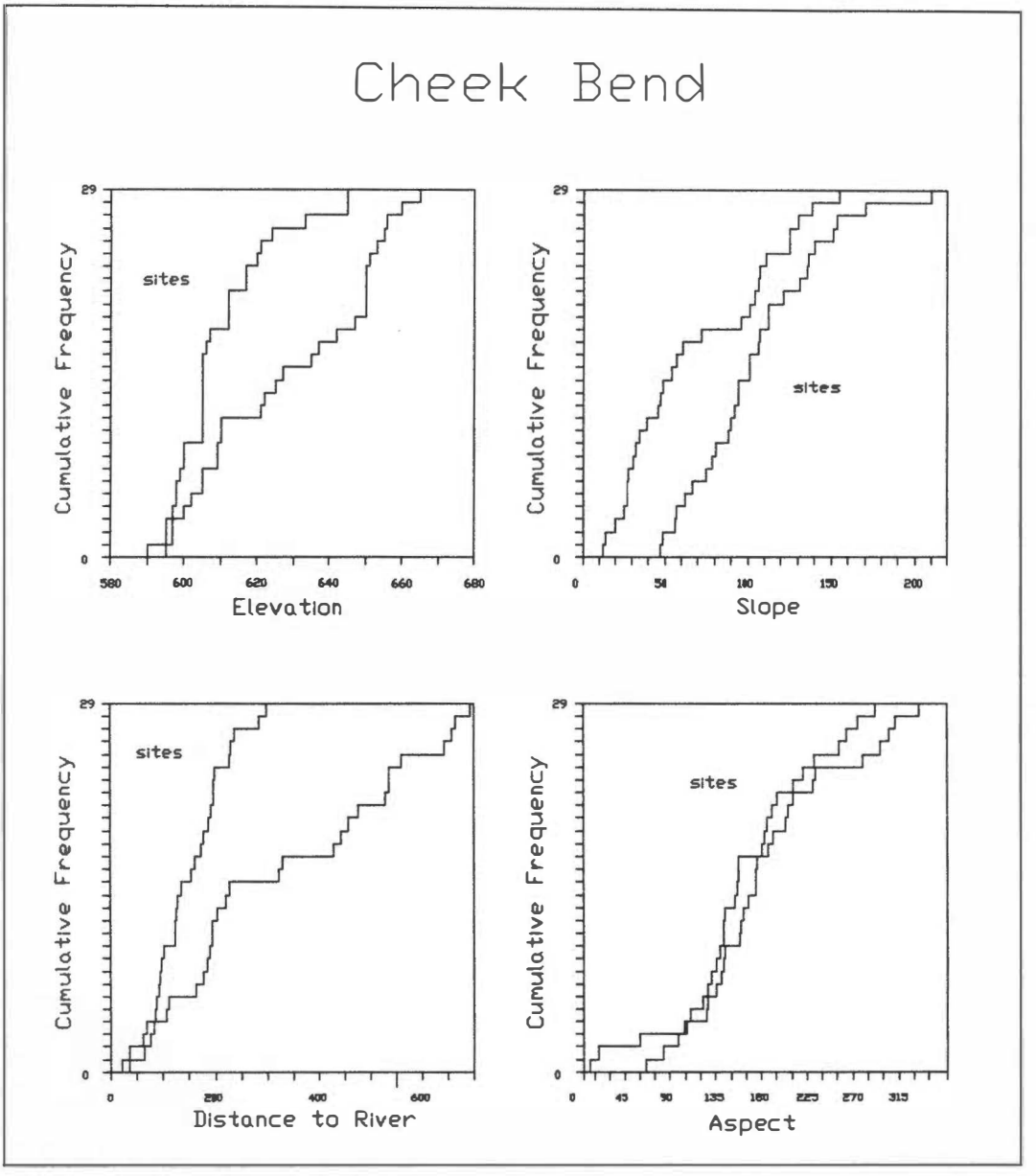


Figure 8.12. Cumulative frequency graphs of situational variables for Middle and Late Archaic sites and random points in Cheek Bend.

Table 8.5. Kolmogorov-Smirnov statistics for two sample comparison of situational variables at Cheek Bend sites and selected random points.

Variable	D	α
Elevation	0.482759	0.00232166
Slope	0.448276	0.00589035
Distance to River	0.482759	0.00232166
Aspect	0.241379	0.36684500

Summary

At an impressionistic level, all expectations have been met for the distribution of Cheek Bend sites. The expectations were also supported statistically with only one exception; no effect for the variable aspect was detected. The distribution of sites appears to be dispersed along the river edge. The southwest corner of the bend represents the most artifactually dense area, but is properly seen as only one of many important clusters in a dispersed pattern. Additionally, considerable patterning was detected within this and many other broad areas of artifact concentration. The distribution of projectile point types across these areas suggests that the definition of temporally distinct assemblages is possible. The importance of this conclusion cannot be overstated; with a level of resolution as gross as the 20 m unit it is possible to sort out the apparent temporal confusion typically observed in plow-zone assemblages. Another conclusion is suggested by this chronological patterning within high density clusters; certain locations are repeatedly being used for settlement. If no spatial patterning of projectile point types was evident, it would be possible to logically conclude that they represent potentially coexistent types lacking temporal meaning. As this was not the case, the obverse is suggested; the selection of certain locations for settlement was not dependent upon temporal period. This would tend to suggest that greater interpretative weight be attributed to the gravity model than on Horn's model; the river margin in Cheek Bend represented an optimal area for settlement throughout the Middle and Late Archaic periods.

In support of this conclusion, all of the situational variables with the exception of facing aspect responded as expected. Sites are located nearer the river horizontally and vertically than random

locations, and are located in less strongly sloped settings than random locations.

Given the observed distribution of sites in Cheek Bend, it is possible to suggest an a posteriori elaboration of the explanatory model. The patchy openings in Cheek Bend are located in the upland-interior areas, away from the river edge (Crites and Clebsch 1986). As these gladey openings would represent the resource acquisition points that made Cheek Bend so attractive to prehistoric hunter-gatherers, it follows that the efficient forager would locate settlements at some distance from them. Hunters well know the value of avoiding resource acquisition points except during the hunt, and collectors would know to avoid disturbing productive plots (e.g. Lee 1978). It may be suggested that the efficiency of Middle and Late Archaic hunter-gatherers in the inner Nashville Basin was even greater than anticipated.

CHAPTER IX

SUMMARY AND DISCUSSION

This examination of the patterning of surface material in Cannon and Cheek bends of the Duck River in Middle Tennessee has included the following tasks:

1. Examination of relevant models of settlement location derived from optimization theory.
2. Prediction of the patterns of artifacts across the surfaces of these bends based on expectations derived from the models.
3. Multivariate definition of Middle and Late Archaic projectile point types.
4. Statistical classification of projectile points collected from the surfaces of Cannon and Cheek bends.
5. Collation of the data from all gridded collections conducted in both bends.
6. Conversion of data from other types of collections conducted within the bends to data comparable to and compatible with the gridded collections.
5. Definition of sites based on observed surface artifact density.
6. Identification of temporal patterns in artifact density through spatial correlation of projectile point types and analytically defined sites.
7. Examination of the pattern of material density distribution in both bends using trend surface analysis and nearest neighbor analysis.
8. Examination of the power of various situational variables to attract settlement using trend surface analysis and Kolmogorov-Smirnov analysis.

The following conclusions were reached:

1. Multivariate definition of five morphologically distinct Middle

and Late Archaic projectile point types (clusters) is possible (Eva, Sykes, Benton, Ledbetter, and Claymine). Discriminate analysis was able to distinguish and classify these types extremely well.

2. Definition of sites based on artifact density is a useful approach that leads to very different patterns than traditional field definition.
3. The distribution of settlements in Cannon Bend appears to be clustered in two spatially distinct areas; the narrow neck of the bend, and the broad bottom in the extreme northeastern corner.
4. The selection of locations for settlements in Cannon Bend apparently was little influenced by slope or elevation. Distance from the river was, however, minimized.
5. The distribution of settlements in Cheek Bend appears to be dispersed along a near continuous chain of high density areas following the river margin.
6. The selection of locations for sites in Cheek Bend was significantly influenced by elevation, slope, and horizontal distance to the river; the values of each of these variables was minimized.

It is concluded that both Horn's model and the gravitational model are useful for explaining Middle and Late Archaic settlement in Cannon and Cheek bends.

Discussion

The two general goals of this study were to describe the patterning of prehistoric cultural material across the surfaces of Cannon and Cheek bends, and to evaluate the power of optimization theory to explain these distributions. In addition to these goals, I have also documented the conduct of this impressive archaeological

undertaking. These three goals are clearly interrelated, and we would normally see their importance in an hierarchical relationship; description is a necessary but subordinate prerequisite to the ultimate goal of explanation, while documentation is a near trivial exercise. In the context of Cultural Resources Management, however, I believe that all three of these tasks are important obligations.

Federal legislation and regulations compelled the Tennessee Valley Authority to sponsor the Columbia Archaeological Project of which the surface survey of Cannon and Cheek bends was a part. The legal mandate is based upon the recognition that archaeological resources are a finite and non-renewable component of our environment, and that they are an important record of a heritage that belongs to all Americans. The legislators of the 1960s and 1970s understood that the American people cared about their past. Indeed, these legislators understood that if they allowed federal agencies to carelessly destroy the fragile and rapidly diminishing record of that past they risked incurring the wrath of their constituents. Make no mistake about it, however, the endangered species analogy does not hold; archaeological sites are not an integral or essential component of the ecosystem. Archaeology can feed the spirit and has the promise of enriching human life, but life will go on perfectly well without it. Public monies were expended to collect the 82,000 plus artifacts from the surfaces of Cannon and Cheek bends ultimately because we <u>want</u> to know what happened in Middle Tennessee between 7000 and 3000 years ago, not because we <u>must</u> know.

Because public dollars were spent to collect these rocks we owe it to the taxpayers to fairly and completely document the work that was done. This documentation must be part of the public record, but it does not fulfill the obligation. While description is a contemporary endeavor that informs about the present, it is also the point of departure for all leaps to the past. It is, therefore,

critical that description be as well documented and as complete as possible. The goal of preservation can be achieved through description alone, and it can be fairly argued that once so preserved the archaeological record can be accessed at any time in the future to explore the past. The obligation, however, does not end with description either. In the end it is the story that we are honor bound to present; what do these 82,000 rocks tell us about the past?

They tell us a great deal about the timing of prehistoric utilization of Cannon and Cheek bends of the Duck River. This knowledge can be gained through the classification of projectile points, and a major contribution of this dissertation is the clear and objective definition of Middle and Late Archaic projectile point types. While some researchers may see this as an unnecessary analytic exercise, it is my firm belief that archaeologists are not as altogether good at recognizing projectile point types as they think. All known prehistoric periods are represented in the projectile point assemblages (see Table 5.3). While only about one third of the some 12,000 years of known prehistory can be assigned to the Middle and Late Archaic periods (7505 B.P. to 3205 B.P., or 4300 years; see Table 5.12), 46% of the classifiable projectile points from Cannon Bend and 60% of those from Cheek Bend are recognizable as diagnostic of these periods. Later periods of prehistory are much better represented upstream in the Normandy Reservoir (e.g. Prescott 1978) and downstream in the Shelby Bend area (Amick et al. 1985). Clearly, the Columbia Reservoir portion of the Nashville Basin was best suited to a hunting and gathering lifeway. Furthermore, the patchy Inner Basin was apparently more attractive to Archaic hunter-gatherers than the more homogeneous Outer Basin environments. I have argued here that this can be explained by optimization theory; as the Inner Basin was the more productive and predictable environment, foraging would have required less time and energy there than in the Outer Basin.

Whether as a result of natural selection or conscious and rational choice, Archaic hunter-gatherers were in the right place at the right time.

The rocks tell us a great deal about the location of prehistoric activities within Cannon and Cheek Bends. While artifacts are widely and broadly spread across all examined ground in reflection of the total utilization of these surfaces, they are not randomly distributed. Neither, we can conclude, were prehistoric activities randomly distributed. Significant departures from random expectations have been defined in this dissertation as "analytic sites." A very important contribution of this work has been the demonstration that these sites were apparently located in a manner so as to minimize the energy necessary to make them comfortable and convenient; they are near the river on relatively level ground. It is one thing to intuitively appreciate that this should be the case; it is another altogether to demonstrate that it is the case. Once again the Middle and Late Archaic peoples utilizing this portion of the Duck River were positioned in the right place.

Finally, it has been demonstrated that the analytic sites are arranged in a less clumped pattern in Cheek Bend than in Cannon Bend. In Cheek Bend sites are distributed in a near continuous and even manner along the river edge. In Cannon Bend sites tend to be less evenly distributed, clustering in a relatively few locations. These patterns are consistent with expectations derived from optimization theory also, as round trip foraging distance would be minimized by dispersed settlement in a spatially predictable environment and by a clumped settlement arrangement in an unpredictable environment. The settlements of Middle and Late Archaic peoples were arranged so as to take maximum advantage of the variable environment they encountered.

The different locational strategies identified in these two river bends suggests that Archaic peoples in Middle Tennessee had a

broad behavioral repertoire. This is a perfectly reasonable condition; as hunter-gatherers making their living in a variable environment, their short-term comfort depended upon an ability to vary their behavior. A probable consequence of this conclusion is that a normative characterization of Middle and Late Archaic organization, subsistence, and settlement can never be complete. Middle and Late Archaic peoples were neither organized as collectors nor as foragers, their subsistence was neither focal nor diffuse, and their mobility was neither logistical nor residential. In each case, Middle and Late Archaic behavior probably conformed to both extremes, and to any number of manifestations in between, depending upon the circumstances. In the end, it may be that the best characterization of Middle and Late Archaic behavior is that it was variable so as to be efficient.

In the long-term, the success of the Archaic adaptation may have led to its ultimate demise. Increased populations would have had the effect of limiting the behavioral options available under any given set of circumstances. Intensification of certain behaviors still possible given these conditions, including territoriality, horticulture, and ceremonialism, could have maintained the efficiency of a less flexible system, and resulted in the pattern we refer to as the Woodland Period.

REFERENCES CITED

REFERENCES CITED

Ahler, Stanley A.
1970 Projectile Point Form and Function at Rodgers Shelter, Missouri. Research Series Number 8. Missouri Archaeological Society, Columbia.

Amick, Daniel S.
1983 Buried Component Testing at the Clay Mine Site (40MU347). Tennessee Anthropological Association Newsletter 8(2): 1-11.

1984 Lithic Raw Material Variability in the Central Duck River Basin: Reflections of Middle and Late Archaic Organizational Strategies. Unpublished Masters Thesis, Department of Anthropology, University of Tennessee, Knoxville.

1985 Buried Late Holocene Terrace Site Testing in the Central Duck River Basin. In Exploring Tennessee Prehistory: A Dedication to Alfred K. Guthe, edited by T. Whyte, C. Boyd, and B. Riggs, pp. 23-38. Report of Investigations Number 42, Department of Anthropology, University of Tennessee, Knoxville.

Amick, D. S., J. M. Herbert, and M. E. Fogarty
1985 Cultural Adaptations in the Shelby Bend Archaeological District. Report submitted to the National Park Service, Southeast Archaeological Center, Tallahassee, Florida.

Antevs, E.
1955 Geologic-climatic dating in the West. American Antiquity 20(4):317-335.

Baden, William W.
1985 Evidence of Changing Settlement Patterns in the Little Tennessee River Valey of East Tennessee. In Exploring Tennessee Prehistory: A Dedication to Alfred K. Guthe, T. Whyte, C. Boyd, and B. Riggs, editors, pp. 135-156. Report of Investigations Number 42, Department of Anthropology, University of Tennessee, Knoxville.

Barry, Roger G.
1983 Climatic Environment of the Great Plains, Past and Present. In A Symposium: Man and the Changing Environments in the Great Plains, edited by W. W. Caldwell, C. B. Schultz, and T. M. Stout, pp. 45-55. Transactions of the Nebraska Academy of Sciences, XI(Special Issue).

Benfer, Robert A.
1967 A Design for the Study of Archeological Characteristics. American Anthropologist 69:719-730.

Binford, Lewis R.
1964 A Consideration of Archaeological Research Design. American Antiquity 29(4):425-441.

1978a Nunamiut Ethnoarchaeology. Academic Press, New York.

1978b Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand. American Antiquity 43(3):330-361.

Binford, Lewis R.
1982 The Archaeology of Place. Journal of Anthropological Archaeology 1(1):5-31.

Boots, Barry N., and Arthur Getis
1988 Point Pattern Analysis. Sage University Paper, Sage Publications, Beverly Hills.

Bowen, William R.
1977 A Reevaluation of Late Archaic Subsistence and Settlement Patterns in the Western Tennessee Valley. Tennessee Anthropologist 2(2):100-120

1979 The Late Archaic in the Upper Duck River Valley. Tenessee Anthropologist 4(2):140-159.

Brakenridge, George R.
1982 Alluvial Stratigraphy and Geochronology along the Duck River, Central Tennessee: A History of Changing Floodplain Sedimentary Regimes. Unpublished Ph.D. Dissertation, Department of Geosciences, University of Arizona, Tuscon.

1984 Alluvial Stratigraphy and Radiocarbon Dating Along the Duck River, Tennessee: Implications Regarding Floodplain Origin. Geological Society of America Bulletin 95(1):9-25.

Braun, E. L.
1950 Deciduous Forests of Eastern North America. The Blakiston Company, Philadelphia.

Broyles, Betty
1966 Preliminary Report: the St. Albans Site (46 Ka 27), Kanawha County, West Virginia. West Virginia Archeologist 19:1-43.

1971 Second Preliminary Report: The St. Albans Site, Kanawha County, West Virginia. Report of Archaeological Investigations 3, West Virginia Geological and Economic Survey.

Bryson, R. A., D. A. Baerreis, and W. M. Wendland
1970 The Character of Late-Glacial and Post-Glacial Climatic Changes. In Pleistocene and Recent Environments of the Great Plains, edited by W. Dort, Jr., and J. K. Jones, Jr., pp. 53-74. Special Publication Number 3, Department of Geology, University of Kansas, Lawrence.

Butler, Brian M.
1977 The Yearwood Site: A Specialized Middle Woodland Occupation on the Elk River. Tennessee Anthropologist 2(1):1-15.

Caldwell, Joseph R.
1958 Trend and Tradition in the Prehistory of the Eastern United States. American Anthropologist 60(6):Part 2, American Anthropological Association Memoir Number 88.

Cambron, James W., and David C. Hulse
1975 Handbook of Alabama Archaeology: Part I Point Types. Revised. The Archaeological Research Association of Alabama, Inc.

Chang, Kwang-Chih
1968 Toward a Science of Prehistoric Society. In Settlement Archaeology, edited by K. C. Chang, pp. 1-9. Nation Press Books, Palo Alto, California.

Chapman, Jefferson
1975 The Rose Island Site and the Bifurcate Point Tradition. Report of Investigations Number 14, Department of Anthropology, University of Tennessee, Knoxville.

1977 Archaic Period Research in the Lower Little Tennessee River Valley - 1975: Icehouse Bottom, Harrison Branch, Thirty Acre Island, Calloway Island. Report of Investigations Number 18, Department of Anthropology, University of Tennessee, Knoxville.

1978 The Bacon Farm Site and a Buried Site Reconnaissance. Report of Investigations Number 23, Department of Anthropology, University of Tennessee, Knoxville.

1981 The Bacon Bend and Iddins Sites: The Late Archaic Period in the Lower Little Tennessee River Valley. Report of Investigations Number 31, Department of Anthropology, University of Tennessee, Knoxville.

Charnov, Eric L.
1973 Optimal Foraging: Some Theoretical Explorations. Unpublished Ph.D. Thesis, University of Washington, Seattle.

Clarke, David L.
1968 Analytical Archaeology. Metheun, London.

1977 Spatial Information in Archaeology. In Spatial Archaeology, edited by David L. Clarke, pp. 1-32. Academic Press, New York.

Cleland, Charles E.
1976 The Focal-Diffuse Model: An Evolutionary Perspective on the Prehistoric Adaptations of the Eastern United States. Midcontinental Journal of Archaeology 1(1):59-76.

Coe, Joffre L.
1964 The Formative Cultures of the Carolina Piedmont. Transactions of the American Philosophical Society, Vol. 54, pt. 5, New Series.

Cohen, Mark N.
1977 The Food Crisis in Prehistory: Overpopulation and the Origins of Agriculture. Yale University Press, New Haven.

Crites, Gary D.
1987 Middle and Late Holocene Ethnobotany of the Hayes Site (40ML139): Evidence from Unit 990N918E. Midcontinental Journal of Archaaeology 12(1):3-32.

Crites, G. D., and E. E. C. Clebsch
1986 Woody Vegetation in the Inner Nashville Basin: An Example from the Cheek Bend Area of the Central Duck River Valley. Association of Southeastern Biologists Bulletin 33, 167-177.

Dancey, William S.
1974 The Archaeological Survey: A Reorientation. Man in the Northeast 8:98-112.

Davis, R. P. Stephen, Jr.
1986 Stability and Change in Aborigial Settlement Within the Lower Little Tennessee River Valley. Unpublished Ph.D. Dissertation, Department of Anthropology, University of Tennessee, Knoxville.

1990 Aboriginal Settlement Patterns in the Little Tennessee River Valley. Report of Investigations Number 50, Department of Anthropology, University of Tennessee, Knoxville.

Deevey, E. S., and R. F. Flint
1957 Postglacial Hypsithermal Interval. Science 125(3240):182-184.

DeJarnette, D. L., E. Kurjack, and J. W. Cambron
1962 Stanfield-Worley Bluff Shelter Excavations. Journal of Alabama Archaeology 8, Numbers 1 and 2.

Delcourt, Hazel R.
1979 Late Quaternary Vegetation History of the Eastern Highland Rim and Adjacent Cumberland Plateau of Tennessee. Ecological Monographs 49(3):255-280.

Delcourt, P. A., and H. R. Delcourt
1979 Late Pleistocene and Holocene Distributional History of the Deciduous Forest in the Sourtheastern United States. Veröffentilichungen des Geohotanischen Institutes der ETH, Stiftung Rübel (Zürich) 68:79-107.

DeSelm, H. R.
1959 A New Map of the Central Basin of Tennessee. Journal of the Tennessee Academy of Sciences 34:66-72.

Dickson, D. Bruce
1976 Final Report on the 1972-1973 Archaeological Site Reconnaissance in the Proposed Columbia Reservoir, Maury and Marshall Counties, Tennessee. Report Submitted to the Tennessee Valley Authority, Norris, Tennessee.

1979 Deduction on the Duck River: A Test of Some Hypotheses About Settlement Distribution Using Surface Survey Data from Middle Tennessee. Midcontinental Journal of Archaeology 4(1):113-137.

Dunnell, Robert C.
1983 Aspects of the Spatial Structure of the Mayo Site (15-JO-14) Johnson County, Kentucky. In Lulu Linear Punctated: Essays in Honor of George Irving Quimby, edited by R. C. Dunnell and D. K. Grayson, pp. 109-165. Anthropological Papers Number 72, Musuem of Anthropology, University of Michigan, Ann Arbor.

Dunnell, Robert C.
1985 Archaeological Survey in the Lower Mississippi Alluvial Valley, 1940-194: A Landmark Study in American Archaeology. American Antiquity 50(2):297-300.

Dunnell, Robert C., and William S. Dancy
1983 The Siteless Survey: A Regional Scale Data Collection Strategy. In Advances in Archaeological Method and Theory, Volume 6, edited by M. B. Schiffer, pp. 267-287. Academic Press, New York.

Edwards, M. H., A. Elder, and M. E. Springer
1974 The Soils of the Nashville Basin. University of Tennessee Agricultural Experiment Station Bulletin 499. Nashville.

Faulkner, Charles H.
1973 Middle Woodland Subsistence-Settlement Systems in the Highland Rim: A Commentary. In Salvage Archaeology at 40FR47, edited by Willard S. Bacon and H. L. Merryman, pp. 35-51. Miscellaneous Paper Number 11, Tennessee Archaeological Society.

Faulkner, C. H., and M. C. McCollough
1973 Introductory Report of the Normandy Reservoir Salvage Project: Environmental Setting, Typology, and Survey. Report of Investigations Number 11, Department of Anthropology, University of Tennessee, Knoxville.

1974 Excavations and Testing, Normandy Reservoir Salvage Project: 1972 Seasons. Report of Investigations Number 23, Department of Anthropology, University of Tennessee, Knoxville.

Fenneman, N. W.
1938 Physiography of the Eastern United States. McGraw-Hill, New York.

Fogarty, M. E., D. S. Amick, and B. H. Riggs
1985 Regional Environment and Cultural Historical Framework. In Cultural Adaptations in the Shelby Bend Archaeological District, edited by D. S. Amick, J. M. Herbert, and M. E. Fogarty, pp. 6-41. Report submitted to the National Park Service, Southeast Archaeological Center, Tallahassee, Florida.

Foley, Robert
1981 A Model of Regional Archaeological Structure. Proceedings of the Prehistoric Society 47:1-17.

Futato, Eugene M.
1977 The Bellefonte Site: 1 Ja 300. The University of Alabama Office of Archaeological Research, Research Series Number 2.

Griffin, James B.
1952 Culture Periods in Eastern United States Archeology. In Archaeology of Eastern United States, edited by James B. Griffin, pp. 352-370. The University of Chicago Press, Chicago.

1967 Eastern North American Archaeology: A Summary. Science 156(3372):175-191.

Griffin, John
1974 Investigations in Russell Cave. National Park Service Publications in Archeology 13.

Gunn, Joel, and Elton R. Prewitt
1975 Automatic Classification: Projectile Points from West Texas. Plains Anthropologist 20(68):139-149.

Haggett, Peter, Andrew D. Cliff, and Allan Frey
1977 Locational Analysis in Human Geography (Second Edition). Edward Arnold (Publishers) Ltd., London.

Hall, Charles L.
1983 Material Chronology at 40MU430: A Stratified Rockshelter in Middle Tennessee. Report Submitted to the Tennessee Valley Authority, Norris.

1985 The Role of Rockshelter Sites in Prehistoric Settlement Systems: An Example from Middle Tennessee. Unpublished Master's Thesis, Department of Anthropology, University of Tennessee, Knoxville.

Hall, C. L., D. S. Amick, W. B. Turner, and J. L. Hofman
1985 Columbia Archaeological Project Archaic Period Radiocarbon Dates. In Exploring Tennessee Prehistory: A Dedication to Alfred K. Guthe, T. Whyte, C. Boyd, and B. Riggs, editors, pp. 61-79. Report of Investigations Number 42, Department of Anthorpology, University of Tennessee, Knoxville.

Hall, Charles L. and Walter E. Klippel
1988 A Polythetic-Satisficer Approach to Prehistoric Natural Shelter Selection in Middle Tennessee. Midcontinental Journal of Archaeology 13(2):159-186.

Hanson, Eric
1985 Regional Site Density Structures: Continuities and Discontinuities in Settlement Pattern Change. American Archaeology 5(1):21-27.

Heffley, Sheri
1981 The Relationship between Northern Athapaskan Settlement Patterns and Resource Distribution: An Application of Horn's Model. In Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses, edited by Bruce Winterhalder and Eric Alden Smith, editors, pp. 126-147. University of Chicago Press, Chicago.

Hodder, Ian, and Clive Orton
1976 Spatial Analysis in Archaeology. New Studies in Archaeology Series, Cambridge University Press, Cambridge.

Hoffman, C. Marshall
1985 Projectile Point Maintenance and Typology: Assessment with Factor Analysis and Canonical Correlation. In For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique, and Theory, edited by Christopher Carr, pp. 566 - 612. Westport Publishers, Inc., Fayetteville, Arkansas.

Hofman, Jack L.
1981 Test Excavation at a Buried Middle Archaic Component on the Duck River, Middle Tennessee. Southeastern Archaeological Conference Bulletin 24:44-48.

1984a Contextual Studies of the Middle Archaic Component at Cave Spring in Middle Tennessee. M.A. Thesis, Department of Anthropology, University of Tennessee, Knoxville.

1984b Radiocarbon Dates from Ervin: A Mid-Holocene Shell Midden on the Duck River in Middle Tennessee. Tennessee Anthropological Association Newsletter 9(2): 2-8

1986 Hunter-Gatherer Mortuary Variability: Toward an Explanatory Model. Unpublished Doctoral Dissertation, Department of Anthropology, University of Tennessee, Knoxville.

Hole, Frank, and Robert F. Heizer
1973 An Introduction to Prehistoric Archeology. Third edition. Holt, Rinehart and Winston, New York.

Horn, Henry S.
1968 The Adaptive Significance of Colonial Nesting in the Brewer's Blackbird (Euphagus cyanocephalus). Ecology 49(4):682-694.

Jermann, Jerry V.
1981 Surface Collection and Analysis of Spatial Pattern: An Archeological Example from the Lower Columbia River Valley. In Plowzone Archeology: Contributions to Theory and Technique, edited by M. J. O'Brien and D. E. Lewarch, pp. 71-118. Publications in Anthropology Number 27, Vanderbilt University, Nashville, Tennessee.

Jermann, Jerry V., and Robert C. Dunnell
1979 Some Limitations of Isopleth Mapping in Archaeology. In Computer Graphics in Archaeology: Statistical Cartographic Applications to Spatial Analysis in Archaeological Contexts, edited by Steadman Upham, pp. 31-60. rizona State University Anthropological Research Papers Number 15.

Jochim, Michael A.
1976 Hunter-Gatherer Subsistence and Settlement. Academic Press, New York.

1983 Optimization Models in Context. In Archaeological Hammers and Theories, edited by J. A. Moore and A. S. Keene, pp. 157-172. Academic Press, New York.

Johnson, J. K..
1977 Prehistoric Settlement Systems in the Middle Duck River Drainage, Columbia, Tennessee. Tennessee Anthropologist 2(2):142-151.

1981 Lithic Procurement and Utilization Trajectories: Analysis, Yellow Creek Nuclear Power Plant Site, Tishomingo County, Mississippi, Volume II. Tennessee Valley Authority Publications in Anthropology Number 28.

Kay, Marvin
1980 The Central Missouri Hopewell Subsistence-Settlement System. Research Series Number 15, Missouri Archaeological Society.

Keene, Arthur S.
1983 Biology, Behavior, and Borrowing: A Critical Examination of Optimal Foraging Theory in Archaeology. In Archaeological Hammers and Theories, edited by J. A. Moore and A. S. Keene, pp. 137-155. Academic Press, New York.

Kellogg, Douglas C.
1987 Statistical Relevance and Site Locational Data. American Antiquity 52:143-150.

Klecka, William R.
1980 Discriminant Analysis. Sage University Paper Series on Quantitative Applications in the Social Sciences.

Klippel, W. E.
1977 Prehistoric Cultural Adaptation to Holocene Environments in Middle Tennessee. Proposal Submitted to the Tennessee Valley Authority, Norris.

Klippel, Walter E., and Darcy F. Morey
1986 Contextual and Nutritional Analysis of Freshwater Gastropods from Middle Archaic Deposits at the Hayes Site, Middle Tennessee. American Antiquity 51(4):799-813.

Klippel, W. E., and P. W. Parmalee
1982 Diachronic Variation in Insectivores from Cheek Bend Cave and Environmental Change in the Midsouth. Paleobiology 8:447-458.

Kneberg, Madeline
1956 Some Important Projectile Point Types Found in the Tennessee Area. Tennessee Archaeologist 12(1):17-28.

Krebs, John R.
1978 Optimal Foraging: Decision Rules for Predators. In Behavioural Ecology: An Evolutionary Approach (1st edition), edited by J. R. Krebs and N. B. Davies, pg. 23-63. Blackwell Scientific Publications, Oxford.

Krebs, John R., and Richard J. Cowie
1976 Foraging Strategies in Birds. Ardea 64:98-116.

Krebs, J. R., D. W. Stephens, and W. J. Sutherland
1983 Perspectives in Optimal Foraging, In Perspectives in Ornithology, edited by G. A. Clark and A. H. Brush, pp. 165-216. Cambridge University Press, Cambridge.

Kvamme, Kenneth L.
1985 Determining Empirical Relationships Between the Natural Environment and Prehistoric Site Locations: A Hunter-Gatherer Example. In For Concordance in Archaeological Analyses, edited by Christopher Carr, pp. 208-238. Westport, Kansas City, Missouri.

1992 A Predictive Site Location Model on the High Plains: An Example with an Independent Test. Plains Anthropologist 37(138):19-40.

Lee, Richard B.
1979 The !Kung San: Men, Women, and Work in a Foraging Society. Cambridge University Press, Cambridge, Mass.

Lewarch, D. E., and M. J. O'Brien
1981 Effect of Short Term Tillage on Aggregate Provenience Surface Pattern. In Plowzone Archeology: Contributions to Theory and Technique, edited by M. J. O'Brien and D. E. Lewarch, pp. 7-50. Publications in Anthropology Number 27, Vanderbilt University, Nashville, Tennessee.

Lewis, T. M. N.
1955 The Hamilton and Eva Point Types of Tennessee. Bulletin of the Oklahoma Anthropological Society, Vol. III, Norman.

Lewis, T. M. N., and Madeline Kneberg
1947 The Archaic Horizon in Western Tennessee. Tennessee Anthropological Papers, Number 2. University of Tennessee Record Extension Series, 23(4). Knoxville.

1959 The Archaic Culture in the Middle South. American Antiquity 25(2):161-183.

Lewis, T. M. N., and M. K. Lewis
1961 Eva: An Archaic Site. Univeristy of Tennessee Press, Knoxville.

Lewontin, Richard C.
1987 The Shape of Optimality. In The Latest on the Best: Essays on Evolution and Optimality, edited by John Dupre, pp. 151-159. MIT Press, Cambridge, Mass.

Lucterhand, Kubet
1970 Early Archaic Projectile Points and Hunting Patterns in the Lower Illinois River Valley. Reports of Investigations Number 19, Illinois State Museum.

MacArthur, R. H., and E. R. Pianka
1966 On Optimal Use of a Patchy Environment. American Naturalist 100:603-609.

McMillan, R. Bruce, and Walter E. Klippel
1981 Post-glacial Environmental Change and Hunting-gathering Societies of the Southern Prairie Peninsula. Journal of Archaeological Science 8:215-245.

Miller, Robert A.
1974 The Geologic History of Tennessee. Tennessee Department of Conservation Division of eology, Bulletin 74, Nashville.

Morey, Darcy F.
1988 Unmodified Vertebrate Faunal Remains from Stratified Archaic Deposits at the Hayes Site, Middle Tennessee. Report submitted to the Tennessee Valley Authority, Norris, Tennessee.

Morey, Darcy F., and Walter E. Klippel
1986 Seasonality and Archaeological Contexts in the Midsouth. Report submitted to the National Science Foundation, Washington, D.C.

Morrison, Donald G.
1975 Discriminant Analysis. In Handbook of Marketing Research, edited by R. Ferber, pp. 2-442 - 2-457. MacGraw Hill, New York.

Morse, Dan F.
1967 The Robinson Site and Shell Mound Archaic Culture in the Middle South. Ph.D. dissertation, University of Michigan. University Microfilms, Ann Arbor.

Nance, Jack D.
1980 Non-Site Sampling in the Lower Cumberland River Valley, Kentucky. Mid-Continental Journal of Archaeology 5(2):169-191.

Neter, H., W. Wasserman, and M. Kutner
1985 Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs. Second Edition. Richard D. Irvin, Inc, Homewood, Illinois.

Odell, George H., and Frank Cowan
1987 Estimating Tillage Effects on Artifact Distributions. American Antiquity 52(3):456-484.

Odum, Eugene
1959 Fundamentals of Ecology. Saunders, Philadelphia.

Orians, Gordon
1971 Ecological Aspects of Behavior. In Avian Biology, edited by D. S. Farner and J. R. King, pp. 513-546. Academic Press, New York.

Paynter, Robert W.
1983 Expanding the Scope of Settlement Analysis. In Archaeological Hammers and Theories, edited by J. A. Moore and A. S. Keene, pp. 233-275. Academic Press, New York.

Phillips, P., J. A. Ford, and J. B. Griffin
1951 Archaeological Survey in the Lower Mississippi Alluvial Valley, 1940 - 47. Papers of the Peabody Museum Volume 25, Cambridge, Mass.

Plog, F. T. and J. N. Hill
1971 Explaining Variability in the Distribution of Sites. In The Distribution of Prehistoric Population Aggregates, edited by G. J. Gummerman, pp. 7-36. Anthropological Reports Number 1, Prescott College, Arizona.

Prescott, William D.
1978 An Analysis of Surface Survey Data from the Normandy Reservoir. Unpublished Master's Thesis, Department of Anthropology, University of Tennessee, Knoxville.

Quarterman, E.
1948 Plant Communities of Cedar Glades in Middle Tennessee. Ph.D. Dissertation, Duke University, Durham, N.C.

1950 Major Plant Communities of Tennessee Cedar Glades. Ecology 31: 234-254.

Read, Dwight W.
1989 Intuitive Typology and Automatic Classification: Divergence or Full Circle. Journal of Anthropological Archaeology 8(2):158-188.

Ritchie, William A.
1932 The Lamoka Lake Site. Researches and Transactions of the New York State Archaeological Association (Lewis H. Morgan Chapter), 7(4):79-134.

1944 The Pre-Iroquoian Occupations of New York State. Rochester Museum of Arts and Sciences Memoir, Number 1, Rochester.

Roper, Donna C.
1976 Lateral Displacement of Artifacts Due to Plowing. American Antiquity 41(3):372-375.

Salmon, Merrilee H.
1982 Philosophy and Archaeology. Academic Press, New York.

Sampson, Robert J.
1975 Surface II Graphics System. Series on Spatial Analysis Number 1, Kansas Geological Survey, Lawrence.

Sanders, W. T.
1956 The Central Mexican Symbiotic Region: A Study in Prehistoric Settlement Patterns. In Prehistoric Settlement Patterns in the New World, edited by G. R. Willey, pp. 115-127, Viking Fund Publication in Anthropology Number 23.

Smith, Bruce D.
1978 Variation in Mississippian Settlement Patterns. In Mississippian Settlement Patterns, edited by B. D. Smith, pp. 479-503, Academic Press, New York.

1986 The Archaeology of the Southeastern United States: From Dalton to de Soto, 10,500-500 B.P. Advances in World Archaeology 5:1-92.

Smith, Eric Alden
1983 Anthropological Applications of Optimal Foraging Theory: A Critical Review (with comments). Current Anthropology 24(5):625-651.

1987 Optimization Theory in Anthropology: Applications and Critiques. In The Latest on the Best: Essays on Evolution and Optimality, edited by John Dupre, pp. 201-249. MIT Press, Cambridge, Mass.

Smith, Eric Alden, and Bruce Winterhalder
1985 On the Logic and Application of Optimal Foraging Theory: A Brief Reply to Martin. American Anthropologist 87:645-648.

Smith, Robert L.
1974 Ecology and Field Biology. Second Edition. Harper and Row, New York.

Steward, Julian. H.
1937 Ecological Aspects of Southwestern Society. Anthropos 32:87-104.

Steward, Julian. H.
1938 Basin-Plateau Aboriginal Sociopolitical Groups. Bulletin 120, Bureau of Americal Anthropology, Washington, DC.

1954 Types of types. American Anthropologist 56(1):54-57.

1968 The Concept and Method of Cultural Ecology. In International Encyclopedia of the Social Sciences, edited by David L. Sills, vol. 4, pp. 337-344. Crowell, Collier, and Macmillan, Inc., New York.

Streuver, Stuart
1968 Woodland Subsistence-Settlement Systems in the Lower Illinois Valley. In New Perspectives in Archaeology, edited by L. R. Binford and S. R. Binford, pp. 285-312. Aldine, Chicago.

Tatsuoka, Maurice M.
1977 Discriminant Analysis: The Study of Group Differences. Selected Topics in Advanced Statistics: An Elementary Approach, Number 6.

Thomas, David H.
1972 The Use and Abuse of Numerical Taxonomy in Archaeology. Archaeology and Physical Anthropology in Oceania 7:31-49.

1975 Non-Site Sampling in Archaeology: Up the Creek Without a Site? In Sampling in Archaeology, edited by J. Mueller, pp. 61-81. University of Arizona Press, Tucson.

1979 Archaeology. Holt, Rinehart and Winston, New York.

Thorne, R. M., B. J. Broyles, and J. K. Johnson
1981 Lithic Procurement and Utilization Trajectories: Archaeological Survey and Excavations, Yelow Creek Nuclear Power Plant Site, Tishomingo County, Mississippi. Volume I. Tennessee Valley Authority Publications in Anthropology Number 27.

Trigger, Bruce G.
1968 The Determinants of Settlement Patterns. In Settlement Archaeology, edited by K. C. Chang, pp. 53-78. Nation Press Books, Palo Alto, California.

Turner, William B.
1986 Surface Artifact Assemblage Variability: A Consideration of the Natural Factors Influencing Artifact Recovery. Unpublished Master's Thesis, University of Tennessee, Knoxville.

Turner, William B. and Walter E. Klippel
1989 Hunter-Gatherers in the Nashville Basin: Archaeological and Geological Evidence for Variability in Prehistoric Land Use. Geoarchaeology 4(1):43-67.

Vogt, E. Z.
1956 An Appraisal of 'Prehistoric Settlement Patterns in the New World.' In Prehistoric Settlement Patterns in the New World, edited by G. R. Willey, pp. 173-182. Viking Fund Publications in Anthropology 23, New York.

Watson, P. J., S. A. LeBlanc, and C. L. Redman
1971 Explanation in Archeology: An Explicitly Scientific Approach. Columbia University Press, New York.

Whallon, Robert
1973 Spatial Analysis of Occupation Floors: The Application of Dimensional Analysis of Variance. In The Explanation of Cultural Change: Models in Prehistory, edited by C. Renfrew, pp. 115-130. Duckworth, London.

1974 Spatial Analysis of Occupation Floors II: The Aplication of Nearest Neighbor Analysis. American Antiquity 39(1):14-34.

Willey, Gordon R.
1953 Prehistoric Settlement Patterns in the Virú Valley, Peru. Bureau of American Ethnology, Bulletin 155, Washington, DC.

Willey, Gordon R. (editor)
1956 Prehistoric Settlement Patterns in the New World. Viking Fund Publications in Anthropology 23, New York.

Willey, Gordon R., and Philip Phillips
1958 Method and Theory in American Archaeology. The University of Chicago Press, Chicago.

Wilmsen, Edwin N.
1973 Interaction, Spacing Behavior, and the Organization of Hunting Bands. Journal of Anthropological Research 29(1):1-31.

Winterhalder, Bruce
1981 Optimal Foraging Strategies and Hunter-Gatherer Research in Anthropology: Theory and Models. In Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses, edited by Bruce Winterhalder and Eric Alden Smith, pp. 13-35. University of Chicage Press, Chicago.

1987 The Analysis of Humter-Gatherer Diets: Stalking an Optimal Foraging Model. In Food and Evolution: Toward a Theory of Human Food Habits, edited by Marvin Harris and Eric B. Ross, pp. 311-339. Temple University Press, Philadelphia.

Winters, Howard. D.
1969 The Riverton Culture: A Second Millenium Occupation in the Central Wabash Valley. Reports of Investigations Number 13, Illinois State Museum, Springfield.

Wright, H. E. Jr.
1976 The Dynamic Nature of Holocene Vegetation: A Problem in Paleoclimatology, Biogeography, and Stratigraphic Nomenclature. Quaternary Research 15:581-596.

Zar, Jerrold H.
1984 Biostatistical Analysis (Second Edition). Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

VITA

Charlie Hall was born in Baltimore, Maryland, in 1956. Third son of a young advertising agent and a registered nurse, he spent most of his first nine years in Ashland, Virginia, and enjoyed the rural southern life with his three brothers. His father left advertising to enter seminary in 1965, and moved the family to New Haven, Connecticut, where Charlie had his first encounter with an anthropological concept: culture shock. After three years in the northeast, the family returned to friendly Richmond, Virginia, and his father became the assistant (later associate) rector of St. James' Episcopal Church. In the fall of 1970, Charlie entered Maggie Lena Walker High School, and had his second serious experience with an anthropological concept: ethnocentrism. His three and one half years at Maggie Walker were extremely formative albeit traumatic. In December of 1973, half-way through his senior year of High School, the family moved to Arlington, Virginia, when his father became rector of St. George's Episcopal Church, and Charlie was graduated from Washington-Lee High School.

In 1974 Charlie matriculated at Washington and Lee University in Lexington, Virginia; an excellent educational experience financed by his mother's work at National Orthopedic Hospital awaited him. During his years at Washington and Lee, he was exposed to anthropology academically under the tutelage of Dr. John McDaniel, and worked on his first archaeological dig at Liberty Hall. Charlie was hooked.

After two years working as a shovel-bum in Arkansas, Missouri, and Illinois, Charlie began graduate training at the University of Tennessee in Knoxville; little did he know it would take him thirteen years to finish. Under the guidance of Dr. Walter E. Klippel, he spent several years doing archaeological field work in Tennessee, completed his Master of Arts degree in 1985, and his Doctor of

Philosophy in 1992. During these years he also spent eight months teaching at Radford University in Virginia, and a year teaching at the University of Tennessee.

While serving as a teaching assistant for a class in North American Indians during the winter semester of 1989, Charlie met his future wife among the students. Mary Beth Griffin, it should be noted, was a full time employee of the university, and was auditing the class. In September of 1990, Charlie and Mary were married in Knoxville. In January of 1991, they moved to Columbia, South Carolina, and Charlie began employment with the Department of Archives and History as Staff Archaeologist in the State Historic Preservation Office. Their first child, Stewart Griffin Hall, was born in August, 1991.

Charlie is now happier than he has ever been, and he still plays the banjo.