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MIDDLE AND LATE ARCHAIC HUNTER-GATHERER MOBILITY STRATEGIES IN WESTERN KENTUCKY

by

Gerald Thomas Conaty
B.A. (Hons.), University of Alberta, 1974
M.A., Memorial University of Newfoundland, 1979

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Middle and Late Archaic Hunter-Gatherer Mobility
Strategies in Western Kentucky

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ABSTRACT

Changes in hunter-gatherer mobility strategies during the Middle and Late Archaic periods in western Kentucky are examined. Two types of mobility strategies are defined: residential mobility and logistic mobility. Any hunter-gatherer society is expected to reflect a mixture of the two. The tendency toward either extreme will be influenced by the availability, abundance and distribution of resources critical to human populations.

Data utilized in this study consist of stone artifacts from 15 assemblages recovered from six sites. These data include seven Middle Archaic assemblages from one site and eight Late Archaic assemblages from six sites. Analysis of lithic material types indicates that local cherts predominate in each assemblage. All material is of good quality and differences in assemblages cannot be attributed to efforts at raw material conservation.

Principal components analyses were undertaken to determine the structure of the assemblages. One analysis included complete assemblages while the second focused on chipped stone artifacts. Both analyses indicate that all assemblages reflect generalized, complex assemblages indicative of residential sites. There appears to be a change toward residential instability from Middle to Late Archaic times.

Further analyses of residential mobility focuses on biface manufacturing trajectories. Research by others has shown that the longer a site is occupied, the greater the trajectory length represented in an assemblage. Biface thinning flake lengths and striking platforms, together with biface width:thickness ratios are utilized as indices of trajectory length. Analyses of flake lengths indicate that trajectory lengths at Late Archaic sites are more restricted than in Middle Archaic assemblages. This suggests a trend toward shorter site occupations.

It is concluded that there was a trend from logistic mobility during the MIddle Archaic toward residential mobility during the Late Archaic. Comparisons with other Archaic sites in the midcontinent reveal patterns both similar to and different from those observed at the sites under study. Responses to local ecological and sociocultural factors are thought to be responsible for these differences and similarities.

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CHAPTER I

INTRODUCTION

The Archaic period in Eastern Woodland prehistory is considered to have been a time of significant social and economic development. J.R. Caldwell (1958), who was among the first to recognize these trends, emphasized the specialized adaptive strategies developed by various social groups within different environments. He argued (Caldwell 1958) that these localized adaptive strategies led to the development of regionally distinctive cultures. More recently, Cleland (1966, 1976) suggested that these strategies involved, not a specialized concentration on a few resources, but rather an intensified exploitation of a diverse range of species. Both agree, however, that the paleoeconomic developments were accompanied by important changes in settlement patterns and networks of social interaction.

Among these important developments was an intensification of the trend toward sedentism. This trend involved a increase in the length of time certain sites were occupied, resulting in semi-permanent or permanent settlements. These changes can be understood as a change in mobility strategies. Such strategies are "the nature of seasonal movements of hunter-gatherers across the landscape: mobility strategies are one facet of the way in which hunter-gatherers organize themselves in order to cope with problems of resource acquisition." (Kelly 1983: 277).

This dissertation examines changes in mobility strategies as reflected in Middle and Late Archaic lithic assemblages from the lower drainages of the Cumberland and Tennessee Rivers in western Kentucky (Figure 1). Special attention is focused on the changes in mobility strategies and the implications regarding the composition of lithic assemblages and the organization of lithic technological systems. These assemblages are suitable for such a study for several reasons.

1. All are derived from sites within the study area of the Lower Cumberland Archaeological Project (Nance 1980). This multidisciplinary research project has provided data regarding local geomorphological developments and the nature and availability of lithic resources. The geomorphological analysis facilitates an understanding of the depositonal context of several assemblages and has contributed to our knowledge of some aspects of the paleoenvironment. Detailed knowledge of lithic resource availability assists in modelling lithic technological organization.
2. Many of the assemblages are derived from small, single component sites. Assemblages from the single, multi-component site exhibit minor comingling of material. Although these assemblages do not represent distinct occupations, they are from relatively discrete time periods. Differences can be examined for diachronic change.
3. The sites are situated both in the river valleys and in the uplands between the rivers. This provides a wider range of variation among the assemblages and the changes can be

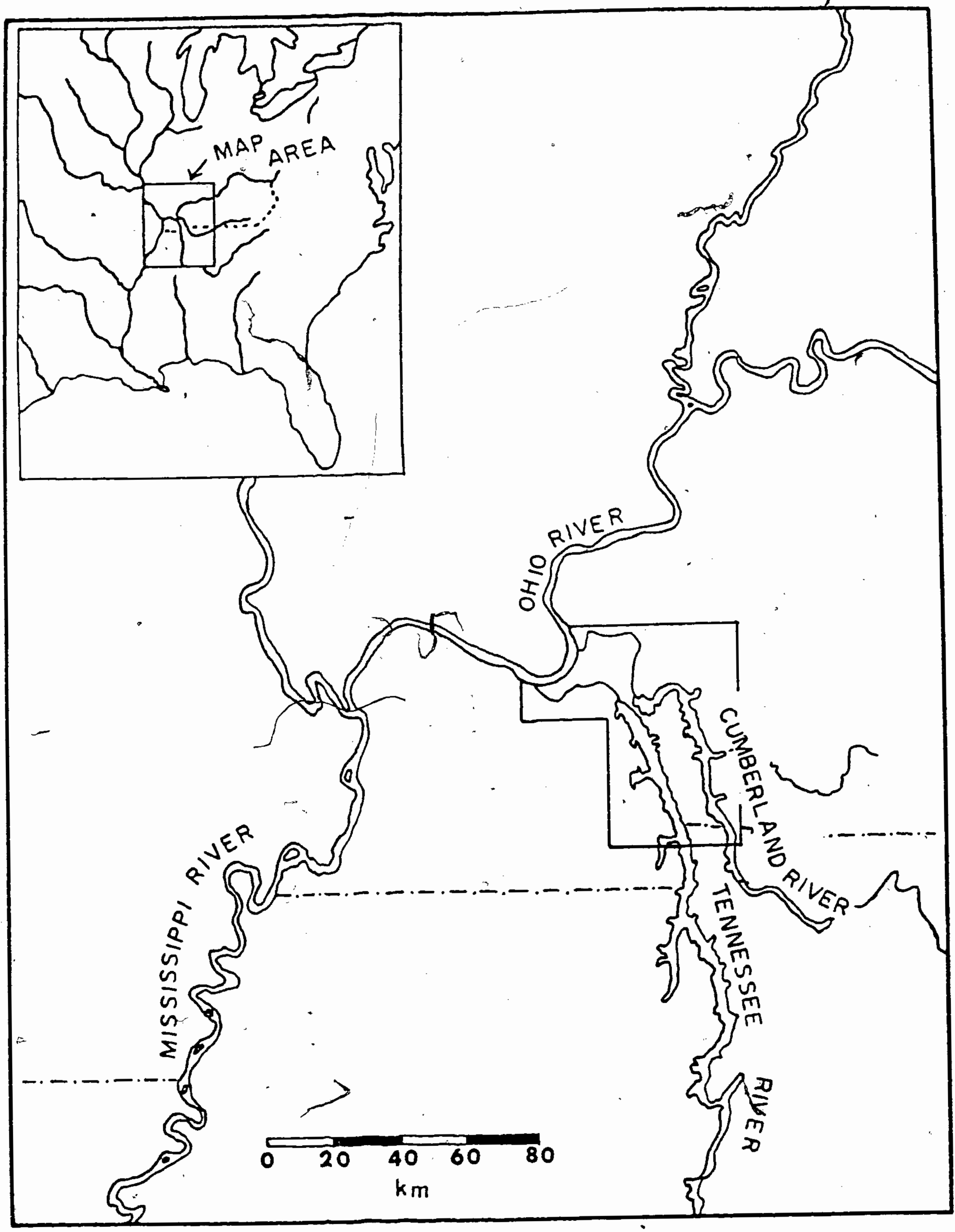


Figure 1. Study area.

considered to reflect long-term adaptive strategies. That is, changes do not reflect strategies within just one ecological zone.

4. Studies focused on Archaic mobility strategies have been undertaken in west-central Illinois (at the Koster site; Carlson 1979; Brown and Vierra 1983), and in east-central Missouri (O'Brien et al. 1982). These areas lie within, or immediately adjacent to the prairie peninsula. The assemblages examined in this study are from an area south of the present prairie and which may have been beyond the prairie in the past. If similar patterns of mobility strategy changes are evident in all areas, then these developments may reflect fundamental changes in Archaic adaptive strategies; changes that are not tied to environmental alterations.

As a first step in understanding how and why the observed changes came about, the material will be discussed in light of the paleoecology of the region and the environmental changes which took place throughout the period under discussion. It is not suggested that a direct causal relationship is to be found between environmental change and culture change. The archaeological data are, however, considered to be indicative of human adaptive strategies.

Previous Research

Although archaeological studies were initiated in western Kentucky during the nineteenth century (Rafinesque 1829; Moore 1916), the prehistory of the area remained largely unexamined by professional archaeologists until the late 1920's (Schwartz 1967: 31). Then, following an archaeological survey of the entire state of Kentucky (Funkhouser and Webb 1932), excavations were undertaken at a number of sites. Among these were the Duncan site in the lower drainages of the Cumberland and Tennessee rivers (Funkhouser and Webb 1931), the Tolu site on the Ohio River (Webb and Funkhouser 1931), the Williams site to the east in Christian County (Webb and Funkhouser 1929), and the McCleod site in the more western Hickman County (Webb and Funkhouser 1933). Later, the construction of the Kentucky Dam and Reservoir on the Tennessee River prompted W.P.A.-funded surveys of the impacted areas in Kentucky and northwestern Tennessee and the excavation of the Jonathan Creek Village site (Webb 1951) and the Eva site (Lewis and Lewis 1961). Further work in the area was withheld until the construction of the Barkley Dam and Reservoir on the Cumberland River led to more surveys and excavations in the area between the two rivers (Schwartz, Sloan and Griffin 1958; Schwartz 1961, 1962; Schwartz and Sloan 1958; Coe and Fisher 1959; Clay 1961, 1963a, 1963b, 1963c, 1963d; Clay and Schwartz 1963; Morse 1963). These were augmented with smaller federally-funded surveys in adjacent areas (Schwartz and Sloan 1960). Although earlier material was frequently noted in these assemblages, it was not until Rolingson's study (Rolingson 1964; Rolingson and Schwartz 1966) that Paleo-Indian and Early Archaic materials were examined in detail. Her analysis of projectile points owned by amateur collectors revealed the presence of a substantial Paleo-Indian occupation throughout the region.

More recent work has provided an elaboration of the prehistory of western Kentucky. Data from northwestern Tennessee have substantiated the evidence for a Paleo-Indian occupation (Dragoo 1973). More sites from the Early Archaic (Mocas 1977; Nance 1974; Nance and Conaty 1982), the Middle Archaic (Nance and Conaty 1982), and the Late Archaic (Peterson 1973; Nance 1974) periods have been added to the culture chronology. In addition, there has been an increasing focus on the total range of sites, including both large riverine localities and smaller sites (Nance 1972, 1975, 1977; Autry and Hinshaw 1979; DiBlasi and Sudhoff 1978 Butler et al. 1979; Ahler et al. 1980). Studies in adjacent areas, although frequently constrained by the terms of reference provided by mitigative contracts, have also provided information regarding the settlement and subsistence systems of prehistoric populations (e.g. Dobbs and Dragoo 1976; Collins 1979; Mocas 1976; Allen 1976; Schock and Wyss 1970; Schock et al. 1977; Butler et al. 1981; Watson and Carstens 1975; Carstens 1975, 1976, 1980; Watson et al. 1969; Watson 1974; Watson and Yarnell 1966; Marquardt and Watson 1976; Levy 1981; Munson and Cook 1980; Winters 1967, 1969).

These studies have revealed a long and complex culture history in western Kentucky and offer a substantial data base for the development of processual models. Clay (1976), for example, has examined Mississippian settlement systems. At present, however, there is no model based upon locally derived data that satisfactorily interprets and explains the variation between Archaic period sites.

Chapter Outline

This study begins with an extensive overview of the culture history of the Mid-South. This discussion places the data from the lower Cumberland/Tennessee drainage within a broader context and underscores the similar economic strategies that existed throughout the Archaic period. Emphasis is also placed on the formal variations of hafted bifaces. These items serve as the only indicators of the age of many of the assemblages considered in this study. It is important, therefore, that assumptions regarding their temporal context be made explicit.

Chapters 3 and 4 provide the theoretical and analytic framework. The former outlines the importance of examining the contexts of assemblages and discusses in detail the application of optimal foraging theory in this study. The latter chapter discusses how the analysis of assemblage structure and technological organization contribute to understanding human foraging and mobility strategies. Chapter 5 is a description of the local environment.

The artifact categories used in this study are defined in Chapter 6 and the sites are described in Chapter 7. The use of lithic material types is analyzed in Chapter 8 and the assemblage structures and technological organization are analyzed in Chapters 9 and 10. Chapter 11 contains the concluding remarks.

CHAPTER II

CULTURAL CONTEXT: OVERVIEW OF THE REGIONAL PREHISTORY

This chapter provides an outline of the cultural history of the midcontinent (Figure 2). It also serves to illustrate the nature of western Kentucky prehistory in relation to neighbouring areas. Such a discussion is important for two reasons. First, the age of many of the assemblages examined here can only be determined through a comparison of temporally diagnostic artifacts, such as projectile points/knives. A discussion of the occurrences of these artifacts in well-dated situations provides verification of the ages to which they are assigned in this study. Second, a consideration of cultural developments in neighbouring areas will provide a foundation for understanding the changes within the lower Cumberland/Tennessee drainages. The detailed discussion that follows is meant to emphasize the overall similarity while, at the same time, illustrating the considerable heterogeneity between major drainage systems.

In this study, the midcontinent is arbitrarily defined to include sites which reflect similar culture histories and which are important in understanding Archaic hunter-gatherer mobility strategies in western Kentucky. In Figure 2, the eastern boundary lies along the western slope of the Appalachians, the southern boundary includes the Tennessee River drainage, and the western boundary extends along the Mississippi River valley. The

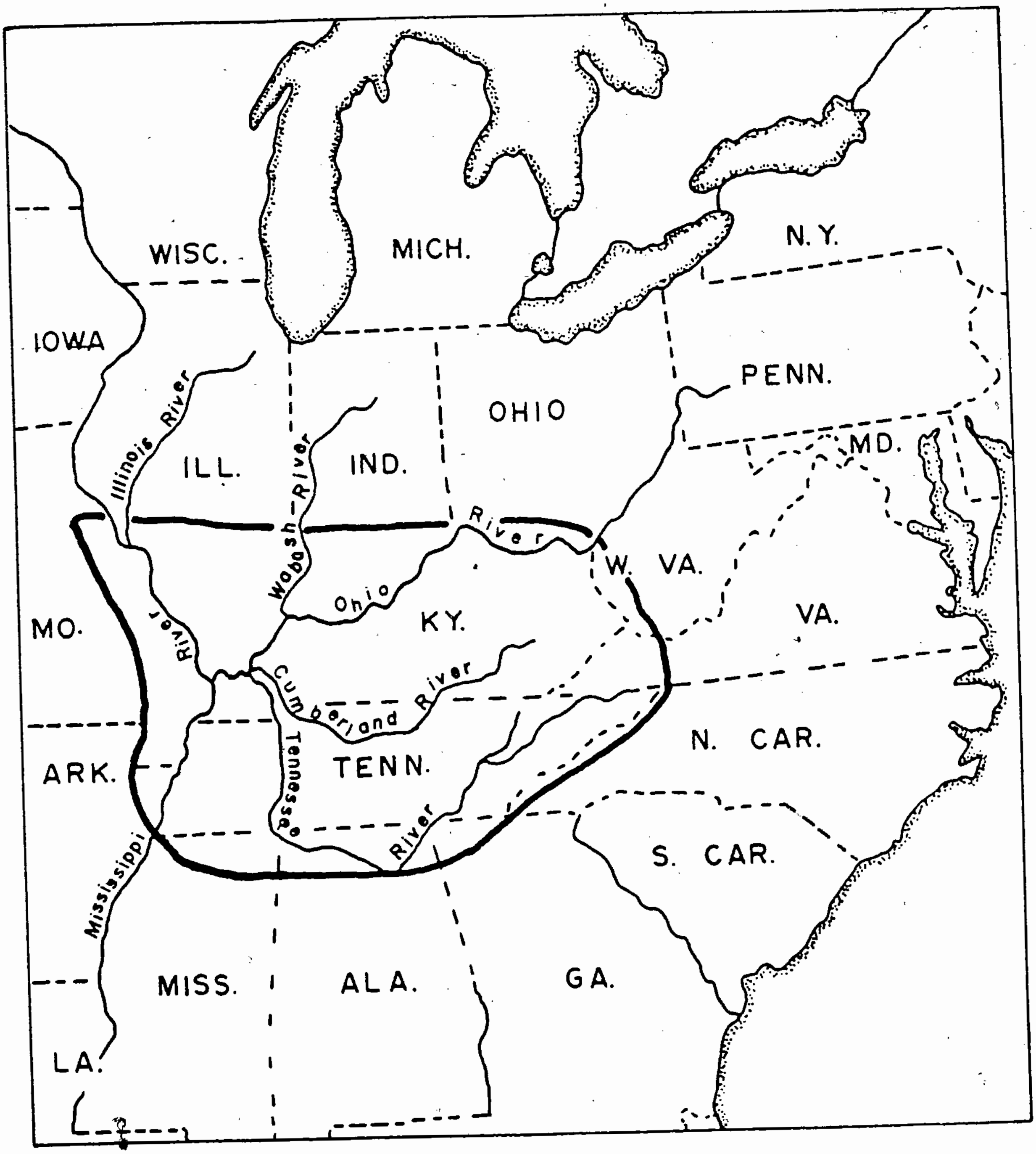


Figure 2. Region included in the midcontinent area.

northern boundary follows the eastern portion of the Ohio River valley, but is extended across southern Indiana and Illinois to include sites of the Riverton Culture and the Koster site.

The prehistory of the midcontinent can be separated into five periods: the Paleo-Indian period (up to 10,500 years bp); the Paleo-Indian/Archaic Transition period (c. 10,500 to 9900 years bp); the Archaic period (c. 9900 to 2900 years bp); the Woodland period (c. 2900 to 950 years bp); and the Mississippian period (c. 950 to 700 years bp) (Table 1). The following presents an outline of the general developmental trends that occurred within each period. The evidence from the lower Cumberland and Tennessee drainages is examined in detail. As this study is concerned with the Archaic, a greater emphasis will be placed on that period.

The Paleo-Indian period (up to 10,500 bp)

The time and nature of the intial human occupation of the midcontinent remains a problem. The earliest undisputed material bears clear resemblances to fluted point complexes from other areas of North America. Artifacts which are believed to be diagnostic of this period include blades and blade tools, gravers, a profusion of unifacial tools, end scrapers (many with graver spurs), channel flakes, and fluted points. Mason (1962: 233) identified a large and a small variety of fluted point. The larger ones exhibit single flutes on each surface and bear a close resemblance to Clovis points recovered elsewhere on the

Table 1. Culture-historical periods of the midcontinent.

AGE (yrs. bp)	PERIOD	SUB-PERIOD
	HISTORIC	
500	MISSISSIPPIAN	
1 500	WOODLAND	LATE WOODLAND
		MIDDLE WOODLAND
2 500		EARLY WOODLAND
3 500	ARCHAIC	LATE ARCHAIC
4 500		
5 500		
6 500		MIDDLE ARCHAIC
7 500		
8 500		EARLY ARCHAIC
9 500	PALEO-INDIAN/ ARCHAIC TRANSITION	
10 500	PALEO-INDIAN	

continent. In the midcontinent they occur at the Thunderbird site in the Flint Run Complex in West Virginia (Gardner 1974), at the LeCroy site in Tennessee (Lewis and Kneberg 1956), at the Pine Tree site in northern Alabama (Cambron 1956), at the Wells Creek Crater site in northwestern Tennessee (Dragoo 1973), and at the Parrish site in west-central Kentucky (Webb 1951; Rolingson and Schwartz 1966). Assemblages with these points are believed to predate occurrences of the smaller variety (Gardner 1974).

The smaller forms are known variously as Quad or Cumberland points. Many are distinguished by the presence of multiple flutes and basal ears. These forms have been found in northern Alabama at the Pine Tree site (Cambron 1956), at the Quad site (Soday 1972; Cambron and Hulse 1972), and at the Flint Creek Rockshelter (Cambron and Waters 1959). In West Virginia they have been recovered at the Thunderbird site (Gardner 1974), while in Tennessee they occurred at the Nuckolls site (Lewis and Kneberg 1958, 1959) and at the Nowlin II site (Keel 1978). Their presence in west-central Kentucky has been noted at the Morris site (Rolingson and Schwartz 1966) and at the Longworth-Gick site (Collins et al. 1979). The deposits at most of these sites contained a variety of point forms in stratigraphic association with one another. Only at the Thunderbird site have fluted points been found in well-controlled circumstances.

<u>Settlement and Subsistence</u>. Knowledge of the lifestyles of these early people is almost non-existent. Evidence from the

Great Plains indicates that these were big-game hunters whose prey included mammoth and other now-extinct fauna (Agogino 1968; Haury 1952; Haury et al. 1953; Haury et al. 1959; Haynes 1973, 1974, 1976, 1978; Hemmings and Haynes 1969; Hester 1966; Irwin et al. 1962; Irwin 1970; Leonhardy 1966; Leonardy and Anderson 1966; Warnica 1966; Wendorf and Hester 1962). In contrast, it has been suggested that Paleo-Indians in northeastern North America hunted caribou (Fitting et al. 1966; MacDonald 1968). Clovis tools were found in association with the remains of mastodon at the Kimmswick site in eastern Missouri (Graham et al. 1981).

Analysis of the spatial distribution of these sites has revealed at least two environmental features of significance. First, some sites have been found on ridges, close to outcrops of cryptocrystalline material (e.g., the Thunderbird and Wells Creek Crater sites). It has been suggested that this reflects a general Paleo-Indian settlement system which included the selection of specific sources of lithic material (Gardner 1974; Goodyear 1979). Second, it has been demonstrated that, in regions of karst topography, Paleo-Indian sites tend to occur near sinkholes (Gatus and Maynard 1978). These sinkholes would have been sources of water for man and other fauna, and would therefore have served as admirable ambush localities.

Cumberland/Tennessee Drainage. All of the Paleo-Indian assemblages in the lower Cumberland/Tennessee drainage were found in association with tools from later periods. Rolingson and Schwartz (1966) provided a detailed analysis of two sites in this region which contained a significant amount of Paleo-Indian material: the Henderson site and the Roach site. Now, almost twenty years later, no substantial additions can be made to their list of sites.

The Henderson site is an unstratified site located at the confluence of Eddy Creek and the Cumberland River. Excavations, which were focused in the area of the most dense concentration of cultural material, revealed cultural deposits 40 cm deep. One complete fluted Cumberland point/knife and fragments of two other fluted points/knives were recovered. Although the shallow deposits had been disturbed by cultivation, and despite the predominance of Archaic point forms (82.76 per cent of all points), Rolingson and Schwartz (1966:26) suggested that the assemblage represented a single cultural component and that the presence of fluted points indicated an age of greater than 8,000 years.

The Roach site was one-quarter mile east of the Tennessee River, on Ewes Branch (it is now under Kentucky Lake). Although it was originally excavated in 1941 as a mitigative action in conjunction with the construction of Kentucky Dam, Rolingson and Schwartz (1966) provided the first published analysis of the material. The unstratified cultural deposits extended to a maximum depth of 3.5 feet below the surface and included material that is representative of Paleo-Indian, Archaic, and Mississippian periods. Paleo-Indian point varieties included seven Quad, two fluted lanceolate and three unfluted lanceolate points/knives.

The early material tended to cluster in distinct areas of the site away from the Woodland and Mississippian material. This spatial distribution strengthens the argument for a distinct Paleo-Indian occupation. It is interesting to note that the Quad points and the fluted lanceolate forms occurred in clusters which were separate from each other. Rolingson and Schwartz (1966: 61) did not consider there to have been an unquestionable Paleo-Indian occupation of the site. Rather, they viewed the lithic assemblage as being Archaic in composition, but reflecting earlier Paleo-Indian influences and later traits of a Woodland culture.

A comparison of the Henderson and Roach materials with those from other Paleo-Indian sites in western Kentucky and Tennessee led Rolingson and Schwartz (1966: 152) to conclude that the sites in western Kentucky exhibited greater similarity to the Nuckolls assemblage (Lewis and Kneberg 1958, 1959) than to other early sites. Important similarities are the presence of Quad and Cumberland Fluted points, the co-occurrence of the same varieties of unifacial scrapers, the presence of graver spurs on some of the unifacial scrapers, and the prevalence of utilized flakes. Notable by their absence are prismatic blades and tools made on such blades. In view of the elements shared by these assemblages, it was concluded that these sites "were, apparently, expressions of the Quad-Dalton tradition in

Kentucky" (Rolingson and Schwartz 1966: 152).

The Trail site, on the south bank of the Cumberland River, has contributed more Paleo-Indian material. There, two Cumberland Fluted points were recovered during an intensive surface collection. The remaining points from this site are distinctly late Middle Archaic in age. Other unequivocally early artifacts cannot be distinguished from the later material. Thus, while this site further documents the presence of Paleo-Indian material, it does not contribute to our substantive understanding of this early period of prehistory.

The Dalton Horizon (c.10,500 - 9900 bp)

Summaries of the prehistory of eastern North America generally consider the period between c. 10,500 and 9900 bp to have been a time of transition from big-game hunting during the Paleo-Indian period to a more generalized foraging economy in the Archaic (Willey 1966: 72; Stoltman 1978: 714). Characteristic of this period is a lithic technology which shares many aspects with the preceding fluted point assemblages and which is characterized by the presence of Dalton points. The technological affinities with earlier times is best exemplified by these points, which have "a lanceolate outline, ... a deep basal concavity, basal and lateral grinding, and a generally well-thinned base, ... which, in some cases, is equivalent to fluting" (Goodyear 1982: 383). The rest of the assemblage associated with Dalton points includes many of the same unifacial tools that occur in fluted point sites. An important addition to this inventory is the chipped adze (Morse and Goodyear 1973; Goodyear 1982: 384).

Stratified sites at which Dalton points have been found include the Rose Island site (Chapman 1975: Table 13), the Icehouse Bottom site (Chapman 1977: Table 3), the Hardaway site (Coe 1964: Table 7), the Stanfield-Worley Bluff Shelter (DeJarnette et al. 1966), Russell Cave (Griffin 1974), the Eva site (Lewis and Lewis 1961), the Big Bottom site (Sims 1971), and the Morris site (Rolingson and Schwartz 1966). In each of these instances, the Dalton forms were found in the same stratigraphic levels as corner-notched points/knives. Associated dates from the Stanfield-Worley Bluff Shelter were 8920 bp (UM-1153) and 9640 +/- 450 years (UM-1152) (DeJarnette et al. 1962). These dates, the apparently clear association with Archaic point forms, and a technology which reflects the Paleo-Indian period led to the characterization of the Dalton complex as a late Paleo-Indian/Early Archaic transitional horizon (Tuck 1974).

In a recent review of the Dalton horizon, Goodyear (1982) noted that Dalton and Early Archaic notched points occurred together only at rockshelters and cave sites. In alluvial deposits and at open air sites the two are mutually exclusive (the Dalton points from the Rose Island and Icehouse Bottom sites were considered to have been "culturally redeposited"; Goodyear 1982: 188). He further observed that the dates from the Stanfield-Worley Bluff Shelter are similar to the ages of Early

Archaic assemblages from the St. Albans site in West Virginia (Broyles 1971) and from a number of sites in the Little Tennessee River valley in eastern Tennessee (Chapman 1975, 1976, 1977). In contrast, charcoal samples from the Dalton zone at Rodger's Rockshelter in the Ozark Highlands of Missouri (Wood and McMillan 1976) have yielded dates of 10,530 bp +/- 650 years (ISGS-48) and 10,200 bp +/- 300 years (M-2333). The assemblage from this zone comprised "a coherent Dalton assemblage very similar to that known from the northeast Arkansas region" (Goodyear 1982: 386). On the basis of this evidence, Goodyear argued that Dalton and corner-notched points were not coeval, and that Dalton occurred only between 10,500 bp and 9900 bp.

Settlement and Subsistence. The early age that Goodyear proposed for the Dalton horizon places it within the time span of the Pleistocene-Holocene transition. In many regions of North America, this was a period during which the environment significantly changed. The periglacial, boreal-like forests were replaced by thermophilous deciduous species. Faunal and floral evidence indicate that the diet of the Dalton people was composed of modern species (Goodyear 1982: 391).

While the settlement patterns of Paleo-Indians is only understood on the most general level, more specific models have been developed for the Dalton period. A settlement pattern has been suggested (Morse 1973, 1975; Morse and Goodyear 1973; Goodyear 1974; see also Schiffer 1975, 1979) that includes large base camps with ancillary, function-specific sites. It is expected that each of these satellite sites will contain a distinctive assemblage of tools that is indicative of the activities that were conducted at the site.

Lower Cumberland/Tennessee Drainage. Dalton points have not been found in undisturbed or unequivocal contexts in the lower drainages of the Cumberland and Tennessee rivers. Lewis and Lewis (1961) reported Dalton points from the Eva site and Rolingson and Schwartz (1966) recorded one Dalton point from the Henderson site and one from the Roach site. At the Roach site, the Dalton material was spatially clustered away from Woodland and Mississippian artifacts and features.

The Archaic Period (c. 9,000 - 2,900 bp)

In the fifty years that have followed W.A. Ritchie's (1932) initial definition of the Archaic, considerable research has been concerned with this period of eastern North American prehistory. In most summary descriptions (e.g. Willey 1966; Chapman 1975: 6; Collins 1979: 20) early, middle and late subperiods have been identified. Within each succeeding subperiod there appears to have been an increasing regionalization of prehistoric cultures. Caldwell (1958), among others (e.g. Cleland 1966, 1976; Hayden 1981), attributed this trend to successful adaptations to local conditions.

In this section, the Early, Middle and Late Archaic subperiods will each be considered in turn. Data from different areas will be presented and compared with Archaic manifestations in neighbouring areas. Following this, the evidence from the lower Cumberland/Tennessee drainage will be examined.

Early Archaic Subperiod (c. 9,000 - 7,900 bp)

The Early Archaic has been defined as "those cultures following in time the Paleo-Indian fluted point users and preceeding in time the emergence of distinctive regional variants of the Archaic in the east." (Tuck 1974: 73). Tuck (1974) originally identified three horizons, defined on the basis of the distribution of specific point styles. Recent research indicates that several other point forms also enjoyed a widespread and coeval distribution.

Early forms of side-notched and corner-notched points appeared sometime after the Paleo-Indian/Archaic transition. At the St. Albans site, in West Virginia, Charles Corner-Notched points were found in association with a hearth which produced a radiocarbon date of 9850 bp +/- 500 years (M-1827). The initial Early Archaic has also been noted at Modoc Rockshelter in southern Illinois. Fowler (1959: Table 1) suggested an average age of 6219 bp +/- 488 years for the Hidden Valley Stemmed and early side-notched points, although dates of 10,947 bp +/- 900 years (C-904) and 11,200 years +/- 800 years (C-905) were also obtained from the same levels as these early points. In 1980, carbon samples obtained from levels containing these point styles yielded dates of 8920 bp +/- 220 years (ISGS-740), 8890 bp +/- 140 years (ISGS-747), 8710 bp +/- 140 years (ISGS-780), 8680 bp +/-150 years (ISGS-797), and 7700 bp +/- 190 years (ISGS-781) (Styles et al. 1981: Table 5). The Stanfield-Worley Bluff Shelter in northern Alabama has also produced very Early Archaic material (DeJarnette et al. 1962). There, Big Sandy I side-notched points initially occurred in the same levels as Dalton points. The two point styles were considered to be variations along a continuum (Dejarnette 1962: 82).

Kirk Corner-Notched Horizon. Following the early point styles, Kirk Corner-Notched varieties appeared and became widespread. These were initially identified by Coe (1964: 56-83) from material recovered at the Hardaway site on the Yadkin River in the Carolina Piedmont. He distinguished between Palmer Corner-Notched and Kirk Corner-Notched forms. The former were smaller, had ground bases and bevelled blades and were slightly older. Kirk Stemmed and Kirk Serrated styles occurred in levels above the corner-notched forms. Radiocarbon dates were not available for the Hardaway site. However, through a comparison with other sites, Coe (1964: 67) estimated that the Palmer Corner-Notched points were approximately 8,000 years old.

Broyles (1971) identified two varieties of Kirk Corner-Notched points at the St. Albans site. A small variety, which resembles Coe's (1964) Palmer type but which lacks grinding, was found in association with a hearth dated 8930 bp +/- 160 years. A large variety of Kirk Corner-Notched point occurred above the smaller forms and was dated 8800 bp +/- 320 years. Three Kirk Stemmed points were also found in the zones associated with the Kirk Corner-Notched assemblage.

Recent research in the lower Little Tennessee River valley has revealed the presence of a number of deep, stratified sites on the floodplain and on islands in the river. Kirk Corner-Notched points occurred as the predominant point form in the lowermost levels at the Rose Island site (Chapman 1975), the Icehouse Bottom site (Chapman 1973, 1977), the Bacon Farm site (Chapman 1978), and the Patrick site (Chapman 1977). Radiocarbon dates for these assemblages are 9350 bp +/- 250 years (GX-4125; Stratum L at Icehouse Bottom), 8525 bp +/- 355 years (I-9137; Stratum L at Icehouse Bottom), and 9330 bp +/- 250 years (GX-3564; Stratum VIII at Rose Island). At each of these sites a progression from small to large varieties was noted. However, no stratigraphic separation could be made between corner-notched points with basal grinding and those without. It was therefore suggested that Charleston Corner-Notched (Broyles 1971), Palmer (Coe 1964), Kirk Corner-Notched small variety, and Kirk Corner-Notched large variety points all represent variations along a continuum (Chapman 1975: 123).

At Russell Cave in northern Alabama, Early Archaic artifacts were recovered from Layer G (Griffin 1974). Although a wide variety of points was recovered from this layer, corner-notched forms dominated the assemblage. Radiocarbon determinations from charcoal samples taken from this layer yielded dates of 7565 bp +/- 250 years (I-827), 8095 bp +/- 275 years (I-828), 8435 bp +/- 275 years (I-822), and 8500 bp +/- 320 years (I-2239)

(Griffin 1974: Table 1).

Corner-notched points have also been found at the Faulkner site (MacNeish 1948; Cole et al. 1951), located across the Ohio River from the mouth of the Tennessee River. Formally, these points resemble Kirk Corner-Notched varieties. Unfortunately, the shallow cultural deposits represent a mixture of early and late material and assemblages from different periods have not been separated.

The Longworth-Gick site (Collins et al. 1979), located adjacent to the Ohio River in west-central Kentucky has further substantiated the early age of Kirk Corner-Notched points. Initially, Dobbs and Dragoo (1976) identified three levels at the site. The lowermost contained two Charleston Corner-Notched points. The middle level, dated 8647 bp +/- 125 years (UGa-1336), yielded two Kirk Corner-Notched points and the upper level had one example of a small variety Kirk Corner-Notched point and eight bifurcate base points.

More extensive excavations (Collins et al. 1979) have revealed cultural material throughout thirteen zones. A number of small variety Kirk Corner-Notched points were found in Zone XIII (dated 9766 bp +/- 237 years; Tx-3012) and Zone VII (dated 8685 bp +/- 391 years; Tx-3011). Stratigraphically above this is a zone (Zone V) in which the large variety of Kirk Corner-Notched point comprised the major point type. One Kessell Side-Notched point was found in Zone IV. It is noteworthy that this position of the Kessell Side-Notched point is dissimilar from its very early place in the St. Albans site sequence (Broyles 1971). Furthermore, the large variety of Kirk Corner-Notched point occurred at the Longworth-Gick site approximately 400 years later that at the St. Albans site and in the lower Little Tennessee River valley (Chapman 1975, 1977, 1978).

Bifurcate Base Horizon. A range of bifurcated base point types occurred in the zones above the Kirk assemblages at a number of sites. At the St. Albans site the sequence included MacCorkle Stemmed (estimated to be 8800 to 8700 years old), St. Albans Side-Notched (8830 bp +/- 700 years), LeCroy Bifurcated Base (8250 bp +/- 100 years) and Kanawha Stemmed (8160 bp +/- 100 years).

MacCorkle Stemmed points have not been found in large numbers in the lower Little Tennessee Valley. Rather, St. Albans Side-Notched forms succeeded those of the Kirk Corner-Notched cluster. Strata in which these comprise the dominant point form have been dated 8660 bp +/- 180 years (Gx-3590; Stratum VIII at the Rose Island site). LeCroy points were generally above the St. Albans Side-Notched points. However, they have not been found in close association with radiocarbon dated material. At the Rose Island site, LeCroy points occurred in greater numbers above a stratum dated 8700 bp +/- 300 years (Gx-3168), and in a zone dated 8920 bp +/- 325 years (Gx-3597). Overlying the LeCroy points were strata in which Kanawha Stemmed comprised the predominant point form. At the Rose Island site, these strata occurred between ones that have been dated 7800 bp +/- 300 years (Gx-3168; Stratum VIII-5) and 7020 bp +/- 190 years (Gx-3563; Stratum IV). In general, however, the Kanawha complex is poorly represented in this area.

Bifurcated base points also occurred at the Longworth-Gick site (Collins et al. 1979), where they were most common in a zone dated 6715 bp +/113 years (Tx-2951). There was, however, no distinct sequence of different varieties.

Settlement and Subsistence. The evidence for the Early Archaic in the midcontinent that has been presented here is clearly biased towards deep stratified sites situated on river floodplains or towards rockshelters and caves. Although these are not the only occurrences of early Archaic material, many of the smaller sites present a mixture of artifacts from a number of time periods.

There is evidence, albeit meager, regarding the subsistence strategies that were undertaken during the Early Archaic. Faunal remains from Russell Cave indicate that deer, turkey, racoon, squirrel, and bear formed the major vertebrate components of the diet (Weigel et al. 1974: 81). Fish remains were scarce and consisted primarily of species "characteristic of a large river" (Weigel et al 1974: 84). Data from the Stanfield-Worley Bluff Shelter (Parmalee 1962: 112-113) indicate a diet composed primarily of white-tailed deer and supplemented with squirrel, racoon, birds, turtles, fish, and molluscs. These faunal remains form a mixed assemblage from the lowermost zone and from miscellaneous features. As such, they represent a general assemblage from all of the occupations and cannot be assigned to any specific time period. At Modoc Rockshelter the faunal remains identified by level (Fowler 1959: 41) indicate that during the Early Archaic fish became the preferred element in the diet. Fowler (1959: 41) suggested that this reliance on fish, especially backwater species, "probably represents an adjustment to the local habitat and an utilization of the resources immediately available."

The tendency toward the use of locally available food resources is reflected by the presence of large quantities of carbonized nutshells at many sites. On this basis it may be suggested that the Early Archaic people were utilizing all of the seasonally available resources.

<u>The Lower Cumberland/Tennessee Drainage</u>. Little is known of the Early Archaic occupation of the lower Cumberland and Tennessee drainages. Most of the material which can be attributed to this period comes either from small, isolated undated sites or from contexts in which the majority of the assemblage is of a younger age. At the Morrisroe site (Nance and Conaty 1982; Conaty and Nance 1983) a date of 8220 bp +/- 100 years (SFU-271) was yielded by a sample of carbonized wood and nutshell retrieved from near the bottom of the cultural deposits. Although points from this stratigraphic zone include

Kirk Corner-Notched and Eva types, these artifacts were recovered up to 20 cm above the level of the dated material. Two Kirk Stemmed points may be contemporaneous with this date.

Middle Archaic Subperiod (c. 7900 - 5900 bp)

The Middle Archaic is distinguished by the decline of the widespread Early Archaic horizons defined by the presence of particular point styles. Rather, a variety of local and regional traditions developed. For this reason, this discussion will proceed by region rather than by sequential horizons.

Carolina Piedmont-Western Appalachian. The Middle Archaic in the Carolina Piedmont is best represented at the Doerschuck site. There, Stanly was the only point form found in the basal zone. Morrow Mountain points occurred above them and comprised the majority of point types in the succeeding two cultural zones. While no radiocarbon dates were obtained for the Doershuck site, Coe (1964: 54) estimated an age of 6900 bp for the Stanly occupation.

Research in the lower Little Tennessee Valley has revealed Middle Archaic assemblages in western Tennessee that are similar to those found in the Carolina Piedmont. Stanly points succeeded bifurcated base types at the Patrick site (Chapman 1977) and at the Icehouse Bottom site (Chapman 1977) where they became the dominant form c. 7790 bp +/- 215 years (GX-4123). At the Icehouse Bottom site Morrow Mountain replaced Stanly as the dominant form c. 6995 bp +/- 245 years (GX-4124). A similar date

(7255 bp +/- 165 years; GX-4704) was obtained from carbonized wood and hickory nutshell associated with Morrow Mountain points at the Howard site (Chapman 1979: 79).

Northern Alabama. Morrow Mountain points, found in three burials at the Stanfield-Worley Bluff Shelter (DeJarnette et al. 1962: 80-82), were associated with White Springs and Crawford Creek points. Although radiocarbon dates were not obtained for these deposits, DeJarnette et al. (1962: 82) noted that bone awls and bone points similar to the ones associated with these points had frequently been found in northern Alabama shellmound sites.

The Middle Archaic occupation at Russell Cave is characterized by Morrow Mountain points in association with a local provisional category P-1 Stemmed (Griffin 1974: 44). Radiocarbon dates of 6250 bp +/- 190 years (I-702) and 6310 bp +/-140 years (I-2238) were obtained from two burials which originated in the Middle Archaic stratigraphic layer.

The Mulberry Creek site is a deep shellmound, located at the confluence of Mulberry Creek and the Tennessee River (Webb and DeJarnette 1942: 235-266; Walthall 1980: 62-65). The c. 6.0 m of deposits revealed multiple layers of shell and cultural material interspersed with layers of sterile river deposits. Walthall (1980: 64) noted that ten burials which originated in the lower chipped stone zone were accompanied by Middle Archaic artifacts, including such point styles as Morrow Mountain, White Springs (cf. Sykes), and Cypress Creek. Three burials were found with Morrow Mountain points embedded in the thoracic cavity, spinal column, and mouth.

Southern Illinois. The Middle Archaic occupation at Modoc Rockshelter occurred in the 16-21 foot levels below the surface. The point styles from these levels included stemless (n=6), lanceolate with concave base (n=3), straight stemmed (n=4), contracting stemmed (n=2), expanding stemmed (n=5), expanding stemmed side-notched (n=9), corner-notched (n=3), side-notched (n=10), and side-notched variant (n=5) varieties. These levels have been radiocarbon dated 5268 bp +/- 230 years (C-899) and 5955 bp +/- 235 years (C-900)(Fowler 1959: Table 1).

Settlement and Subsistence. The limited number of Middle Archaic assemblages that have been described in the midcontinent greatly restricts the discussion of the settlement patterns and subsistence systems of this time period. The data that are available indicate a distinct trend towards the utilization of locally available resources. In some areas of the Tennessee River drainage, for example, the use of freshwater mussels became more important as the development of shellmounds intensified (e.g. Mulberry Creek site, Webb and DeJarnette 1942; Walthall 1980; some levels of the Eva site, Lewis and Lewis 1961). The lithic and bone industries accompanying these shellmound occupations were reflected in the Middle Archaic levels at the Stanfield-Worley Bluff Shelter (DeJarnette et al. 1962) and at Russell Cave (Griffin 1974). At these sites mollusc remains were negligible while deer, squirrel, and a variety of birds comprised the majority of the faunal remains. The tendency for locally available food resources to dominate Middle Archaic faunal assemblages has been characterized by Fowler (1959: 55) as indicative of a period of localized adaptation.

Lower Cumberland/Tennessee Drainage. The Middle Archaic period in the lower Cumberland/Tennessee drainage is becoming increasingly better understood. The earliest discussion was provided by Lewis and Kneberg (1959) in their description of the Eva phase and in their analysis of the Eva site (Lewis and Lewis 1961). Diagnostic artifacts of the Eva phase include Kirk Serrated, Eva I, Eva II, Cypress Creek I and Sykes points. A radiocarbon date derived from antler at the Eva site yielded an age of 7150 bp +/- 500 years (M-357; Lewis and Lewis 1961: 13). The Middle Archaic at the Eva site is also represented by the Three Mile phase (Lewis and Lewis 1961) and the associated artifacts include Morrow Mountain I, Eva II, Cypress Creek II, and Big Sandy points.

Undated Archaic components have been identified at the Roach site (Rolingson and Schwartz 1966) and at the Allen site (Morse 1963). The strong shouldered and straight stemmed points which predominate at the Roach site resemble forms recovered in late Middle Archaic contexts at the Eva site and at the Morrisroe site (Nance and Conaty 1982; Conaty and Nance 1983). At the Allen site a Middle Archaic assemblage was dominated by Cypress Creek, Eva, and Kirk Serrated points.

Radiocarbon dates from the Lawrence site provide an age for Kirk Stemmed points (Mocas 1977). The charcoal retrieved from feature-fill yielded dates of 7265 bp +/- 305 years (UGa-240), 7470 bp +/- 85 years and 7320 bp +/- 125 years (UGa-436). Similar ages have been provided by the Morrisroe site (Nance and Conaty 1982; Conaty and Nance 1983) where Morrow Mountain I and II and Kirk Serrated points were associated with a date of 7530 bp +/- 150 years (SFU-130). Other Morrow Mountain I and II points, as well as forms resembling Kirk Corner-Notched and Eva II forms, were associated with a date of 7110 bp +/- 250 years (SFU-121), while unnamed stemmed and broad stemmed varieties were dated 7180 bp +/- 130 years (SFU-270).

The Trail site, on the Cumberland River floodplain, also contained representative artifacts of the Middle Archaic. Most of the identifiable points are Big Sandy, while Kirk Serrated, Rowan, Rowan/Brewerton Eared, and Morrow Mountain types are also present. Lewis and Lewis (1961) noted the presence of Big Sandy points in the later part of the Three Mile component and the initial part of the Big Sandy component at the Eva site. The Trail site seems to represent the late Middle Archaic or the early Late Archaic.

Late Archaic Subperiod (c. 5,900 - 2,900 bp)

The trend toward a greater regionalization of artifact styles intensified during the Late Archaic. The distribution of point styles became more restricted and settlment systems reflects an intensification of seasonal reliance on a more limited number of species. Evidence of these trends may be found in assemblages from the Carolina Piedmont, the Duck River and Little Tennessee River valleys in eastern Tennessee, northern Alabama, and southern Illinois/west-central Kentucky.

Carolina Piedmont. Two Late Archaic assemblages were recovered at the Gaston site on the Roanoke River in North Carolina (Coe 1964). The earlier of these was characterized by the presence of shallow side-notched Halifax points, most of which were made of vein quartz. Carbon samples from hearths which were associate with these points provided ages of 4280 bp +/- 350 years (M-522) and 5440 bp +/-350 years (M-523) (Coe 1964: Table 15).

Savannah River stemmed points were found stratigraphically above the Halifax points. Charcoal samples from three hearths in this level were combined and gave a date of 3900 bp +/- 250 years (M-524; Coe 1964: Table 15).

Eastern Tennessee. In eastern Tennessee, the Late Archaic is best understood in the upper Duck River valley (Faulkner and McCollough 1973, 1977; Keel 1978; Davis 1978). There, the most diagnostic artifact group of this period is the Ledbetter point cluster (Faulkner and McCollough 1973) which includes Ledbetter (Kneberg 1956), Pickwick, and Cato Creek (DeJarnette et al.1962) types.

An Archaic/Woodland transitional phase has also been defined in this area. This phase is defined by the presence of straight-stemmed Wade Cluster points, including Wade and McIntire types (Faulkner and McCollough 1973: 149). Dates associated with Wade phase occupations range from 2960 bp +/135 years (UGa-569; feature 137 at the Banks III site, Keel 1978) to 2920 +/- 215 years (Nowlin II site; Keel 1978: 156).

Two sites in the lower Little Tennessee River valley have yielded substantial amounts of Late Archaic material. At the Bacon Bend site, Savannah River/Applachian Stemmed were the predominant point style (Chapman 1981). Concentrations of fire-heated and fire-cracked cobbles were the most common features, although fire pits, fired areas, and basins/depressions were also found (Chapman 1981: Table 4). Pharyngeal teeth of freshwater drum were the only identifiable faunal remains, while carbonized plant remains included squash rind and fruit, maygrass, hickory nutshells, walnuts, and acorns. Radiocarbon assays of this material provided dates of 4390 bp +/- 155 years (GX-5043), 3580 bp +/- 225 years (GX-5044) and 4070 bp +/- 70 years (UGa-1897). Chapman (1981: 40) favoured a third millenium bp date for the assemblage.

The points from the Iddins site were divided into 15 types, of which Iddins Unidentified Stemmed comprised more than any other category (Chapman 1981). Noting the taxonomic problems inherent in Late Archaic point typologies, Chapman (1981: 77) observed that this type may belong to the Ledbetter Cluster defined by Faulkner and McCollough (1973: 151-152). Other points included a variety of side-notched, corner-removed, and stemmed forms. Fire pits were the most common type of feature although pits with redeposited human remains, rock concentrations, fired areas, and netsinker concentrations also occurred. No faunal remains were recovered and hickory nut, butternut, walnut, acorn, wild grape, chenopodium, and maygrass were the major paleobotanical remains recovered. Radiocarbon dates of 3655 bp +/- 135 years (GX-4705), 3205 bp +/-145 years (GX-4706), and 3470 bp +/- 756 years (UGa-1883) provided a consistent age for this assemblage.

Northern Alabama. Non-shellmound aspects of the Late Archaic in northern Alabama were found in Layer E at Russell Cave (Griffin 1974). Three-quarters of the points from this layer were assigned to provisional categories. Pickwick points were the only widely recognized type represented by as many as three specimens. The faunal remains indicate a slight reduction in the number of squirrel, white-tailed deer, turkey, and turtle remains.

Southern Illinois/west-central Kentucky. The Late Archaic trend toward activity-specific sites is reflected at the Ferry site (Fowler 1957) and in the upper levels of Modoc Rockshelter (Fowler 1959; Styles et al. 1981). The Ferry site contained an assemblage primarily composed of hammerstones (21%), scrapers (39%), and grinding stones (3%). Expanding stemmed and straight stemmed were the dominant point forms present, although stemless, side-notched, contracting-stemmed, corner-notched, and long-stemmed forms were also found.

The upper levels of Modoc Rockshelter were characterized by straight-stemmed, corner-notched, and expanding-stemmed points. These artifacts comprised 54 per cent of the total artifact assemblage for the Late Archaic occupation. Fowler (1959: 56-57) suggested that this, and the dominance of deer and waterfowl remains in the faunal sample, reflected a change in the use of the site from a domestic habitation site to a specialized hunting camp. These levels have been radiocarbon dated at 4720 bp +/- 300 years (M-483) and 5280 bp +/- 300 years (M-484) (Fowler 1959: Table 1).

Shellmound Archaic. The development of focal economies during the Late Archaic is perhaps most notably expressed by the formation of large midden deposits comprised primarily of freshwater mollusc remains. These shellmounds occur along the Tennessee River in northern Alabama (Webb 1939; Webb and DeJarnett 1942, 1948a, 1948b, 1948c, 1948d), the lower and middle Tennessee and Cumberland Rivers in Tennessee (Morse 1967; Lewis and Lewis 1961), the Green River in west-central Kentucky (Moore 1916; Webb 1950a, 1950b, 1974; Watson and Marquardt 1983), and the Wabash River in southeastern Illinois and southwestern Indiana (Winters 1967, 1969).

Diagnostic points include straight-stemmed and undifferentiated stemmed varieties (including Frazier, Ledbetter and Adena types).

In spite of sharing a wide variety of artifact types, shellmound sites from any given area can be differentiated from shellmound sites in other areas. Lewis and Kneberg (1959) observed ceramics (Baumer type) at some sites, while Walthall (1980: 70) noted the presence of large steatite and sandstone bowls at sites in northern Alabama. In the central Wabash Valley, Winters (1969) identified a unique combination of artifacts in the Riverton Culture.

Settlement and Subsistence. A number of researchers have investigated Late Archaic settlement systems. Fowler (1959:52-54) examined four sites in McClean County, west-central Kentucky, and noted that the assemblages were complementary. Two had large proportions of ornaments and grinding tools, one had a large proportion of manufacturing tools, and one had a large proportion of projectile points. Winters' (1969) analysis of sites in the central Wabash Valley revealed that each site was occupied during a specific season and that they formed an integrated settlement system (Winters 1969: 137).

Jenkins (1974) reviewed the data from a number of sites in the middle Tennessee River valley in northern Alabama and concluded that a tripartite resource procurement system existed. The first aspect, represented by shellmound sites, was concerned with shellfish gathering. The second part was concerned with nut procurement and the third component involved hunting. Seasonal resource scheduling and the rise of annual floodwaters apparently forced the abandonment of shell collecting sites and the movement to smaller upland sites in the late autumn. In a similar analysis, Bowen (1976) compared an upland site (the Cherry site) with a shellmound site (the Ledbetter site) in west-central Tennessee. He, too, found that while the two sites shared a number of stylistic elements, they represented different aspects of a subsistence system. Bowen (1979) also examined the Late Archaic settlement system in the upper Duck valley where he found that the majority of Ledbetter phase sites were situated on the first terrace of major streams. He concluded that these seasonal camps were situated to facilitate the exploitation of both floodplain and upland ecozones.

Faunal remains indicate that, while generally a wide range of species was exploited, at some sites there was a focus on a relatively small number of species. At Modoc Rockshelter (Fowler 1959: 56-57; Styles et al. 1981: 31), for example, there was a marked reduction in the variety of species present in the Late Archaic levels compared with the Middle Archaic occupation.

Paleobotanical remains have substantiated suggestions that a variety of locally available food resources were used during the Late Archaic. Nutshells consistently comprise the majority of botanical remains (Faulkner et al. 1976; Chapman and Shea 1977; Crawford 1982), the predominant types being hickory, walnut, and acorn. The relative importance of hickory and walnut varies, apparently as a function of local availability (Crawford 1982: 212; Carstens 1980: 181). Seeds, while often present, occurred in such small numbers that their significance is difficult to evaluate. The discovery of squash rind in number of Late Archaic deposits (Chapman and Shea 1977; Crawford 1982) suggests that horticulture may have been initiated during this period.

Lower Cumberland/Tennessee drainage. The evidence of the Late Archaic in the lower Cumberland/Tennessee drainage is meager. The Eva site represents a riverine shellmound site, while the Morrisroe site is also adjacent to the Tennessee River, but lacks shellfish remains. Numerous small, upland sites have been found between the two rivers (Nance 1972, 1974a, 1974b, 1975, 1976, 1977; Schwartz and Sloan 1958; Schwartz et al. 1958; Funkhouser and Webb 1932). At all of the Late Archaic sites, with the exception of the Eva site, faunal remains were poorly preserved. Charred botanical material does occur, but only samples from the Morrisroe site have been analyzed. In general, the settlement pattern and subsistence system for this area remains largely unexamined.

The Woodland Period (c. 2,900 - 950 bp)

Three significant developments occurred during the Woodland period which set it apart from the preceeding Archaic period: the introduction and spread of pottery; the apparent intensification of horticulture; and the occurrence of burial mounds (Willey 1966; Dragoo 1976; Griffin 1978). Each of these appeared and reached a florescence at different times and to different degrees in various parts of the midcontinent. As a consequence, the Woodland period reflects an even greater regionalization of cultural traditions.

The Woodland period can be subdivided into three subperiods: Early, Middle, and Late. In the following sections, the major developments of each subperiod will be examined and the local expressions of these trends will be outlined.

Early Woodland Subperiod (c, 2900 - 1900 bp)

Much of the material culture of the Early Woodland subperiod exhibits a marked continuity with the Late Archaic: bifaces, scrapers, atlatl weights, netsinkers, choppers, and drills are all common elements. Rounded base points (such as Adena) and straight-stemmed forms continue to be predominant. Significant additions to the lithic technology include blade and blade cores, and groundstone celts. Pottery also became abundant during this time with grit, sand, limestone, and quartzite being used as temper. The choice of temper and decorative technique varied from area to area, apparently as an expression of regional cultures.

Paleobotanical remains from this time indicate that sunflower, chenopod, maygrass and marshelder may have been important dietary constituents (Yarnell 1969, 1974a, 1974b; Stewart 1974; Marquardt 1974; Watson 1969, 1974; Carstens 1980; Faulkner and McCollough 1977; Chapman and Shea 1980). Evidence from both floral and faunal material indicates that a broad spectrum economy was important.

Middle Woodland Subperiod (c. 1900 - 1200 bp)
Three important traditions developed and coexisted in the midcontinent during the Middle Woodland: the Adena, the Hopewell, and the Copena cultures. The Adena culture, which was the first to appear, was focused in the lower Ohio Valley. It is characterized by extended burials which were sometimes interred in log tombs within conical earthen mounds. Many of the burials were stained with ochre and accompanied by stone effigy pipes, patterned stone tablets, packets of bone needles, and marine conch shell ornaments and tools (Willey 1966: 271-272). Sometime after the early part of the Middle Woodland, the Adena people were supplanted by a new population of a different physical type (Willey 1966: 272; Dragoo 1976: 28-29). The new people brought with them the Hopewell culture.

Like Adena, Hopewell is characterized by red ochre-stained burials in log tombs within earthen mounds. The variety of artifacts accompanying these burials was greatly increased and included copper and mica objects, freshwater pearls, polished stone ear spools, effigy pipes, engraved human and animal bones, atlatl weights, caches of chipped flint and obsidian blades and points, marine shell containers, and worked bear canines (Willey 1966: 275; Stoltman 1978: 7). The geographical areas from which this material was obtained range from northern Michigan (copper and mica) to the western Plains (obsidian). Although the largest Hopewellian sites are restricted to the lower Ohio Valley, stylistic elements and raw materials (especially copper, mica, and obsidian) occur at many Middle Woodland sites throughout the midcontinent. In eastern Tennessee, Chapman (1973) recovered blades made from chert that originated at Flint Ridge, Ohio. The length:width dimensions indicated a close correlation with blades from Ohio Hopewell sites. Struever (1977: 88; Struever and Houart 1979) termed this exchange of raw material and ideas the Hopewell Interaction Sphere.

Copena sites occur almost exclusively in the middle Tennessee River drainage in northern Alabama (Webb 1939; Walthall 1980: 123). As was the case with Adena and Hopewell, Copena was typified by log-tomb graves in earthen mounds. Among the grave furniture were items of copper and galena, neither of which occur locally. In a recent examination of the galena from some of these sites, Walthall et al. (1980: 39) found that it originated in the upper Mississippi Valley region of Wisconsin-Illinois-Iowa. They suggested that a complex network existed for the diffusion of ritual and idealogy between localized areas of complex cultural and social developments (Walthall et al. 1980: 40).

The existence of Middle Woodland cultures which did not intensively participate in the Hopewell Interaction Sphere has been reiterated by Davis (1978). In his analysis of the Wiser-Stephens site in the upper Duck Valley, east-central Tennessee, he noted that except for a few trade goods there was not much evidence of contact with Hopewellian groups.

Adena, Hopewell, and Copena burial mounds are often found in association with postmolds and various types of earthworks. The patterns of the postmolds indicate the presence of circular houses made by single post construction. It has been suggested (Willey 1966; Dragoo 1976; Prufer 1977; Walthall 1980) that these features indicate a significant population growth and an increase in the complexity of social organization during that time. Struever (1977: 103) suggested that these developments followed a shift in subsistence strategies toward a focus on the harvesting of chenopodium from the mudflats bordering sloughs and streams. This trend has been confirmed by paleobotanical data from the upper Duck Valley (Crites 1978: 90), where it was also found that domesticated squash and maize had been introduced at that time.

Late Woodland Subperiod (c. 1200 - 950 bp)

The Late Woodland is marked by a shift from the economic patterns of the Middle Woodland and the demise of the interaction spheres. (Dragoo 1976; Cleland 1976; Styles 1981). Cleland (1976: 72) suggested that as maize agriculture became more important, technological and social variation between different geographical areas was reduced. Dragoo (1976: 19) agreed that the intensification of agriculture was important, but suggested that it led to a greater competition for land and the development of local authorities in opposition to cult elites. In either case, the Late Woodland economy seems to have been focused on agriculture.

This development is not reflected by settlement patterns outside of the major river valleys. In the upper Duck Valley, Faulkner and McCollough (1973: 427-428) discerned a shift from floodplain sites during the Early and Middle Woodland to locations on the first terrace and in the uplands during the Late Woodland. They attributed this pattern to a seasonal congregation and subsequent dispersal of family groups. Elsewhere (Faulkner and McCollough 1977: 298-299), they have suggested that the first terrace is drier and better drained than the floodplain and would, therefore, have held advantages for groups which exploited the floodplain, terrace, and upland biozones at specific localities for long periods of time.

The most significant change in the material culture during this time was the introduction of the bow and arrow. Local variations in point styles were greatly reduced with the appearance of a standardized triangular form. Pottery became more elaborate as regional decorative styles flourished. Limestone, sand, quartzite, and grit continued to be used as temper.

Lower Cumberland/Tennessee Drainage

In his analysis of the ceramic complexes from western Kentucky, Clay (1963, 1979) observed that the Woodland is poorly represented in the lower Cumberland/Tennessee drainage. Diagnostic elements include a number of varieties of pottery tempered with non-shell materials. A distinct Woodland occupation has been identified only at the Driskill site (Clay

1963; Schwartz 1962; Clay and Schwartz 1963; Schwartz and Sloan 1958). Grit, sand, clay and grog tempered sherds have been found in stratigraphic association with Mississippian shell-tempered sherds at the Rodgers site (Clay 1963a; Clay and Schwartz 1963), the Birmingham site (Clay 1963a; Clay and Schwartz 1963), the Goheen site (Clay 1963a; Clay and Schwartz 1963), the Jonathan Creek site (Clay 1963; Clay and Schwartz 1963; Webb 1952), the Wilson site (Clay 1963a), and the Roach site (Clay 1963a; Rolingson and Schwartz 1966). A similar mixture was found at the Shamble's site and the Sloan site (Coe and Fisher 1958) in the Tennessee portion of the Barkley Basin.

Clay (1963a) suggested that these incidents resulted from a mixing of early and later occupational debris. At the Tinsley Village site (Clay 1961, 1963a, 1963d; Schwartz 1961), however, a non-shell tempered type - Morris Plain - occurred between two zones that contained predominantly shell-tempered sherds. These Morris Plain sherds were tempered with crushed shell-tempered pottery, leading Clay (1963a: 76) to suggest a Woodland occupation after the appearance of Mississippian people at the site.

The first ceramics to appear in the lower Cumberland/Tennessee region (fibre-tempered Alexander Pinched) reflects an influence from more southerly regions (Clay 1963a: 32). Following this, cord-marked ceramics from the Driskill site indicate an affiliation with cultures north of the Ohio River. The estimated age of these latter traditions (1750 bp; Clay

1963a: 320) coincided with the developmental growth of Adena and Hopewell cultures. Interestingly, Clay (1963a: 320) suggested that as ceramic technology diffused from northern areas, small triangular projectile points were being introduced from the south. This diffusion pattern has been substantiated by Walthall et al.'s (1980) analysis of galena trade and their suggestion that it was traded through major river drainages.

Few data are available regarding the economic basis of the Woodland occupation in this area. The variety of sites range from extensive middens adjacent to major streams to upland rockshelters. An analysis of the faunal remains from one such rockshelter indicates that a wide range of animals were present, but that deer predominated (Kusmer 1980). The importance of seed plants has not yet been assessed.

The Mississippian Period (c. 950 - 700 bp)

The final major prehistoric developments considered here occurred during the Mississippian period. Important aspects of this period include villages centered around a plaza with flat-topped, pyramidal mounds; square or rectangular wattle-and-daub houses with post-in-trench or single post construction; stockades around the villages; a greater reliance on squash, maize, and beans; the development of shell-tempered pottery and a proliferation of pot designs and decorative techniques; and an increase in the use of groundstone tools and in the importance of the bow and arrow. (Willey 1966; Griffin

1978; Dragoo 1976; Walthall 1980). The cultivation of maize, beans and squash and the construction of pyramidal mounds suggests strong Mesoamerican influences during this period. The nature of this contact, whether it was direct or otherwise, remains a problem as no intermediary has been found between the Mississippian centers and Mesoamerica.

The major developments of the Mississippian period were focused in three areas: 1) the central Mississippi valley; 2) the Cumberland/Tennessee drainage; and 3) the Caddoan area of eastern Oklahoma, Texas, and Louisiana (Walthall 1980: 187). The central and lower Mississippi Valley were the regions in which the Mississippian first appeared. These early agriculturalists exploited the broad, fertile floodplain and established such complex centers as Cahokia in southwestern Illinois (Fowler 1977). As it developed, this culture spread outside of the Mississippi River valley. The Obion site in western Tennessee (Kneberg 1952) and the Hiwassee Island site in eastern Tennessee (Lewis 1946) represent such incursions into new areas. Often these areas were already occupied by Woodland peoples. The palisaded Mississippian villages have led some researchers to suggest that the confrontation between the two cultural groups was often hostile (Dragoo 1976: 21; Willey 1966: 295; Clay 1976).

Sometime after this initial expansion, the tension between Mississippian and Woodland groups was apparently reduced and the Cumberland/Tennessee drainage became a major locus of

Mississippian settlement (Jolly 1983). Large mound complexes were built at such sites as Moundville in northern Alabama (Walthall 1980; Peebles 1971) and Etowah in northwestern Georgia (Willey 1966: 302). Stone box graves became a common mode of interment in the central Cumberland Valley (Dowd 1972) and the practice soon spread to neighbouring areas (Nance 1974c; Hensley 1982). Although sites in each of these areas are clearly Mississippian, variations in pottery styles, stone sculptures, and details of the burial customs indicate regional elaborations on a basic cultural theme. The major ceremonial centers were part of a network of villages, hamlets and farmsteads which were dispersed throughout the region to take advantage of all available resources (e.g. papers in Smith 1978).

Lower Cumberland/Tennessee Drainage

Excavated Mississippian sites in the lower Cumberland/Tennessee drainage include the Tinsley Hill mound, village, and cemetary complex (Schwartz 1961; Clay 1963a, 1963b, 1963c, 1963d; Clay and Schwartz 1963; Schwartz and Sloan 1958), the Jonathan Creek Village site (Webb 1952; Clay 1963a, 1979; Clay and Schwartz 1963), the Rodgers site (Clay 1963a, 1963b, 1979), the Wilson site (Clay 1963b), the Duncan site (Funkhouser and Webb 1931), the Birmingham site (Clay 1963a,1979), the Goheen site (Clay 1963a, 1979), the Roach site (Rolingson and Schwartz 1966; Clay 1963a, 1979), the Dedmon site (Allen 1976; Clay 1979), the Serpent Bluff site (Nance 1974c), site Tr-12 (Schwartz and Sloan 1958), the Shambles site (Coe and Fisher 1959), and the Stone site (Coe and Fisher 1959), among others (e.g Funkhouser and Webb 1932). These sites include fortified and unfortified villages (e.g., Tinsley Hill, Jonathan Creek, Rodgers, Birmingham, Roach, Dedmon, Shambles, and Stone), mounds (e.g., Tinsely Hill and Shambles), and stone box grave cemetaries (e.g., Serpent Bluff, Shambles, Stone, Duncan, and Tinsley Hill). Ceramic studies (Clay 1963a, 1979) and analyses of village construction episodes and sequences (Rolingson and Schwartz 1966; Clay and Schwartz 1958; Clay 1976) have enhanced our understanding of the development of the Mississippian.

R.B. Clay (1979) defined two phases of a local Mississippian ceramic sequence. The Jonathan Creek phase is characterized by plainly decorated ceramics which did not have incising, engraving, punctating, negative painting, or combinations of negative painting and direct painting. This phase occurred at the Jonathan Creek Village, Tinsley Hill and Dedmon sites (Clay 1979: 114-115). The Jonathan Creek site was a fortified village while the occupation at the Tinsley Hill site is represented by wall-in-trench and post-in-ground house structures. Charcoal from a feature at the Dedmon site yielded dates of 905 bp +/- 75 years (UGa-521; Allen 1976: 167) and 905 bp +/- 85 years (Allen 1976: 167).

The Tinsley Hill phase includes incised and painted ceramic decorations (Clay 1963a: 227-282). This phase is known from the Tinsley Hill, Jonathan Creek, Goheen, Roach, Birmingham, and Rodgers sites (Clay 1979: 119). Structural aspects of this phase include an unfortified village, mound and stone box cemetary at the Tinsley Hill site; unfortified villages or farmsteads at the Jonathan Creek, Roach, and Rodgers sites; and fortified villages at the Goheen site and, possibly, at the Birmingham site. Charcoal samples from the structural features at the Roach and Goheen sites have given dates of 288 bp +/- 85 years (I-477; Clay 1963a) and 410 bp +/- 85 years (I-479; Rolingson and Schwartz 1966: 34).

These changes in settlement types and patterns reflect the process of initial invasion and subsequent establishment of Mississippian groups in the lower Cumberland/Tennessee drainage. Clay (1976) considered the early pattern of small, relatively dispersed fortified and unfortified villages to be a tactical response to a new (for the Mississippian people) environment. As these groups became more familiar with the environment, they sought to maximize their returns by strategically locating their settlements. As these settlements began to interact, they became more stable and a heirarchy between sites became more pronounced. The establishment of small farmsteads in proximity to the Tinsley Hill complex may reflect just such a strategy (Clay 1976: 148).

The nature of the relationship between Woodland and Mississippian groups is not well understood. One opinion considered a migration of Mississippian into the area from the Mississippi Valley (Clay and Schwartz 1963: 11). It was suggested that the fortified villages represented a precaution against people who were already inhabiting the area and who were hostile toward the interlopers (Clay 1976: 142). A contrary view, held by Allen (1976: 181), suggested that trade between Woodland and Mississippian groups led to a diffusion of ideas and the eventual acculturation of the Woodland people. While neither case can be proven, it is apparent that the two groups did coexist (however inhospitably). The occurrence of Morris Plain, a Woodland ceramic type that was tempered with shell-tempered pottery, substantiates such a claim.

Chapter Summary

In this chapter I have provided a summary of the culture history of the Mid-South. Five periods were identified: Paleo-Indian, Paleo-Indian/Archaic transition, Archaic, Woodland, and Mississippian. The important aspects of the material culture of each period have been presented and the significant social, subsistence, and technological developments were discussed. The manifestations of each period in the lower Cumberland/Tennessee drainage were emphasized as the local cultural developments were place within the context of regional trends and traditions.

CHAPTER III

THEORETICAL FRAMEWORK

This chapter provides the theoretical framework within which differences between assemblages will be interpreted. It will be argued that these differences are most profitably understood through the examination of the context within which the different assemblages were deposited. Although such contexts should properly include both the natural and the sociocultural environments, the emphasis here is on the natural variables. Admittedly, this approach places limits on the analysis. However, as Jochim (1979: 82) observed, such restrictions "may be necessary and fruitful components of ecological research as long as the imposed limitations are viewed as temporary." That is, an ecological approach can provide a useful "first approximation" understanding of a problem. Other sources of variability may then be considered as original models are refined and revised. With this in mind, the model developed here is offered as a first approximation.

I begin by offering a justification for this approach and by defining the environmental variables considered to be important in the present study. Models provided by optimal foraging strategy are then reviewed. While it is acknowledged that the limitations of the data restrict the precise application of these models, they can provide insights on a general level. Having provided this background, the expected relationships between site type and environmental context will be offered.

These provide a set of testable hypotheses and constitute the framework within which the results of the analysis can be interpretted. Finally, the assumptions of the model will be discussed.

Contextual Analysis

Recently, Butzer (1982) argued for a greater concern with the environmental context of archaeological sites. The objective of this contextual archaeology is "the study of archaeological sites or site networks as a part of a human ecosystem", for "It is within this human ecosystem that earlier communities interacted spatially, economically, and socially with the environmental matrices into which they were adaptively interwoven" (Butzer 1982: 7). Consideration of the environmental matrix requires the identification of those variables which are of greatest importance to the problem under investigation. The more specific the problem, the greater the need for refined and accurate measures of the environmental variables which comprise the context of the archaeological sites.

In this study, the biome will be considered to be the fundamental unit of ecological analysis. Odum (1971: 378; emphasis in original) defined a biome as "the largest land community unit which it is convenient to recognize" in which "the life form of the climatic climax vegetation . . . is uniform." While a biome is readily identified by the major plant associations, it is properly considered as complete community with distinctive faunal as well as floral aspects (Odum 1971: 378; Pianka 1978: 42). The suitability of an analytical unit as large as the biome for a contextual archaeological analysis reflects the mobility of human hunter-gatherers. Since task groups may be detached from a residential base to procure resources from distant localities, it is not necessary that these resources all occur within the immediate vicinity of a site. The strategy which determines the location of sites is, from a human ecology perspective, related to the distribution of important resources within the biome.

Students of evolutionary ecology have noted that populations, generally, respond to the patchiness of resource distribution in the biome (Wiens 1976; Pianka 1978; MacArthur and Pianka 1966). Patches are:

> distinguished by discontinuities in environmental character states from their surroundings; implicit are the notions that the discontinuities have biological significance, and that they matter to the organism (Wiens 1976: 83).

There are two important aspects to the concept of patchiness. First, the distribution of resources within a biome is characterized by discontinuities in space and time. Second, organisms respond to the discontinuous distribution of those resources which are important to their survival. The identification of critical resources varies between groups or within the same group at different times. In recognition of this, it is important that patchiness be organism-defined such that "a patch structure is that which is recognized by the organism under consideration." (Wiens 1976: 83).

Responses to patchiness can be identified as <u>fine grained</u> or <u>coarse grained</u> (Wiens 1976: 84; Pianka 1978: 263). A fine grained utilization of the environment entails the use of patches in the same proportion in which they occur; patches are used randomly. A coarse grained response to patchiness is non-random, implying that disproportionate amounts of time will be spent in patches of different types. Wiens (1976: 84) noted that this concept of grain response "was originally framed with reference to relations between sizes of environmental patches and individual mobility...." Fine grained responses may occur where the patches are small relative to the size and mobility of the organism (or groups). Consequently, most large animals encounter the world with a fine grained response. As with the concept of patches, definitions of patch response should be developed from the perspective of the organism under study.

The patchiness of a biome is related to the discontinuous distribution of resources. This discontinuity may occur in both space and time. Horn (1968: 689), recognizing the dual nature of resource distribution, described such variation along these two dimensions. Spatially, resources were described as being either evenly distributed or clumped. Their temporal occurrence was characterized as either stable or transient. Within the context of his study, Horn (1968) dichotomized the resource base into evenly distributed stable resources and clumped, transient resources. It is possible, however, that some resources will be spatially clumped and temporally stable while others are evenly distributed but transient.

The foregoing discussion outlines the means by which the context of the sites considered here may be fruitfully examined. The absence of detailed local paleoenvironmental analysis makes it necessary to refer to a large scale biome as the basis for contextual analysis. It has been argued that this may lead to more meaningful analysis through the consideration of resource patchiness and grain responses to this patchiness. Hunter-gatherer mobility and the ability to form cooperative groups suggests that fine grained responses (or generalist exploitation strategies) are likely to have characterized Archaic foragers. The specific nature of these responses, however, may have been tempered by the nature of the patchiness. In this regard, spatial (evenly spaced or clumped) and temporal (stable or transient) resource distributions are important.

Settlement Analysis

Any study which seeks to define relationships between the variability of archaeological sites and their environmental context should, ideally, be undertaken within the theoretical framework of settlement archaeology and/or site catchment analysis. Unfortunately, the data requirements of such analyses limits their applicability in the present study.

~~Site~~ catchment analysis "emphasizes such considerations as the availability, abundance, spacing, and seasonality of plant, animal and mineral resources as important in determining site location." (Roper 1979: 120). It is important that those resources which were of paleoeconomic importance be identified and their past availability determined. This requires, in addition to adequate samples of floral and faunal remains from the archaeological sites, a detailed knowledge of the paleoenvironmental surroundings of these localities. Such knowledge should be extended to the entire system of sites, for it is possible that a single residential base may have been supplied with resources through a dispersed network of smaller sites. The near absence of faunal and floral remains in the sites examined in this study provides an immediate hinderance to the development of a site catchment analysis. Furthermore, available environmental information prohibits detailed determination of the occurrence of resources in the past. Western Kentucky has undergone significant ecological disturbance from Euro-American settlement over the past two hundred years. Detailed analysis of current resource distributions will not accurately reflect prehistoric conditions.

Settlement archaeology focuses on either the settlement pattern or the settlement system (Winters 1969). Settlement pattern examines the distribution of sites on the landscape, relating this distribution to environmental variables (Winters

1969: 105; Parsons 1972: 132). Settlement systems analysis considers the functional relationship between sites (Winters 1969: 110; Parsons 1972: 132). The investigation of either requires a knowledge of the environment and a comprehensive understanding of the variety and locational distribution of contemporaneous sites. Struever (1968a, 1968b, 1971) discussed the data requirements for a settlement pattern analysis. These include reconstruction of paleoenvironmental microzones, systematic sampling of these microzones, analysis of surface collections, and excavations of at least two examples of each settlement type (initially by random testing and, subsequently, through large scale excavation). In addition, the time-frame considered should be very restricted (Parsons 1972: 135). These data enable the development of a settlement pattern model. Only after several such models have been developed is it possible to compare patterns and explore the settlement system. It is apparent that data required of settlement analysis far exceeds the limits of the present study.

Mobility Strategies

On a more general level, efforts have been made to relate differences between sites to the activities undertaken there. Binford and Binford (1966) initially proposed a dichotomy between maintenance and extractive sites. Maintenance activities include the preparation of food, shelter, clothing, the final stages of tool manufacture, refurbishing of broken and worn out tools, and a wide range of other 'domestic' tasks. Extractive activities are concerned with the procurement of raw materials and nutrients.

In an analysis of Archaic sites in the inter-riverine piedmont of South Carolina, House and Wogaman (1978) based their examination of interassemblage variability on a similar model. A number of test implications reflecting the attributes of assemblages from each site type were applied to the archaeological data. A major drawback of this model is the assumption of tool use which underlies the identification of activities. It is often the case that tools believed to be indicative of one type of activity may, in fact, have been used for a number of tasks. Examinations of hafted bifaces, for example, have shown that they often served equally well as either projectile points or knives (e.g. Greiser 1977; Ahler 1971; Nance 1971). The overlap of maintenance and extractive activities within one type of artifact seriously undermines the model.

A second major problem arises from the fact that foragers seldom separate the activities undertaken at a site into such discrete categories. In view of this, Binford (1980) modified the model based on a dichotomy of activities, recognizing that the variations between assemblages are better understood through an analysis of resource procurement strategies. Two fundamental strategies were identified: those with a logistic mobility; and those with a residential mobility.

Hunter-gatherers practising a logistic mobility strategy "supply themselves with specific resources through specifically organized task groups." (Binford 1980: 10). As a part of this logistic strategy, task groups may periodically leave a residential location and establish a field camp or station from which procurement operations may be planned and executed. Thus, specific goals can be identified for each task group. His study of the Nunamiut led Binford to identify five types of sites within a logistic organization: residential base; location; field camp; station; and cache. These are defined in Table 2. Variability between the assemblages from these sites arises from a number of sources. First, the different activities undertaken at each site type will produce interassemblage variability. If the variety of the types of sites increases, the interassemblage variability may be expected to increase. Second, seasonal variability in resource abundance and distribution may require the development of a complex system of sites, leading to an increase in the variability among assemblages from these sites.

Third, some places may serve as locations for a number of different types of sites through time. A place serving as a station at one point in time may be used later as a field camp and, still later, as a residential base. Thus, as variability between assemblages increases with the number of site types, re-use of locations may homogenize the assemblages. In Binford's (1980: 12; emphasis in original) words:

> <u>The point is simple, the greater the number of generic types of functions a site may serve, the greater the</u>

Table 2. Site types defined for hunter-gatherers (after Binford 1980).

Stations*	sites where special-purpose task groups are localized when engaged in information gathering; e.g. lookouts;
Cache*	sites of temporary field storage of resources prior to transport away from the residential base;
Field Camp*	sites where a hunting-gathering party is maintained while away from the residential base;
Location	site of extractive activity; e.g. a kill site;
Residential Base	the hub of subsistence activities; the locus out of which foraging/collecting parties originate and where most processing, manufacturing and maintenance activities occur;

* found only in a logistic mobility strategy

> *number of possible combinations, and hence the greater the range of intersite variability.*

Clearly, a complex array of variability could be produced among assemblages left by a logistically organized hunter-gatherer society.

In contrast, Binford (1980) defined hunter-gatherers with residential mobility as those groups who collected their food daily by "mapping on" to the distribution of resources. Only two types of sites were identified among such groups: the residential base and the location. The residential base serves as the center of subsistence activities and may be periodically moved. The duration of occupation at any given place, the spacing between residential bases, and the size of the group occupying the residential base were seen as dependent upon the patchiness of resource distributions. Locations are occupied only briefly resulting in a low rate of tool use, exhaustion, and abandonment. It is to be expected that locations will be scattered across the landscape, rather than being concentrated in certain places. Where such concentrations do result, the archaeological assemblage which is formed will lack the internal spatial organization of a residential base.

In his study of the !Kung Bushmen, Yellen (1977) provided an ethnoarchaeological analysis of the settlement system and resulting interassemblage variability from a residential mobility strategy. He found, first of all, that "Both hunting and gathering activities take place away from the living site, and they leave few if any marks on the landscape" (Yellen 1977: 78; see also Hayden 1978). He furthermore noted that the size, location, and membership of residential bases varied between the rainy season and the dry season. However, this variation had little effect on the composition of the artifact assemblages:

> differences between the largest rainy camps ... and their dry season counterparts are of degree rather than of kind. On the basis of size, number of occupants, and overall configuration, they could easily be confused with dry-season sites. The only crucial difference lies in their location: Dry season camps are always near permanent water, rainy season ones only rarely so. But from an archaeological perspective, even this criterion may become relative, for reconstruction of past water distribution is by no means an easy task (Yellen 1977: 80).

It is clear that in areas where environmental change has been extensive, the chore of reconstructing a forager's settlement system and determining sources of interassemblage variability will be very difficult.

More recently, Binford (1982) elaborated on his discussion of site patterning among hunter-gatherers. He noted that an observed pattern of sites was the result of "long-term repetitive patterns in the 'positioning' of adaptive systems in geographic space..." (Binford 1982: 6). The components of the system are the sites at which various activities were undertaken. Seasonal changes in the subsistence orientation and in the suitability of some sites for various activities lead to complex artifact assemblages. This complexity is increased when some sites serve as the focus of different activities during different seasons.

Several important points emerge from Binford's and Yellen's discussions. First, it is apparent that most archaeological assemblages are the result of the long-term accumulation of debris at residential sites. Sites of "extractive" activities (to use Binford and Binford's 1966 term) will, in general, not be highly visible. Nonsite (Thomas 1975) or siteless (Dunnell and Dancey 1983) surveys provide the most appropriate means of examining this aspect of activity pattern. In those instances where extractive locations have been reutilized as residential bases, they may be identified as archaeological "sites."

Second, the nature of assemblages from residential bases will vary with regard to group composition and size. These variables, in turn, are influenced by the particular subsistence strategy of the hunting-gathering group. With a residential mobility strategy, there arises a distinct dichotomy between residential bases and extractive locations. The size of the residential base depends upon the distribution and patchiness of important resources. Larger sites may be expected to occur near localities where important resources are most abundant.

In contrast, logistic mobility strategies result in a number of distinct types of sites. Overlap of activities at any given site may frequently occur, depending upon changing resource availability at various sites throughout the year. The size of the groups occupying the various types of sites will vary with the season of occupation and the availability ~~and~~ nature of the critical resources. In his initial discussion of residential and logistic mobility strategies, Binford (1980: 13-17) related the development of a specific strategy to environmental variations in the distribution of food resources. Rather than examining the array of sources of variation, he selected effective temperature as a single indicator reflecting "biotic activity and hence production" (Binford 1980: 13). The ensuing analysis indicated that hunter-gatherers in polar and sub-polar regions should develop strategies of logistic mobility, while residential mobility should be adopted by equatorial groups. Binford (1980: 15) perceived the environment in the former instance as being less stable, but with more concentrated resources, resulting in a larger number of resources which are critical for subsistence and survival. In equatorial areas critical resources may be more dispersed and a strategy of residential mobility is sufficient to adjust to resource variability.

Mobility strategies were also the focus of a study by Kelly (1983). He addressed the relationship between the size of the foraging group and various aspects of the available resources. The definition of residential and logistic mobility Kelly proposed concurred with that developed by Binford (1980), and while it was recognized that these strategies may not be completely independent of one another, the dichotomy was retained for analytical purposes. It was explicitly assumed that hunter-gatherer mobility would be closely related to "the structure of the food resources in a given environment" (Kelly 1983: 277).

Three important environmental variables were defined (Kelly 1983: 283):

1. primary production, or the amount of energy from photosynthesis remaining in the vegetation after respiration; this represents the net amount of plant material potentially available for consumption by herbivores.
2. primary biomass, or the total amount of standing plant material present in a region at a particular point in time; mostly unavailable for human consumption.
3. resource accessibility, or the amount of time and effort required to extract faunal and plant resources from the environment.

Resource accessibility, especially as concerns fauna, is related to several factors. While the absolute number of animals in an area is important, individual size and gregariousness of the prey also determine the quantity of calories, protein, and other nutritive requirements that can be economically exploited by human foragers.

Following an examination of the relationship between these variables and mobility strategies, Kelly (1983: 291) concluded that "where there is little need to monitor resources we should expect resource accessibility to be the primary variable conditioning the number of residential moves." The number of residential moves should increase as resources become less accessible. He also found that storage, by increasing resource accessibility, led to an increase in the length of time that residential sites were occupied. Furthermore, it was noted that as residential bases become occupied for longer periods of time (i.e., as sedentism increases), extensive logistic trips of longer duration are required to obtain the required resources. Under such conditions, the use of stored food and plant resources may become very important.

Two important points emerge from the foregoing discussion of mobility strategies. First, extractive localities will not be archaeologically visible unless they have been repeatedly occupied. Even in such instances, they will be small and not complex. Second, the sites which will be most visible are residential bases and base camps. Variability among such sites will occur as a result of differences in the size of the group occupying the site and the length of time they remained at specific localities. This variability may occur in the composition of the artifact assemblage and the spatial structure of the site, as well as in the organization of the technology. The variables of group size and occupation duration result in four categories of sites: long term/large group; long term/small group; short term/large group; and short term/small group. Base camps will, in general, be occupied by small groups for a relatively short period of time. Residential bases are formed by any combination of group size and occupation duration. Within a residential mobility strategy, such sites are unlikely to be occupied by large groups for long periods. Logistic mobility strategies will, in general, not result in residential bases occupied by small groups for only short periods of time (Figure 3).

So far, this chapter has provided a discussion of the important aspects of the environment and of the different mobility strategies through which resources may be exploited. It has been suggested that resource distribution may be examined in terms of the patchiness of their distribution. This patchiness relates to both spatial and temporal dimensions and resource attributes include aggregation/dispersal and stable(predictable)/transient (unpredictable). The examination of mobility strategies indicated the presence of two types: residential mobility and logistic mobility. Within a residential mobility strategy, residential base sites are likely to be the most visible. In a logistic mobility strategy both residential bases and field base camps will be archaeologically visible, but will differ in the structure and organization of their technological systems. Such differences will also be evident between residential bases of both mobility strategies. Important factors which result in the formation of either site types (residential bases in either mobility strategy; base camps in a logistic mobility strategy) include group size and the length of time a given site was occupied.

	Group Size	
LENGTH OF OCCUPANCY	Large	Small
LONG - TERM	Residential Base (Logistic Mobility)	Residential Base (Residential Mobility)
SHORT - TERM	Residential Base (Logistic or Residential Mobility)	Residential Base (Logistic or Residential Mobility) Logistic Base Camp

Figure 3. Site type, group size and length of occupation.

Optimal Foraging Theory

Strategies by which foragers adjust to the patchy distribution of their resources have been included in studies of optimal foraging theory. Optimal foraging theory:

> provides a cluster of simple models, partially derived from neo-Darwinian postulates, which produce operational hypotheses about foraging behaviours expected in different environmental circumstances (Winterhalder 1981: 13).

Smith (1983: 627) further characterized the theory as:

> an attempt to specify a general set of "decision rules for predators" (Krebs 1978) based on cost-benefit considerations that are in turn deducible from first principles of adaptation via natural selection.

Thus, while optimal foraging theory is one of a suite of theories of feeding strategies, it differs from those theories by focusing on optimization strategies (Schoener 1971). This focus enables the solution of foraging problems through the use of mathematical equations (including linear programming, cf. Reidhead 1979; Keene 1981, 1982), or through more simple graphic models. In either case, "the model must be assumed to be qualitatively true, and then the consequences of it can be examined" (Bayham 1979: 227).

The models included within optimal foraging theory focus on various aspects of the problem of obtaining sufficient quantities of critical resources. These models may be included within one or more of three general classes:

1. <u>Models of Optimal Diet.</u> These models "are concerned with the forager's choice of food items and with the range or variety

of items that are harvested in different environmental circumstances" (Winterhalder 1981: 23).

2. <u>Models of Optimal Foraging Space (Winterhalder 1981) or Patch Use and Time Allocation (Smith 1983)</u>. These models examine "the temporo-spatial abundance of food resources - what the resource gradients look like, where the patches occur, how fast resources depleted for a given area renew, how predictable the appearance of abundant food is in space and time, and what mappings of efficient pathways are for search and pursuit" (Schoener 1971: 386).

3. <u>Models of Group Formation and Optimal Group Size (Winterhalder 1981; Smith 1983)</u>. Schoener (1971) noted that three variables are fundamental for a quantification of these models: 1) some measure of foraging efficiency; 2) the determination of the probability of predation; and 3) a definition of the defendable area per unit cost of defense. Each component can be calculated on a cost-per-individual basis and the results used to determine the optimal group size and the conditions under which group formation is viable (cf. Caracao 1979a, 1979b; Caracao and Wolf 1975).

Schoener (1975: 369) noted that the operationalization of any of these model involves a three step process: 1) selection of a currency; 2) selection of an appropriate cost-benefit function; and 3) arrival at the optimal solution. Most often, the currency selected is a measure of the time and energy spent searching and pursuing prey. In selecting the appropriate cost-benefit function one may consider caloric consumption, other nutritional requirements, or time allotted to other activities.

It is clear that for a successful application of optimal foraging theory a considerable amount of specific information is required regarding both the environmental setting of the group under study (i.e., information concerning resource availability and distribution) and the foraging strategy of the group. In view of the limited paleobotanical and faunal data in the present case, it would appear as though the theory has little to contribute to analysis of mobility strategies.

However, it must be borne in mind that the foregoing discussion of optimal foraging theory presents an outline of its idealized application in cases where suitable data are available. In a discussion of the use of models in population biology, Levins (1966: 421) observed that the idealized data-set might not be available and, that even if it were, the resulting solution might be so mathematically complex that it would lose all meaning in terms of the original problem. Therefore, he recognized the need to simplify the models while still preserving their essential features. This simplification can be achieved in a number of ways, each one requiring that certain aspects of original model be sacrificed in order that other aspects be emphasized.

Levins (1966: 422) recognized three types of models. First are those which sacrifice generality to realism and precision. These models reduce the parameters of the problem to those relevant to short term behaviour. They require relatively accurate measurements of the variables relevant to the problem and arrive at precise, testable predictions which are applicable to the situations defined by the problem. A second class of models sacrifice realism to generality and precision. These models frequently include many unrealistic assumptions which, it is hoped, will cancel each other out. Precise patterns of behaviour are modelled from very general equations. Third are models which sacrifice precision to realism and generality. These models are concerned with long-run qualitative results rather than the quantification of short-term situations. In general, models of this class are flexible and rely primarily on dichotomies and inequalities (such as patchy vs. uniform environments; dispersed vs. clumped resources) rather than utilizing specific mathematical equations.

The legimate use of simplifying assumptions depends, to a large extent, on the stage of development of a particular discipline (Levins 1966: 421-422). An assumption which is legitimate at one time may, following further research, be shown to be unacceptable. As a further caution, Levins (1966: 423) noted that one must determine "whether a result depends on the essentials of a model or on the details of the simplifying assumptions."

The nature of archaeological data and the cultural and natural transformations it has undergone (cf. Schiffer 1972, 1976; Wood and Johnson 1978) greatly reduces the amount of precision attainable in the application of most models. In addition, a great number of assumptions are required regarding the socio-cultural significance of the archaeological data-base as well as the biophysical environment in which prehistoric groups existed. For these reasons, it is often appropriate that models applied to archaeological data treat most variables as dichotomies rather than deriving precise mathematical expressions. The application of optimal foraging theory to archaeological problems thus requires that much of the precision offered by the theory be sacrificed for the sake of generality and reality. At the present stage of development of archaeological theory, this sacrifice is not unrealistic.

Models of Group Size

Binford's analyses of residential and logistic mobility strategies indicates that much interassemblage variability is attributable to the formation of residential and task groups of different sizes. It will be useful, therefore, to examine more closely optimal foraging models which are concerned with the conditions under which foragers aggregate and disperse.

Horn (1968) developed one of the first models which considered the distribution of food as an important mechanism in the aggregation and dispersion of predators. Although his study was concerned with populations of Brewer's blackbirds (Euphagus cyanocephalus) in eastern Washington, the model and many of its fundamental concepts have been applied in archaeology (Wilmsen 1973; Heffley 1981). In the initial development of the model:

> Clumped and even nest distributions are superimposed on clumped and even distribution of food, and the average distance which the birds have to fly to gather sufficient food to the nest is calculated (Horn 1968: 688).

The distribution and availability of food was then examined in more detail and resources were characterized as either evenly distributed and stable or highly clumped and transient (Horn 1968: 689). Initially, it was assumed that there was a continual requirement for resource replenishment as nestlings demanded constant feeding. Horn also assumed, for the sake of simplification, that there would be no interaction between foraging pairs (nest mates).

Horn (1968: 692-693) concluded that when food resources were evenly distributed and available in consistent quantities (i.e., stable), then a dispersed nesting pattern enabled the most efficient exploitation. He found that the average time spent by each foraging pair in search of food was reduced when nests were spread throughout a widely occurring food source. However, when food was clumped and transient (and, therefore, less predictable) it was apparent that an aggregated nesting pattern led to more efficient foraging. When the assumption of non-communication between foraging pairs was relaxed to provide a more realistic model, Horn found that his model was strengthened. The mere act of bringing food to the nest enabled other, less successful foragers, to observe the food and to follow the successful individual as he returned to his foraging patch. This pattern of behaviour increased the foraging effeciency of the groups as a whole and underscored the advantages of an aggregated nesting pattern.

Other studies in population ecology have noted that a range of factors interact to determine optimal sizes of foraging groups. Among these are defense, time budgeting, and various characteristics of the prey (e.g. size and nutritional quality) (Caracao 1979a, 1979b; Caracao and Wolf 1975). While the integration of these variables increases the reality of the model, their quantification within the context of archaeological analysis is very imprecise. In fact, a number of anthropological and archaeological studies have applied Horn's model without considering these other factors. A review of these will serve to illustrate the usefulness of the optimal foraging approach to the study of foraging mobility strategies within an archaeological and anthropological framework.

One of the initial uses of Horn's model in an anthropological context was by Wilmsen (1973). Following from Horn's results, he predicted that:

> Stable foods should be harvested by minimal work units. When a group is primarily dependent upon this type of resource, members should be dispersed over all - or, at least, most - of the group's territory. (Wilmsen 1973: 9)

On the other hand, he suggested, hunter-gatherers who depend on highly mobile food resources should form one or more large residential units composed of aggregations of two or more bands. Among the spatially stable resources available to hunter-gatherers are plants and various animals with restricted movements and localized spacing (e.g. deer). Typical mobile resources are migratory herding species such as bison, caribou, and antelope.

This bipolar model was then modified to provide a more realistic portrayal of foraging adaptations. As a result, mixed strategies were identified as those which are designed to exploit both stable and mobile resources as they become available throughout the year. Similarly, the aggregation/dispersal pattern of group formation achieved a balance between the extremes of the original model:

> Most environments offer combinations of stable and mobile foods. Mixed strategies designed to exploit both achieve a balance between the contrasting poles of efficiency associated with each. They also allow a group to concentrate on those foods that are most available at a particular time. If this part of the model is valid, there will be few large sites and many small ones in any hunting-gathering system. (Wilmsen 1974: 71-73)

After demonstrating the mathematical foundations of the model (Wilmsen 1973), Wilmsen (1974) used it as a basis for the interpretation of variability between lithic assemblages from the Lindenmeier site. The presence of non-local lithic material, as well as variations in the spatial distribution of some attributes of the artifacts indicated that the group which had occupied the Lindenmeier site was, in fact, an aggregation of a number smaller groups. It was suggested that the aggregation was a response to the demands of hunting bison, whose remains dominated much of the faunal assemblage.

In a more recent study, Heffley (1981) examined the historic and ethnohistoric settlement pattern of three Athapaskan groups:

the Upper Tanana; the Ingalik; and the Chipewyan. Again, Horn's (1968) model provided the interpretive framework. Heffley (1981: 128) noted that, while any particular settlement pattern results from a number of interacting factors, subsistence activities may still be considered central:

> There are many activites that compete with the time and energy investment involved in the food quest. The maintenance of the social unit requires time and energy which can, along with non-foraging selective forces, alter observed behaviors, thus compromising foraging efficiency. However, without a minimum net energy return from a foraging strategy, a society is not viable.

The economically important animal resources were then categorized as evenly spaced or clumped, and as stable or unpredictable and the settlement pattern of each culture group was compared with the resource distribution. The results indicated general support for Horn's (1968) model:

> large settlements were centrally located in relation to resources which were clumped, mobile and unpredictable. Small settlements were dispersed in the exploitation of evenly spaced, stable resources. (Heffley 1981: 146)

It was noted, however, that a simple distinction between two types of resources (evenly spaced and stable or mobile, clumped and unpredictable) did not account for all situations. In particular, no consideration was given either to resources which were preserved and stored from one season to the next or to those which were distributed throughout the environment but were plentiful only during a limited season. As a result, it was suggested that a third category of resources be defined to include those which were clumped and predictable.

Heffley (1981: 147) concluded that Horn's (1968), model fails to account for human forager settlement patterns in two contexts:

> (1)when detailed information about resource locations was being actively shared; and (2) when clumped but predictable resources (including stored food) were being used.

In both instances the result was a large aggregated settlement in a situation where smaller, dispersed sites were expected. These exceptions do not render the model inapplicable, since these factors may be readily incorporated within the mathematical model. The amenability of the model to these various conditions underscores its usefulness in the analysis of aggregation and dispersion of foragers in general, and of human foragers in particular.

Chapter Summary

This chapter has outlined the theoretical framework of this dissertation. It is suggested that variation between artifact assemblages can best be understood by considering them within their environmental context. The biome constitutes a suitable unit of analysis and the availability of resources is assessed by examining their patchiness within these biomes. Spatial (clumped vs. evenly dispersed) and temporal (stable vs. transient) characteristics of resources are identified as important determinants of patchiness. Hunter-gatherers respond to this patchiness through different mobility strategies. Two such strategies are defined, Residential mobility, involving sequential moves of residential bases, is correlated with the exploitation of evenly distributed and relatively stable resources. Logistic mobility, associated with the use of more clumped and transient resources, is characterized by the location of a residential base near several patch types. Smaller task groups are dispersed to exploit these patches.

CHAPTER IV

ASSEMBLAGE STRUCTURE AND TECHNOLOGICAL ORGANIZATION

This chapter examines the ways in which the structure of lithic assemblages and the organization of the technology are related to the length of site occupation (group mobility), group size, and range of activities. Using these relationships, it will be possible to derive a set of expectations regarding the structure of artifact assemblages and the technological organization which results from each type of site. Keeping in mind that the variables of residential stability, group size, and range of activities are all relative, the comparison of Archaic assemblages with these expectations will enable one to estimate the relative stability of the residential base and estimate whether sites are more like residential bases or base camps. As Brown and Vierra (1983) noted, sedentism will also be reflected in the structure and organization of the site (i.e., increases in activity-specific areas, refuse dumps, habitation structures, storage facilities). Unfortunately, sampling biases and preservational problems have resulted in no such "features" being discovered in the sites considered in this study. Therefore, the structure of the lithic assemblages and organization of the technology must serve as the only indices of the range of activities, the relative sedentism and the size of the group.

Assemblage Structure

The structure of an archaeological assemblage, as used here, refers to the variety of items present, their relative abundance, and their patterns of covariation. The concept is similar to that used in linguistic analysis, wherein "structuralism":

> means that each language is regarded as a system of relations (more precisely, a set of interrelated systems), the elements of which ... have no validity independently of the relations of equivalence and contrast which hold between them (Lyons 1968: 50 cited in Fillenbaum and Rapoport 1971: 1; emphasis in original).

The distribution of various artifact classes is considered in relation to the distribution and covariation of other classes. Defined in this way, structure differs from the concepts of site structure (which implies the spatial organization of material within a site or structure) and technological structure (which links the procurement of raw material, manufacturing technology, and the products and by-products of production; cf. Sheets 1975). This section examines how the variables used to define site types (i.e. range of activities undertaken; length of occupation; size of group) affect the structure of the assemblage. The effects of variations in the technological structure and raw materials will also be examined.

Range of Activities

Residential bases have been defined as the place where "the widest observable range of activities (are) performed by the widest range of the population, including people of both sexes and all ages." (Gould 1980: 132). Activities which involve division of labour by sex or age may occur together at a residential base, whereas they may be excluded from a base camp with its less diverse composition of people. A greater variety of activities will enlarge the range of items within the artifact assemblage. It is, therefore, expected that residential bases will have a greater number of artifact types than base camps.

Other features of residential bases may contribute indirectly to the variety of items within an assemblage. Binford (1979) noted that residential bases and base camps are the places where groups "gear up" before embarking on logistic procurement trips. That is, they ensure that all of the equipment which they anticipate needing is in working order. Worn or broken items are repaired or replaced prior to embarkation. Keeley (1982: 804) further noted that retooling of hafted artifacts may occur when it is convenient, rather than when it is necessary. It may often be most convenient at sites where there are fewer extractive activities (as defined by Binford and Binford 1966) to make demands on one's time. While activites directly related to the use of tools may have been undertaken elsewhere, the observations of Binford (1979) and Keeley (1982) indicate that all of a group's activities may be reflected in the discarded items at a residential base.

In view of these "gearing up" and retooling activities, it is expected that residential bases will have a greater number and a wider range of items than a base camp. Residential bases are the loci from which a wide variety of logistic groups are dispatched, while a more restricted range of such trips are organized at base camps.

Length of Occupation

Yellen (1977: 82) stated that the longer a site is occupied, the more activities (especially those related to manufacturing) will be undertaken:

> If one assumes that most activities are initiated by a specific individual, and this most often is the case, the greater the number of man-days spent at a camp, the greater the likelihood of any specific activity happening.

He went on to suggest (Yellen 1977: 82-83) that the occurrence of specific manufacturing activities at specific !Kung residential bases was "an almost random process and best appreciated through rules of probability and chance." These observations were drawn from a group typified by a high degree of residential mobility. They indicate that the variability between artifact inventories from the residential sites of such groups should be very high.

As sedentism increases, the probability that a given task will be performed may be expected to increase. This results, most simply, from the increase in the number of person-days for which the site is occupied. In addition, as sedentism increases there is greater variety and quantity of material (both food and non-food items) that will be needed to be replenished. As these items are obtained and processed, more tools will be worn out and need to be repaired or replaced.

Group Size

The relationship between the size of the group occupying a site and the structure of the artifact asemblage is much the same as that described for the length of occupation. This is because the number of person-days for which a site is occupied is a function of the length of time a group is in residence and/or the number of people present. In either instance, the number of items discarded may be expected to be indicative of the number of person-days for which a site is occupied. The variety of items deposited, however, may not necessarily increase with a large group. Larger groups may occupy specific sites briefly to undertake specific activities. In such cases, large, but relatively homogeneous assemblages may be expected to result.

Technological Structure

Analyses of technological structure are concerned with examining the inter-relationships between the kinds of raw material that were procured, the techniques used to reduce it into stone tools, and the kinds of tools (defined on the basis of formal and technological variation) which were produced (Sheets 1975: 370). Models of technological structure are frequently presented as flow diagrams of lithic tool production (Muto 1971; Sheets 1975; Collins 1975; Boisvert et al. 1979; Flenniken 1981). This approach is based on the observation that the manufacture of stone tools is a reductive (or subtractive) process (Muto 1971: 3; Collins 1975) that can be analyzed as a series of sequential steps. It is reductive because materials (flakes and other debris) are removed from a larger mass of raw material (cores, pebbles, cobbles, etc.) until the desired item is produced. The technique (e.g. the production of specialized cores; the production of blades) and methods (e.g. hard hammer or soft hammer percussion) of removal of this material requires choices to be made on the part of the knapper. These choices can often be identified through the analysis of artifacts and debitage in an assemblage.

Different choices made at each stage of the lithic reduction process may result in assemblages which are quantitatively and qualitatively distinct. The production of specialized cores and other items are the more obvious means by which technology can serve to structure an assemblage. In more subtle ways, the decision to use unretouched or only marginally altered flakes may separate one assemblage from another in which more effort was spent to form tools. Similarly, decisions to conserve raw material may result in assemblages which are very different from those which result when little attention is paid to the amount of raw material expended in the production of functional tools. Even where the variables discussed above (activities, group size, length of occupation) are similar, variations in technological structure may result in the formation of very distinct assemblages.

Raw Material

The lithic raw material selected for the manufacture of stone tools may also have a significant effect on the structure of lithic assemblages. Characteristics of the raw material may require special techniques for the removal of useable flakes or for the production of tools. For example, Flenniken (1981) demonstrated that the bipolar technology at the Hoko site in northwestern Washington was, in part, a function of the diminutive nature of the quartz pebbles which served as the raw material. Similarly, in the lower Little Tennessee River valley the occurrence of microblades seems to be correlated with the procurement of small river cobbles.

Variability in lithic raw material may result in assemblage variability in other ways. Gould (1980: 132) noted that, as a general rule, "lithic raw materials that are labour-expensive to procure and/or to work will tend to be used in artifacts that have relatively long use-lives." As a corollary of this, it might be expected that efforts will be made to extend the use-lives of such tools for as long as possible. This means that items which were made of such material will tend to be underrepresented in archaeological assemblages, relative to items made of more common material. If the patterns of lithic procurement change over time, then the structures of the respective assemblages may appear to be significantly different. It is, therefore, important to examine the types of raw material present in the assemblages. Variables which are important include the types of material present, their source locations, and their distribution among various classes of artifacts. The identification of source locations provides an indication of the "expense" of lithic procurement activity. The examination of raw material distribution among artifact classes can help to identify variability arising from efforts to conserve "expensive" stone.

Technological Organization

The analysis of technological organization is directed toward understanding how a technology is organized to adjust to the discontinuous distribution of resources. In most instances, discontinuities in biotic resources will be dealt with by adjusting seasonal movements to coincide with the location of available resources, by dispatching task groups to harvest more distant resources, or by processing and storing resources in order to prolong their availability. Discontinuities in lithic resources may be overcome by organizing the technology to insure that sufficient raw material is on hand and that appropriate tools are available for extractive and processing tasks. In other instances, however, the discontinuities may be unexpected. In these cases, alternative strategies must be available to cope with the unforeseen circumstances.

The requirement that alternate strategies be available to cope with unpredictable contingencies requires that a technology be "flexible" (Goodyear 1979: 4). The nature and extent of this flexibility may vary from situation to situation since the response is conditioned by unique circumstances. These "situational contingencies" (Binford 1979) are most likely to occur at extractive localities, away from either residential bases or base camps. It is assumed that such flexibility is a minor source of the differences between the assemblages examined here.

The organization of lithic technology involves two aspects. The first concerns the procurement of appropriate raw material for the manufacture of stone tools. The second involves the scheduling of manufacture and repair of tools. As the relative mobility of a group changes, the technological organization may also be altered. Lithic raw material constitutes a stable and predictable resource. Increased sedentism or a reduction in the size of a territory may limit the opportunity to exploit some sources of lithic material. On the other hand, increased mobility, either residential or logistic, may increase the range of source locations available to a group. As logistic task groups become more economically important, more planning will be required to ensure that these groups are well-equipped. The following discussion examines the relationships between hunter-gatherer mobility and technological organization.

Lithic Procurement

Binford (1979: 259-260) distinguished between direct and embedded strategies for the procurement of lithic material. A direct procurement strategy involves purposive excursions to some lithic source localities to obtain lithic material. Embedded strategies, in contrast, are characterized by the recovery of suitable material in the course of logistic trips undertaken primarily for other reasons. Such procurement strategies are:

> embedded within some other strategy and, therefore, the cost of procurement was not referable to the distance between the source location and the location of use, since this distance would have been travelled anyway (Binford 1979: 260).

Such strategies have been observed among the Australian Aborigines (Gould 1980; but see also Gould and Saggers 1985) and !Kung Bushmen (Yellen 1977), in addition to the Nunamiut studied by Binford.

Goodyear (1979) suggested that an embedded procurement strategy has been the primary method of obtaining lithic raw material throughout most of prehistory. He noted that the exchange of lithic material in unmodified forms has no known ethnographic correlates. Rather, exchange among hunter-gatherers usually involves finished objects. He concluded that those varieties of raw material represented by both finished tools and by debitage would have been obtained through embedded strategies.

It is important to distinguish between embedded procurement strategies and direct procurement strategies. With embedded strategies comes the observation that:

> the presence of exotic cherts may simply be a fair measure of the mobility scale of the adaptation appearing as a consequence of the normal functioning of the system, with no extra effort expended in their procurement. (Binford 1979: 261)

While identifying specific source localities would enable a demarcation of territorial bounds, even more general estimates of the origins of the material types will provide insights regarding the mobility of hunter-gatherers.

Direct procurement strategies, on the other hand, have important implications regarding the social relationships between groups. Gould (Gould 1980; Gould and Saggers 1985) suggested how these procurement strategies affect interaction between groups. In a discussion of the archaeological material recovered from Puntutjarpa in Central Australia, he noted the presence of a significant number of adzes made from non-local chert. A comparison of the physical properties of the local and exotic chert varieties indicated that the exotic types "had poorer edge-holding properties ..." (Gould and Saggers 1985: 120). Ethnoarchaeological studies revealed a similar pattern of chert use among the modern Australian Aborigines, who often made long trips to acquire specific types of chert. The sources of these materials were often located near sacred sites and in the geographic territories of other groups. Journeys to these lithic sources brought various groups into contact with one another, reinforcing social contacts as well as the relationships with the sacred sites (Gould and Saggers 1985: 122). Gould (Gould and Saggers 1985: 122) concluded that these extended journeys "were instrumental in establishing social networks over wide areas of the desert" and that such networks were an important adaptive strategy for coping with "extreme uncertainties with respect to a key resource such as water."

In an examination of the formation of tribal societies during the Archaic, Bender (1985) suggested that the exchange of various types of raw material formed an important basis upon which the social relationships within, as well as between, groups were maintained. During the Archaic, the geographic distribution of some raw material (such as copper, galena, steatite, banded slate, Busycon shells, and some chert types) increased. While these materials occur in raw forms near the source locations, finished objects (especially those which are non-utilitarian) predominate at more distant localities. The system of exchange implied by this material distribution has implications concerning the socio-political relations between groups and, perhaps, the status of groups located along the exchange routes (Bender 1985: 56). It was further argued (Bender 1985: 57-58) that the inclusion of rare raw material in funeral contexts reinforced status differences within groups. Such differences are expected to have been accentuated as food production intensified and populations became less mobile (Bender 1985: 58).

These examples indicate that the archaeolgoical data will provide equivocal evidence regarding lithic procurement strategies. Assemblages will be similar whether they result from Binford's (1979) example of an embedded strategy or from Gould's (1980; Gould and Saggers 1985) study of the Aborignes' direct procurement strategy. In both instances, the number of items made from exotic material will be small relative to the number of items made from local material. In addition, the earliest stages of lithic reduction will not be present (or will be present only in small quantities) among material from distant sources. The initial reduction would have been undertaken to reduce the weight of the transported material.

Manufacture and Repair of Stone Tools

The mobility of hunter-gatherers requires that the manufacture and repair of tools be scheduled such that appropriate items are available when they are required. This involves anticipating which items are most likely to be required before a logistic trip is undertaken. Planning is an important aspect, for as Binford observed (1979: 263; emphasis in original):

> One <u>never</u> went into the field with personal gear that was not in good condition and relatively new; informants agreed that personal gear was inspe~~ct~~ed before going into the field so that worn items or items in need of repair were either repaired first or replaced before leaving for the field.

Binford went on to note that the discard of such gear whose use-life was exhausted most often occurred at residential bases. Such patterns are in agreement with Keeley's (1982) suggestion, cited earlier, that the repair of the most complex tools required a significant amount of time and was, therefore, not necessarily undertaken where the item had been broken or worn out.

Although the discard of such "curated" tools may occur most often at residential bases, their manufacture may be undertaken at a variety of sites. Just as the procurement of raw material may be an embedded strategy, so too the manufacture of tools may be staged throughout all parts of the group's movements, whenever time permits. For example, Nunamiut were observed manufacturing and repairing tools at hunting stands (the Mask site; Binford 1978) far removed from both residential bases and sites where the tools were most likely to be utilized. The longer a site is occupied, the more phases of production will occur. These considerations are most applicable to tools which were "curated" (sensu Binford and Binford 1966) and are expensive, in terms of the time and effort required to replace them.

The analysis of the organization of tool repair and manufacture is most profitably directed toward the more complex aspects of technology. Since it is these aspects in which the most energy is concentrated, they will require the most planning to ensure that energy is not wasted. Three aspects of Archaic material culture represent considerable amounts of energy investment: groundstone tools (including grinding slabs and atlatl weights); steeply retouched flakes (i.e., end and side scrapers); and bifaces.

In the assemblages examined in this study, groundstone tools and steeply retouched flakes were represented by very few specimens and, in some cases were entirely absent. While their absence may be significant, it is not clear whether this arises from non-use and non-production of the implement at the site, or from the fact that they remained functional and hence were transported elsewhere. This is especially true of steeply retouched flakes and atlatl weights. Grinding slabs, because of their size, may be considered to have been "site furniture" (Binford 1978; Gould 1978). Their presence or absence is more likely to have consequences regarding the activities undertaken at a site. Bifaces, and the debris from their manufacture, are present in all assemblages considered in this study. Therefore, a comparison of the biface manufacturing stages provides a means of investigating technological organization.

Biface Manufacturing Trajectory. The analysis of biface manufacturing stages represented in Archaic assemblages has been the focus of a number of studies. Since the results of these studies substantiate the utility of the approach taken here, it will be useful to review these works in some detail. Furthermore, these works outline the attributes which are important in determining various stages of lithic reduction.

The debitage from biface manufacturing provided a basis for the differentiation between Late Archaic sites in the Ozarks of Arkansas by Raab et al. (1979). It was assumed that "base camps would have been the locus of a variety of activities, including "the full range of tool manufacturing process (as well as repair)... (Raab et al. 1979: 169). Alternatively, a more narrow range of activities would have been undertaken at special-purpose sites, where only a limited amount of tool modification would have occurred. Following Newcomer (1971), Raab et al. (1979: 175-176) suggested that as biface reduction proceeded, the bifacial thinning flakes would become successively shorter and would exhibit increasingly acute striking platforms. Debitage from replicative experiments confirmed this assumption and provided an index for the identification of various stages in the manufacturing process.

In all but one instance, debitage from the archaeological sites was recovered using a 3/64-inch screen; in the exception a 1/4-inch mesh was used. Their results indicate that different manufacturing stages may be represented in different assemblages. Furthermore, it was found that the sample screened through a 1/4-inch mesh contained more of the smaller classes of bifacial thinning flakes. Thus, their procedure was found to be useful in spite of the fact that certain classes of data (e.g. the smallest debitage fragments) were missing from one sample. Raab et al. (1979) argued that this indicates that their model is robust and applicable to other analyses of biface reduction trajectories.

This model was expanded by Johnson (1981; 1982) in his analysis of assemblages from the Yellow Creek Nuclear Power Plant Site in northeastern Mississippi. Rather than dichotomizing between "base camps" and "extractive localities", Johnson (1981: 2) followed Holmes (1897, 1919) in differentiating between sites with long trajectories and those with short trajectories. Assemblages from the former included the by-products from a number of stages of biface manufacture while the latter provided a reduced variety of debitage and bifaces. His expanded analysis (Johnson 1981) included the statistical manipulation of a number of variables to determine patterning in the association of variables and the clustering of assemblages. The attributes were examined on both bifaces and flakes.

One means of comparing bifaces involved the calculation of a thinning index for each specimen. This index was defined as the weight of the artifact divided by its planar area. Planar area was calculated by projecting a series of triangles over the surface of a silhoutted piece. The areas of the triangles were then summed. It was argued that planar area provided a more accurate indicator of overall thinning than either measurements of thickness or the calculation of a maximum thickness:width ratio (both of which measure a small portion of the artifact and not overall thinning; Johnson 1981: 13). The comparison of thinning indices was based on the assumption that thinner bifaces represent those which are nearly completed. Thinning indices provided the primary means of characterizing assemblages. In some cases, analyses based on other criteria were used to substantiate the patterns derived from the analysis of thinning indices. In other instances, the correlation of thinning indices with other variables was used as a basis to suggest patterns of technological organization. Thus, when examining fracture types, Johnson (1981: 53) found that bifaces with the highest thinning indices were discarded less frequently after they had been broken, so that, "as the labor investment increased there were more attempts to overcome single and sometimes double errors." (Johnson 1981: 53). He also noted a tendency to increase recovery from errors with increased distance from the lithic source.

In his examination of "non-tool discards" (Johnson 1981: 101), Johnson followed others (e.g., Newcomer 1971; Jeffries 1978; Raab et al. 1979) in assuming that debitage decreases in size as the reduction proceeds. Accordingly, samples of flakes were passed through a series of screens with 1-inch, 1/2-inch, and 1/4-inch mesh to determine the frequency distribution of each size class in each assemblage. Other important attributes were: platform lipping and facetting (both of which were assumed to be more pronounced in later stages of reduction); gloss from either heat treatment (trajectory-dependent in the Yellow Creek assemblages) or from use (in which case it was assumed to be restricted to rejuvenation flakes); and platform crushing resulting from the use of a hard hammer (indicative of early reduction stages). Analysis revealed that platform lipping and facetting and flake gloss were, indeed, aspects of the later stages of reduction. It was also found that crushing was common at late stage sites (Johnson 1981: 142). An examination of non-tool debitage attributes at various site types (i.e., long or short trajectory sites as identified through an analysis of biface thinning indices) indicated that long trajectory sites possess a more diverse assemblage than short trajectory sites. In addition, it was found that larger flakes were more common at early stage sites while smaller flakes predominated in assemblages produced during later stages of the biface manufacturing trajectory (Johnson 1981: 113). Unlike Raab et al. (1979), Johnson included other flake types in addition to biface thinning flakes.

These studies indicate that the analysis of bifaces and the debitage from their manufacture provides a useful means of examining differences between assemblages. They have been discussed in detail because they provide the basis from which the present study will proceed. The distinction between long trajectory and short trajectory assemblages leads to the question of technological organization. Long trajectory assemblages contain the by-products of a number of reduction stages. Short trajectory assemblages, on the other hand, reflect only a few stages. This reduction may have occurred during the initial stages (quarrying; blank production), near the end of a tool's use-life (rejuvenation), or at any intermediate stage. Analyses which relate the technological organization to the environmental context of the assemblage begin to address questions concerning the adaptive strategies of prehistoric foragers.

Chapter Summary

This chapter has examined the ways in which the structure of lithic assemblages and the organization of the technology are related to group mobility, group size, and the range of activities undertaken at a site. The assemblage structure examines the variety of items and their patterns of association and covariation. The widest range of items, and the greatest number of items, are expected to occur at residential sites. The analysis of technological organization, focusing on lithic procurement and the manufacture and repair of stone tools, reveals much about group mobility. If a group is highly mobile, the range of lithic material at any given site may reflect a variety of sources. Previous analyses of the manufacture and repair of stone tools suggest that a greater number of stages will be represented at sites occupied for longer periods of time.

CHAPTER V

ENVIRONMENTAL SETTING

This chapter provides an outline of the environment of the region encompassed by this study. It has often been sugested (e.g. Streuver 1968: 287; Clarke 1978: 124; Rick 1980; Keene 1982) that the geographic location of archaeological sites is, in part, a function of the resource requirements of the prehistoric people who occupied them. The non-random distribution of these resources, both spatially and seasonally, resulted in similar non-random distributions of sites on the landscape. Mobility strategies are related to the distribution and availability of those resources which are critical to hunter-gatherers. A knowledge of the environmental variables provides a basis for understanding the nature of the mobility strategy.

In the following discussion, various components of the environment are discussed in turn. It should be noted, however, that each of these components interact within an ecological system. Variations in one aspect may be accompanied by perturbations throughout the entire interconnected network.

Climate

The lower drainages of the Cumberland and Tennessee rivers lay within the warm temperate rainy classification, without a dry season and with hot summers (Koppen's classification: Cfa;

Pettersen 1969: fig. 17.1). The following climatic data are from Visher (1954), United States Environmental Department (U.S.E.D.) (1968) and United States Geological Survey (U.S.G.S.) (1970).

The normal precipitation is 1016 mm (40 inches), of which 40-50 per cent is received during the warm half of the year (spring and summer). Approximately two-thirds of this is retained in the soil as the normal annual runoff is 381 mm (15 inches). Convection storms are frequent with an average of 60 thunderstorms occurring yearly. June has the most thunderstorms. The frost-free season lasts for 210 days, between May and October. The average annual temperature is 12.8° C (55° F) and ranges from a normal winter temperature of 1.7° C (35° F) to 23.9° C (75° F) in the summer. Prevailing winds vary between southwesterly between January and July, northwesterly during August to October, and southerly in November and December.

Geology

The nature of the geologic formations in this part of western Kentucky have far-reaching effects on the hydrology, soil development, and the distribution of the flora and fauna of the area. The distribution of outcrops of various geologic formations also determines the local availability of chert suitable for the manufacture of stone tools. The discussion presented here is based upon interpretations of 1:24,000 geologic maps of the area (Amos 1974; Amos and Wolfe 1966; Amos and Hays 1974; Amos and Finch 1968; Lambert and MacCary 1964;

Hays 1964; Seeland 1968).

The floodplains and terraces of the Cumberland and Tennessee rivers and their tributaries are underlain by fluvatile and fluvio-lacustrine deposits of Pleistocene and Holocene age. At some localities these deposits form the alluvium. The co-occurrence of fluvial and lacustrine deposits resulted from the formation of lakes upstream from the confluence of these rivers with others that headed in glaciated regions to the north. These latter streams acted as glacial sluiceways, and their increased sediment load blocked the discharge of streams that did not head in glaciated regions. At the end of the glacial period, the load of the main streams was reduced and they eroded their valley trains. As the level of these streams lowered, the dammed streams were able to empty into them and, consequently, downcut through the lacustrine sediments (Leach 1981: 2-5).

A silt and clay loess forms a blanket-like mantle in upland areas. This loess is equivalent to the Peorian Loess of Wisconsin age that has been identified in Illinois (Amos and Finch 1968).

Beneath the loess and fluvio-lacustrine deposits are the Continental Deposits (or Lafayette Gravels; Potter 1955). These consist primarily of sub-angular to sub-rounded chert pebbles, although ellipsoidal quartz pebbles occur as well (Amos and Hays 1974). This deposit is irregularly distributed. It underlies the dissected uplands between the Cumberland and Tennessee rivers above an altitude of 380 feet a.s.l. (Lambert and Brown 1963) throughout the area, apparently as a result of slumping and reworking (Amos and Wolfe 1966).

Cretaceous deposits of the Tuscaloosa and McNairy Formations comprise the strata underlying the Continental Deposits. These Cretaceous formations are composed of sands and gravels with variable bedding and cementation characteristics. The gravels consist of sub-rounded and poorly sorted chert pebbles and cobbles up to eight inches in diameter. At places, cobbles in the lower part of the formation are derived from the residuum of the underlying limestones (Amos and Hays 1974). The thickness of these Cretaceous beds varies as a function of the presence of faults or fault-line scarps (Amos 1974). They underlie dissected ridges between the Cumberland and Tennessee rivers (Lambert and Brown 1963).

The Caseyville formation of Pennsylvanian age underlies the Cretaceous deposits in sections near the Ohio River. This formation includes sandstones and siltstones, as well as some quartzite cobbles.

Beneath the Pennsylvanian formation are the Mermac and Osage series of the Mississippian system. The Mermac series includes the Ste. Genevieve, upper St. Louis, lower St. Louis-Salem, and Warsaw limestones. The Ste. Genevieve limestone member, which underlies the rolling karst uplands (Lambert and Brown 1963), contains sub-angular and sub-rounded chert pebbles. In some sections Levais limestone, Rosiclaire sandstone, and Fredonia limestone have been recognized as members of the Ste. Genevieve formation (Amos and Hays 1974; Amos 1974). The Ste. Genevieve formation is underlain by the upper member of the St. Louis formation. This unit contains dense to fine textured chert nodules, some of which are oolitic. Near the base, these nodules may comprise five to ten per cent of the strata (Seeland 1968). This member rarely crops out and often forms a residuum of dense to fine textured chert. The lower member of the St. Louis limestone (termed lower St. Louis-Salem) has fine-textured chert pebbles scattered throughout it. Outcrops are rare except where streams have downcut. This formation is often covered with a thick mantle of cherty soil which may contain angular chert fragments. St. Louis limestones underlie dissected uplands and ridges and form steep valley walls along the Cumberland River (Lambert and Brown 1963). Warsaw limestone is the lowest member of the Mermac series. Chert is sparse in the Warsaw limestone, occurring most frequently as thin lenses and discoids (although large blocks do occur; Amos and Hays 1974). This formation underlies dissected uplands and ridges adjacent to the Cumberland and Tennessee rivers and their tributaries (Lambert and Brown 1963).

Near the Ohio River, the Mermac series has not been mapped. Rather, the Chester series occurs as the upper Mississippian strata. This series includes, from upper to lower, Kinkaid limestone, Degonia sandstone, Clore limestone, Palestine sandstone, Menard limestone, Watersburg sandstone, Vienna limestone, Tar Springs sandstone, Glen Dean limestone, and Hardinsburg sandstone (Amos and Wolfe 1966). Chert may be found in most of these formations and occurs in beds up to three feet thick in the Degonia limestone. This series underlies gently rolling uplands (Lambert and Brown 1963).

The lower Mississippian is represented by the Fort Payne formation of the Osage series. The chert in this formation occurs as beds and lenticular masses and comprises 10 to 40 per cent of the unit. Residuum chert is often moderately weathered to form sub-angular cobbles. The Fort Payne formation is highly resistent and outcrops frequently along streams and river cuts. A number of such exposures along the Tennesee River were reported historically, but have recently been submerged as a result of river stage maintenance by Kentucky Dam (Amos and Finch 1968). This formation underlies dissected ridges between the Tennessee and Cumberland rivers (Lambert and Brown 1963).

The upper Devonian series lies beneath the Osage series. These lower strata are represented locally only by the Chattanooga shale. This unit does not outcrop and is known only from a single drill hole, located north of the Tennessee River, near Calvert City.

Physiography

The study area lies within the Highland Rim section of the Interior Low Plateau province (Figure 4). The surficial features of this province are closely related to the underlying geological structure (Fenneman 1938: 413-414). In the Pennyroyal District of the Highland Rim Section these geological features consist of an extensive surface of middle Mississippian limestones which decline gently westward from the Mammoth Cave area to the Tennessee River. Relief is generally low, although local variations do occur. Such variation most often results from the formation of solution caverns and subsequent slow collapse of the limestone (Fenneman 1938: 420-423).

The Tennessee River marks the western extremity of the Interior Low Plateau Province and the landscapes east and west of this boundary are distinctly different (Fenneman 1938: 413; Braun 1964: 156-157). Westward, surficial relief is more repressed and no upland areas exist. Locally, Bailey and Winsor (1964: 27) have defined a Cumberland-Tennessee Section, extending from five miles east of the Cumberland River to five miles west of the Tennessee River. This hilly section represents the former shoreline of the Mississippian Embayment.

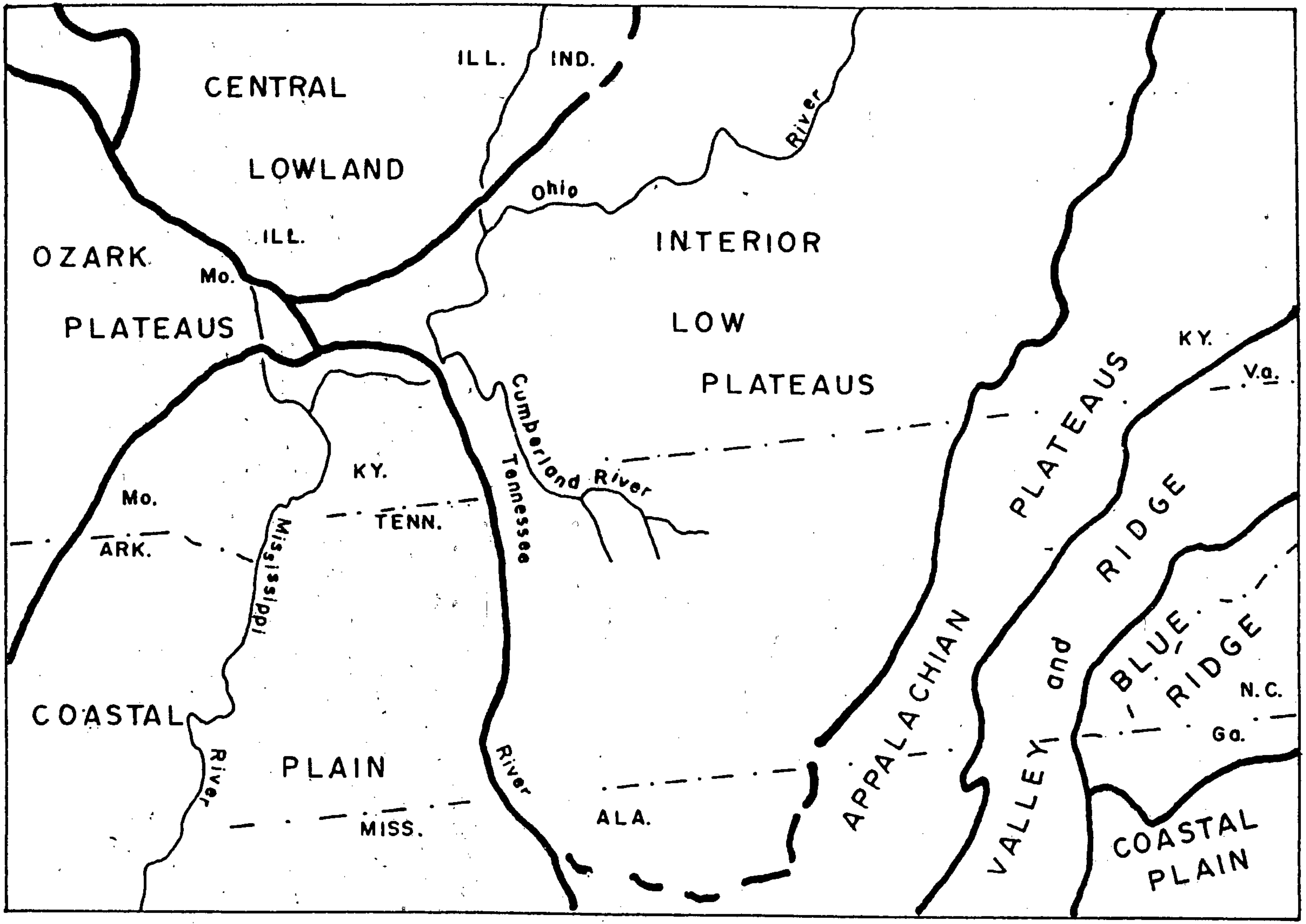


Figure 4. Physiography of the study area and adjacent region.

Soils

Many of the soils in this region developed on a thin mantle of loess overlying gravel and chert beds (Bailey and Winsor 1964: 27). Three principal series are recognized: Bodine Series developed from cherty, low grade limestone; Brandon Series developed from loess overlying Coastal Plain material; and Gain Series developed from sandy and gravelly Coastal Plain material. Each of these are well-drained or excessively well-drained, low in fertility, and occur primarily in upland areas.

Sediments on the valley floor, on the other hand, reflect the fluvial and fluvio-lacustrine processes that were important during the Pleistocene (Leach 1981: 4). Frequent flooding throughout the Holocene has resulted in the deposition of fluvial sediments on top of the lake deposits in the areas immediately adjacent to the rivers and their tributaries.

Drainage

All of Kentucky is drained by the Mississippi and Ohio rivers and their tributaries. Locally, the Cumberland and Tennessee rivers are the largest streams and are tributaries of the Ohio River. Both the Cumberland and the Tennessee are underfit streams, with floodplains too broad to have been created by the current streams (Leach 1981: 2). This situation resulted from Holocene downcutting through Pleistocene lake sediments. A number of smaller streams, many of which are ephemeral, drain into the Cumberland and Tennessee rivers. The non-contributing area of the lower Tennessee River is not significant, while that of the Cumberland River extends up to 38-66 per cent in the tributary basins of the Little and Red rivers (McCabe 1962: 8).

In addition to surficial streams, springs and sinks are important sources of water. Aquifers frequently form in the underlying rocks. Downstream from Kentucky and Barkley Dams, the Mississippian rocks of the Mermac Formation retain water in the lower parts of the uplands, above the alluvial plain. In the sections upstream from the dams, Mississippian rocks of the Mermac and Osage series are important sources of aquifers. These formations are distributed as narrow bands adjacent to the alluvial plain and along major tributaries. Impoundment of the Kentucky and Barkley Lakes following the construction of the dams has submerged much of these formations. In the highest part of the uplands between the two rivers, the upper Cretaceous Tuscaloosa formation retains water. This formation is a considerably poorer source of water than the Mississippian age rocks, and wells that have been drilled in upland areas have generally proven to be an inadequate source of water (Lambert and Brown 1963).

The locations where the surface water drains into the underground channels of the aquifers in these formations are indicated by sinks. As this surface water flows towards a local base level, it dissolves the limestone and enlarges the channel. This, in turn, increases the carrying capacity of the aquifer.

Ultimately, this water may be brought close enough to the surface to be accessible through local springs.

Flora

The plant resources of an area may be important to hunter-gatherers as potential food items, sources of fuel, or resources from which other elements of their material culture can be formed. As greater emphasis is placed on the available plants, sites may be situated in locations which provide an opportunity for the efficient exploitation of these resources. However, the importance of various plants to the Archaic economy is difficult to assess. As various researchers (Asch et al. 1972; Keepax 1977; Minnis 1981; Munson 1981; Hally 1981; Conaty 1983) have pointed out, the botanical remains recovered from an archaeological deposit may be a greatly distorted sample of the range and abundance of plants that had been used originally. Uncarbonized plant remains, such as roots or leaves, are unlikely to have survived from the time of the initial deposition. On the other hand, the process of cabonization may completely consume the smaller seeds. Minnis (1981) noted that seeds may have been accidently introduced into a deposit when other parts of the plant were used, perhaps as non-food resources or as part of the seed rain in the past. With these precautions in mind we can assess the importance of the potential availability of plant resources in determining the location of sites and the size of the population aggregation.

The study area includes three distinct plant communities (Kuchler 1964; U.S.G.S. 1970) (Figure 5). First, the lower drainage of the Cumberland and Tennessee rivers lie, generally, within the southern part of the oak-hickory forest. Second, the Southern Floodplain Forest extends along the Tennessee River as far upstream as the vicinity of Kentucky Dam. Its occurrence along the Cumblerland River is problematic, for it has been portrayed as not present (Kuchler 1964), or as occurring as a part of the Ohio Valley floodplain biome as far upstream as Horseshoe Bend (near the Trail site) (U.S.G.S. 1970: 154-155). Third, patches of Lafayette Prairies lie near the river valleys. This biome is a mosaic of bluestem prairie and oak-hickory forest.

The components of each plant association are listed in Appendix A with a description of the habitat in which the species most frequently occurs, the months in which the fruit is available, and a list of animals that consume the ripened fruit.

The former extent of the prairie association is not readily apparent. Delcourt (1978, 1979) and Klippel and Parmalee (1982) have suggested that a mid-Holocene (c. 8000-5000 bp) dry period may have led to an association of xeric flora in some areas of the Mid-South. Prior to that time, xeric species, such as grasses, would have been greatly restricted. Humphrey et al. (1966) cite references to intentional burning of these prairies to reduce the encroachment of trees. However, most of the arboreal species in this area are directly or indirectly

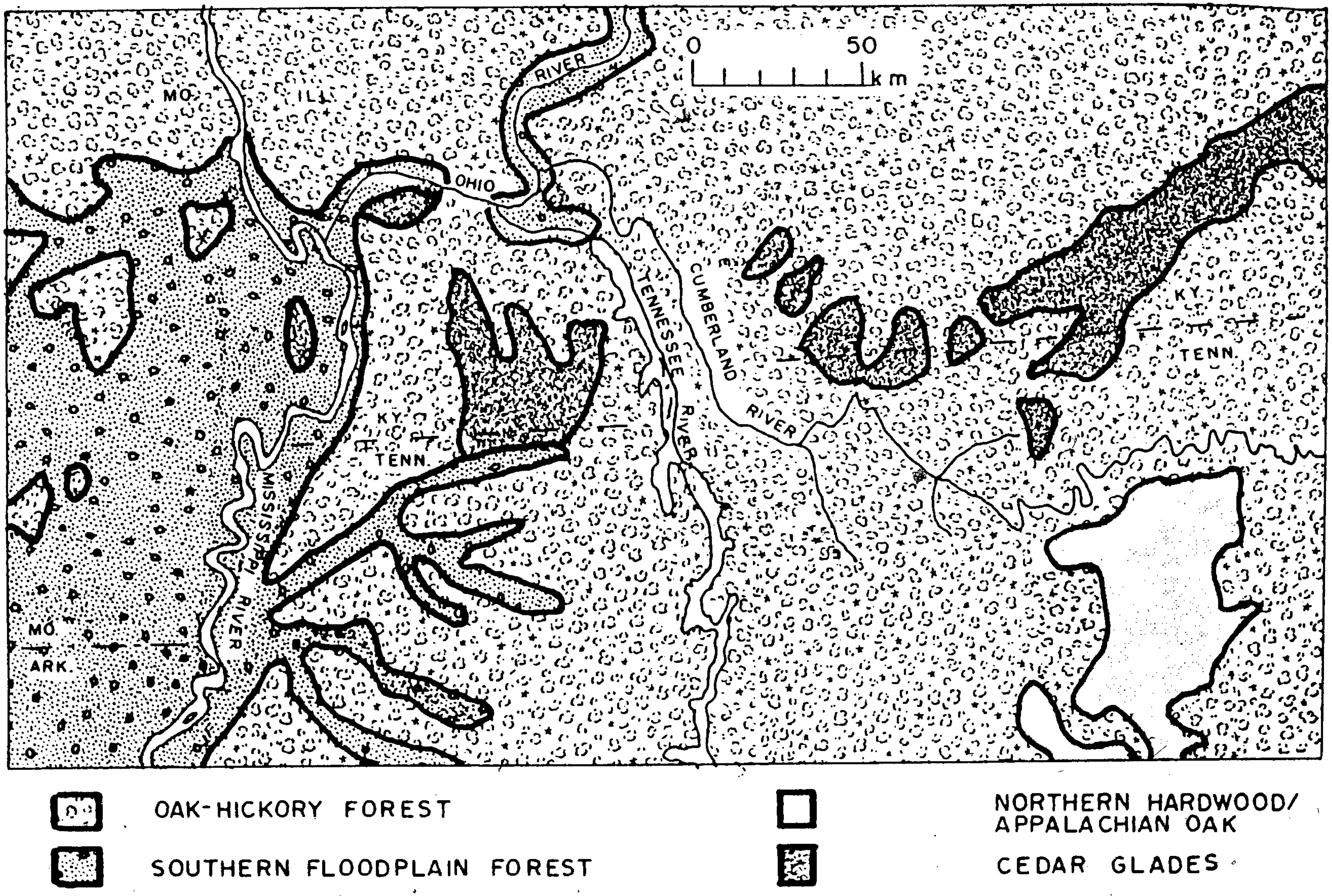


Figure 5. Phytogeography of the study area and adjacent region.

susceptible to damage by fire. The degree to which prehistoric Natives selectively burned areas to promote prairie growth cannot be determined. In view of the dietary importance of acorns, nuts, and berries to both humans and other animals, these burnings may have been infrequent.

Paleobotanical remains have been recovered from the Morrisroe site (Nance and Conaty 1982), and from the Whalen, Cox, Gordon, Lv98, Iuka, McKinney, Dyke, and Brandstetter Rockshelter sites. Analysis of this material indicated that the nutshell fraction was overwhelming dominated by hickory nut fragments, while acorns comprised a very small proportion (Wymer and Cowan 1982: Tables 1 and 2). In addition, grape seeds were found to be the dominant type of seeds, with hawthorn, black cherry, and honey locust forming minor elements. These species probably do not represent the entire range of plants used by the prehisoric people at the site. They do, however, suggest that the site was occupied at least during the autumn months when seeds and nuts were most abundant.

Fauna

An assessment of the animal resources that were available to prehistoric hunter-gatherers suffers from many of the same drawbacks that are inherent in paleobotanical analysis. In the absence of butchering marks, one must consider the possibility that faunal remains in a site represent natural death assemblages. In addition, bones may be preserved only under some types of soil conditions. Finally, archaeological recovery techniques may not be suited for the recovery of many of the smaller remains that are present in archaeological sites. Casteel (1974), for example, noted that the absence of fish scales in faunal assemblages may be a function of archaeological sampling bias and not indicative of prehistoric selection. These problems are further complicated when estimates of the dietary significance of various species are attempted. The following discussion outlines the variety of animals that may have been available for human consumption during the Archaic. Alteration of the environment after Euroamerican settlement has undoubtedly changed the faunal associations of the area. The data presented here must, therefore, be considered only as a general outline of past conditions.

A compendium of potential animal resources that were available to western Kentucky Archaic populations is provided in Appendix B. Also included is a description of the habitat of each species and an estimate of its seasonal availablity. Elk, bear, and bison, while not present today, were observed by early explorers (Ashe 1809; Altshelter 1931). The occurrence of bison herds east of the Mississippi River was probably a relatively recent occurrence (Haines 1970: 73; Roe 1970: 228). Roe (1970: 232), however, suggested that some portions of the herds west of the Mississippi may have frequented the eastern shore as well. It is possible, therefore, that small numbers of bison may have inhabited western Kentucky. Bats and songbirds have not been included because it is unlikely that they were economically important: the labor input to harvest them would have far exceeded their dietary return. The same may have been true for many of the rodents included in this list. However, paleofecal analysis from several Woodland period sites (Yarnell 1969; Cowan 1972) indicate that such animals were consumed, if only as a starvation food. Many of the reptiles and amphibians may, similarly, have been eaten only in times of stress. Most species would have been unavailable during winter hibernation.

Of the fish, nearly all could have been consumed by man. As Limp and Reidhead (1979) and Garson (1980) observed, species living or spawning in backwater lakes and sloughs could have been effectively harvested by a few individuals who drove or herded the fish onto the bank. Yerkes (1981) suggested that this technique would have yielded the best results during the spring and early summer spawn, before some of the species moved to deeper water and lost some of their fat content. Capture of deep channel fish would have required a greater expenditure of energy for the possible return. However, during the spring many of the channel fish explore the shallow overflow lakes and would have been more accessible. Few of these species migrate and the low probability of freezing would have made them available throughout the year. However, as they moved to deeper water in the winter, their capture would have become more difficult. Rostlund (1952: Table 4) estimated a prehistoric yield of 60 lbs. of fish per acre of water in this area and observed that fishing would have been profitable at all times of the year.

Finally, freshwater molluscs may have been an important food source. The development of shellmounds elsewhere in the midcontinent reflects the prehistoric regard for these species (Webb 1939; Webb and DeJarnette 1942, 1948a, 1948b, 1948c, 1948d; Morse 1967; Lewis and Lewis 1961; Moore 1916; Webb 1950a, 1950b, 1974; Winters 1967, 1969). In addition to those species listed, other species may have been formerly present in the lower drainages of the Cumberland and Tennessee rivers. Industrial pollution and siltation resulting from impoundment projects have eliminated many species (Casey 1982).

Archaic period faunal remains have been recovered only from the Morrisroe site. Kusmer (1983) reported that 97 per cent (by weight) of this material is unidentifiable as a result of fragmentation and burning: all of the bone from unit I and 50 per cent from unit II is calcined. Identifiable mammal bones included white-tailed deer, cervidae tooth fragments (probably either white-tailed deer or wapiti), microtine teeth, squirrel and other small mammals. Squirrel and white-tailed deer remains were restricted to the lowest levels, while the others occurred throughout the deposit. Bird remains were also found in all levels. Except for a single waterfowl element from the middle levels, identification could not be made beyond the level of Order, although all sizes of birds were present. Turtle bone and shell occurred in all zones, while snake was found only in the lowest zone. Finally, although fish remains were recovered from all zones, they were found predominantly in the lower half of the deposit. Freshwater drum was the only species identified. Differential preservation of the teeth may have resulted in an overrepresentation of this species.

As almost all of the faunal material is calcined, Kusmer (1983: 5-8) concluded that the entire range of animals represented were included in the diet of the inhabitants of the Morrisroe site. The only important trend was a marked decrease of fish remains in the upper zones. This may be due to a sampling error following erosion of the site's surface deposits (Nance 1981; Nance and Conaty 1982).

Paleoecology

There have been no paleoecological studies undertaken in western Kentucky. Pollen studies have been conducted in north-central Tennessee (H.R. Delcourt 1978, 1979), south-central Illinois (Gruger 1972a, 1972b; King 1981), and southeastern Missouri (King and Allen 1977). These studies reveal the dynamic environmental changes that occurred in eastern North America during the Holocene. In many instances, these changes profoundly affected the quantity and quality of resource available to the prehistoric people.

H.R. Delcourt (1978, 1979) examined pollen samples from two ponds in north-central Tennessee to determine the vegetation history of the Eastern Highland Rim and portions of the adjacent

Cumberland Plateau. She found that, during the early Holocene (c. 12,500 - 9500 bp) the forest was dominated by oak, ash, and ironwood and that hickory, birch, walnut, elm, beech, maple, and basswood were also present. By c. 9500 bp an essentially modern forest had become established which included such warm-temperate species as magnolia, holly, sweet gum, and tupelo. Non-arboreal elements reflected a swamp similar to that which presently exists at the sites. During the mid-Holocene (c. 8000 - 5000 bp) a greater oxidization of plant macrofossils indicates that, while the swamps remained wet, there was a significant fluctuation or general lowering of the water table. At this time as well, spruce pollen disappeared from the sample and non-arboreal elements became less frequent as oak, ash, and birch became more abundant. Delcourt (1978: 109) concluded that "During the mid-Holocene, mixed mesophytic forest taxa became increasingly restricted in distribution and topographic position in areas peripheral to the Cumberland Mountains of eastern Kentucky." An analysis of insectivore remains from a deeply stratified cave deposit in central Tennessee has confirmed the changes suggested by Delcourt (Klippel and Parmalee 1982).

E. Gruger (1972a, 1972b) found oak to be consistently present throughout the pollen sequence from the Pittsburgh Basin, south-central Illinois. The samples which comprise this sequence have been consistently dated to the late glacial (c. 37,000 - 20,000 bp) and Gruger (1972b: 2732) argued that a pine-oak forest existed within close proximity to the ice margin. Subsequent work by King (1981) extended the vegetation history of Illinois into the late Holocene. In the early segment of King's sample, spruce was the dominant arboreal pollen, in terms of both percentage and rate of influx. Oak had a low influx rate, suggesting long-distance transport of pollen (King 1981: 53). By 11,000 - 8000 bp, an oak-dominated deciduous forest had become established. King (1981: 57) interpretted an abrupt increase in non-arboreal pollen (especially Ambrosia) after this date as being indicative of the formation of prairie communities in upland areas. These prairies remained in place until historic times.

The Old Field Swamp in southeastern Missouri provided a vegetation record from c. 9000 - 3000 bp (King and Allen 1977). The basal zone, dominated by oak and other deciduous arboreal pollen with a high proportion of grass pollen, was interpretted as "a mixture of oak forest on the dry valley terrain and the Ozark uplands, canebrakes on the wet surfaces just above the high water level, and swamp in the lowest topographic areas." (King and Allen 1977: 317). In the zone above this, arboreal pollen declined significantly as grass, ambrosia, chenopodium, and pine and juniper increased to a maximum at c. 7000 bp. There followed a return to higher percentages of arboreal pollen (especially oak) and a decline in the percentage of grass pollen. King and Allen (1977: 314) suggested that these trends reflect changes in the groundwater reservoir in the lowlands as a response to precipitation changes throughout the midcontinent.

The vegetation history suggested by these studies have been confirmed by analyses of general paleoenvironmental trends in eastern North America (e.g. Bernabo and Webb 1977; Watt 1980; Wendland and Bryson 1974). Of special interest to analyses of the Archaic is the increase in the proportion of xeric species between c. 8000 - 5000 years ago. In Illinois (King 1981) and southeastern Missouri (King and Allen 1977) this was a time of grassland expansion. Evidence from Tennessee indicates that, while grasslands did not become prominent, a mosaic of oak-hickory forests and prairies did supplant mesic hardwood forests (Delcourt 1978, 1979). This Hypsithermal Interval (Wright 1976) was most pronounced in the Mid-West.

The effects of the Hypsithermal Interval (Wright 1976) on the vegetation of the lower Cumberland and Tennessee drainages is not clear. As Leach (1981:17) observed, because these rivers drain northward from the southeastern United States, the effects on the water levels may have been minimal. It is possible, as Delcourt (1978, 1979) found, that there may have been restrictions of mesic species to sites near sources of locally available water.

Distribution of Resource Availability

The resources that were important to the Archaic foragers of the study area can be subsumed under four categories: water, lithic material, plants, and animals. Table 3 summarizes the spatial and seasonal distribution of each category. Water is found in

Table 8. Spatial and seasonal distribution of resources.

Resource	Distribution
water	well distributed; annual flooding, especially of large streams and rivers.
lithic material	Mississippian limestones and Lafayette Gravels (Continental Deposits) provide sources of a variety of cherts; outcrops occur throughout the study area.
botanical	nut-, acorn-, and fruit-bearing species occur throughout the area, but are only available seasonally; more nut- and acorn-bearing species occur away from river edges.
fauna	potential food species occur thorughout the area; amphibians, reptiles, migratory birds are available seasonally; large river resources available seasonally due to flooding; backwater species of fish increase during flooding; deer probably do not yard.

abundance throughout the area, although spring flooding increases the turbidity of the rivers and the lowermost sections of streams. Chert is found in most of the Mississippian limestone formations and is an important constituent of Lafayette Gravels. Recent alteration of the river stages may have obscured many bedrock outcrops that were prehistorically important. Because such outcrops do not occur randomly or evenly throughout the area, lithic material can be considered as a stable resource with a clumped distribution.

The seasonal availability of some economically important plants is discussed in Appendix A. This list is biased toward fruit and nut producing species. Other plants which were consumed or used for other purposes may also have influenced the selection of site locations. It is also important to note that an abundance of certain plants may attract a variety of animals. Acorns, for example, are important food for many animals (Cushwa et al. 1970; Hosley 1956; Goodrum et al. 1971; Stafford and Dimmick 1979). On the other hand, Short and Epps (1976: 289) suggested that, except for rodents, most animals are incapable of "cutting the thick and tough shells of hickories and black walnuts." Acorns and nuts are accessible on the ground for several months after they fall and become unpalatable only after they have sprouted. Although mast yields vary from year to year, the presence of a variety of species reduces the effects of this periodicity as small yields of one species are balanced by large yields of another species (Goodrum et al. 1971: 525). However, this balance is achieved only if producing and non-producing trees occur in an even ratio.

Faunal resources are variable in their distribution and availability (Appendix B). Mammals are, generally, evenly distributed throughout the area and only chipmunks and groundhogs are seasonally inactive. Shrews, chipmunks, squirrels, rats, mice, and voles all have relatively small territories (c. 0.5 ha) which may overlap. These animals are, therefore, somewhat clumped. Deer become clumped when they yard in the winter. The climate in Kentucky, however, is rarely severe enough to precipitate this behaviour.

Amphibians and reptiles do not occur in socially coherent groups. However, their lack of territoriality and preference for specific habitats can result in their co-occurrence in significant numbers. In addition, because they are cold-blooded, they hibernate during the coldest months and are unavailable for capture. These animals are, therefore, clumped spatially and seasonally, but represent a predictable resource.

Fish may also be considered a clumped resource. Although few species migrate, most become relatively inactive during the winter. River floods from January to May would have rendered deep channel species inaccessible, while increasing the number and variety of fish found in backwater lakes. Thus, the availability of fish can be viewed as clumped and unpredictable.

Waterfowl must be considered a clumped and unpredictable resource. Few species inhabit the area year-round, and only a few winter there. Most of those observed pass through on an annual migration (Bellrose 1968). Parr et al. (1979) found wood ducks to be highly selective in their choice of roosts and habitat utilization, preferring buttonbush swamp. If such selectivity is common in waterfowl, they can be considered to be clumped and unpredictable in terms of spatial distribution as well as season of their availability.

The period from January to May is a time of relatively dispersed resources. This corresponds to the winter and spring, during which floodwaters periodically render the river floodplains uninhabitable. A second period, from May to August, reflects the recedence of the floodwaters and the increased availability of fish in main channels and backwater sloughs. Finally, the production of acorns, nuts, and fruits between August and December results in a great abundance of food resources during this period. The attraction of numerous animals to areas of dense concentrations of nuts and acorns would have accentuated this clumped distribution.

CHAPTER VI

TYPOLOGY

The typology developed for the analysis of lithic artifacts examined in this study has been constructed to serve two purposes. The first, is to permit the analysis and comparison of the structure of each assemblage, and the second is to permit the analysis and comparison of the technological organization. Thus, the analysis must proceed simultaneously from two different perspectives. On the one hand, analysis of assemblage structure requires the development of a method of data-ordering which will lead to meaningful comparisons of assemblages. On the other hand, the analysis of technological organization requires a generalized model of stone tool production which provides information about the culture of the people who made the stone tools.

The data-structuring approach employed in this study is a paradigmatic classification (Dunnell 1971; Whallon 1972). The system has been designed to accomodate all possible combinations of technological and activity-related variables and to insure the consideration of the widest possible range of variation between assemblages. This approach is required, in part, by the very large size of the collections. It is expected that the range of variation in larger collections will be greater than in small assemblages. Since all of the possible combinations of attributes cannot be anticipated before hand, simplified analytical systems may inhibit a complete analysis of the entire range of variation.

The system used here is based upon flow-diagram models of lithic reduction (Collins 1975; Boisvert et al. 1979). Similar models have been used elsewhere (e.g. Morrow 1981) as data-ordering devices, without deriving processual inferences. The general model of lithic reduction includes five steps (Collins 1975: 17): acquistion of raw material; core preparation and initial reduction; optional primary trimming; optional secondary trimming and shaping; and optional maintenance/modification. Each stage yields output (both objects destined for further modification or use and waste material) which is characterized by identifiable associations of attributes.

In the present study, emphasis is placed on the use of various chert types, the products and by-products of the technology, and a general consideration of the activities for which the tools may have been used. Archaeological and ethnoarchaeological studies of stone tool manufacture and use indicate that some variables are important in the examination of differences between assemblages. The following discussion outlines the attributes considered important in this analysis. This is followed by a description of the types whose definitions are based upon association of various attributes.

Raw Material

Two features of raw material exert important influences on the composition of stone tool assemblages. The first is the size and shape of the naturally occurring material. Because the manufacture of stone tools is a subtractive process (Muto 1971; Collins 1975), the size of the initial pieces constrains the size and form of the final product. In addition, differences in the shape of the raw material may require different techniques of reduction to arrive at similar forms of finished artifacts. For example, chert which occurs as large, angular blocks may require different approaches to lithic reduction than chert which is found as small or medium-sized stream-rolled cobbles.

Variations in the physical properties of different types of raw material may also affect the composition of archaeological assemblages, since flake removal is more easily accomplished on some types of lithic material than on others. This is especially evident in categories such as bifaces and hafted bifaces which require the well-controlled removal of a relatively large number of flakes. Material variations may limit the successful removal of desired flake forms, thereby restricting the intermediary and final forms of various tools. In addition, the physical properties of a material determines the rate of edge attrition (Greiser and Sheets 1979; Gould and Saggers 1985). This may have influenced prehistoric tool users in their decisions to manufacture tools of specific forms (such as buttressed edges on brittle materials) or to use specific materials for certain tasks (as reflected in correlations between tool types and material types; e.g. R.C. Chapman 1977; Reher and Frison 1980; Frison and Bradley 1980).

The attributes of raw material selected to examine these sources of variation are: the types of chert present in each assemblage; and the types of cortex found on these chert types. States of the type of material include the number of items, their weight, and the artifact classes in which they occur. The cortex is classified as either weathered (indicating residuum or outcrop source) or as water-rolled (suggesting that the material was recovered from a stream bed or gravel bar).

Technology

Technological variations between assemblages can occur in two ways. First, there may be differences in the quantity of output from the lithic reduction sequence. This is most easily determined when all aspects of the manufacturing system are present. However, even when all aspects are not present it is possible to infer if sites were the loci of many stages or only a few. Second, the use of specialized techniques to reduce raw material and to form functional tools also affects the composition of archaeological assemblages. For example, a developed blade and core industry will yield tools and debitage that are quite different from an industry in which the production of random flakes predominates. Similarly, variations in the form of such tools as bifaces and hafted bifaces may be a function of the manufacturing techniques available to the producers of those artifacts.

A large number of attributes are involved in the examination of technological variations. Those reflecting initial stages of reduction include indications of core preparation and flake removal and the presence of cortical flakes. Subsequent reduction stages are indicated by the production of flakes of various sizes and unifacial and bifacial alteration of the artifacts. Biface manufacture is also indicated by the presence of biface thinning flakes. The attributes associated with each of the various classes are presented in the definitions provided in the following section. In most instances, definitions are derived from the presence or absence of a given attribute on a specimen. Those related to biface thinning flakes include platform angle and maximum flake length.

Activities

The intended utilitarian (cf. Sackett 1982) use of tools may have a significant bearing on tool forms. Any tool, if it is to be useful, must incorporate three elements in its design (Bordes 1969; Pye 1964). First, it must possess an edge or surface which is of suitable shape for successfully achieving the desired result. Second, this edge must be strong enough to "transmit forces as the intended result requires." (Pye 1964: 21). Third, the user must have access to the tool through some means of prehension. This prehension can be achieved either through a simple modification of a flake (e.g. backing), the manufacture of composite tools with separate hafting elements, or through the initial selection of flakes which do not require such manufacture. The intended use places important constraints on the form of any given tool.

The first two elements are reflected in the configurations of the working edges. Thus, the outline of the specimen provides the primary attribute for analysis. Variations of these attributes include straight, incurvate, and excurvate outlines as well as the presence of projections. These are then combined with indications of the relative amounts of buttressing which may have been added to strengthen the working edge. Thus, for example, steeply retouched flakes (buttressed edges of any shape) can be differentiated from notches (concave, unbuttressed edges).

Elements of prehension are restricted to those which indicate the use of a hafting element. Generally, this involved the production of a stem or bilateral notches on a relatively large item (usually a biface). The nature of the hafting segment (e.g. stem or notches) has important implications regarding the age or cultural association of the item.

Types Defined in this Study

The preceding discussion outlined the factors which contribute to interassemblage variability and enumerated those attributes which, it was felt, could be examined most profitably for the effects of variations in each of these factors. The non-random association of these attributes combine to form types which can be identified within the artifact assemblages examined in this study. Each of these types are defined below and reflect the actual occurrence of attribute sets in the assemblages. Many of the names used to distinguish these types reflect ad hoc combinations of functional, technological, and formal assumptions about the tools and, it may seem, are misleading and ambiguous. These names are retained here, however, because they pervade the archaeological literature of eastern North America and, therefore, facilitate comparisons with other assemblages. It should be emphasized, however, that specific functional assumptions have not been made regarding any of these artifacts.

Heavy, Retouched Objects. These include large flakes and cobbles which have had one or more edges modified by the systematic removal of a series of flakes. Flaking may be unifacial or bifacial. Elsewhere (e.g. Chapman 1975: 157) it has been suggested that similar objects functioned as choppers or scrapers. They may also represent material that was discarded after preliminary flaking revealed it to be unsatisfactory for further reduction.

Cores. Crabtree (1972: 54) defined cores as "Piece(s) of isotropic material bearing negative flake scar or scars." Here, the defining characteristics include the presence of a platform and evidence of the removal of a flake, or series of flakes, from that platform. Cores were not further separated into morphological or technological varieties. It is also important to note that none of the cores examined exhibited macroscopic evidence of use as a tool (cf. Crabtree 1973).

Angular fragments. Angular fragments are amorphous pieces of lithic material and exhibit neither platforms, the systematic removal of flakes, nor extensive areas of cortex. Where such objects are made of chert, the possibility exists that they have been naturally eroded from the underlying chert-bearing limestones. Alternatively, they may be items whose natural fracture planes rendered them useless for flake removal. In this study, the presence of angular fragments on archaeological sites is assumed to have been the result of cultural processes.

Artifacts in these categories represent the by-products of the initial stages of lithic reduction (Collins 1975: 20-21). They do not, however, indicate if the raw material was procured at the site or was transported from a distant source. Nor do they reveal if all of the core reduction was done at one locality. Such information is more profitably obtained through an analysis of other classes of lithic debitage.

Unretouched Flakes

Cortical Flakes. Items assigned to this category include all flakes with 50 per cent or more of their dorsal surface covered by cortex, but which did not exhibit evidence of retouch. The bulb of percussion and platform need not be present. Two types of cortex were identified. One is smooth, with pitting and abrasion as a result of stream rolling. The second type of cortex represents weathering within the soil deposits. This distinction between cortex types is important in the analysis of lithic material use within each assemblage.

When they comprise a large proportion of a lithic assemblage, cortical flakes represent the discarded products of the early stages of lithic reduction. It is not clear, however, if their occurrence in smaller numbers is similarly indicative of a specific reduction stage. Conceivably, such flakes may have been produced at later stages of tool manufacture as remnant areas of cortex were removed.

Bifacial Thinning Flakes. These flakes are:

> characterized by marginal areas of applied force, thin and slightly curved longitudinal cross sections, parallel to convergent unidirectional or bidirectional flake scars, and medium flake scar counts (5 to 7). Cortex may or may not be present. (Frison and Bradley 1980: 24)

The platform, when present, may exhibit pronounced lipping and cluttered facets which "are the result of the removal of previous flakes from the face of the biface opposite that from which the flake under examination was detached." (Ellis 1979: 37).

The distinctive forms of these flakes suggests that they were specially produced and are indicative of certain stages of lithic reduction. That is, as the name suggests, they were produced during the manufacture or repair of bifaces. Although several varieties of bifacial thinning and resharpening flakes have been defined elsewhere (Ellis 1979) no such distinctions are made in this study. It was felt that such identifications are most profitably done within the context of comparative replicative experiments.

Microblades. These are diminutive forms of blades. A blade was defined by Crabtree (1972: 42) as a:

> specialized flake with parallel or subparallel lateral edges; the length being equal to, or more than, twice the width. Cross sections are plano-convex, triangulate, sub-triangulate, rectangulate, trapezoidal. Some have more than two crests or ridges.

Taylor (1962) restricted microblades to those forms 2.0 mm or less in width. These formally distinctive flakes are included in a separate category because they are frequently associated with a specialized production technique. Luke (1982), however, found that such flakes were consistently, but fortuitously, produced in small numbers during biface manufacture. None of the members of this category exhibited marginal retouch.

Secondary Flakes. All flakes not subsumed under the above categories are described as secondary flakes. Platforms may or may not be present and a wide variety of formal variation exists among these flakes. No marginal retouch was observed on these artifacts. Only a limited amount of cultural inference can be derived from this category, as they represent the discarded waste from a number of stages of lithic reduction.

Marginally Retouched Flakes

Gravers. Gravers are defined by the presence of "one or more spurs formed by localized retouch" (Chapman 1975: 139). These spurs may be lightly or heavily polished or may exhibit no polish at all. Gravers occur on both cortical and secondary flakes and are not resticted to specific marginal locations.

Perforators. Chapman (1975: 139) observed that perforators are distinguished by "a single projection exhibiting retouch." The projections differ from graver spurs in that they are longer and more slender and are formed by more extensive retouch. Such retouch occurs on flakes of all sizes and shapes.

Notches. Notches are narrow, deep concavities produced by the removal of a single retouching flake. Additional retouch may or may not be present on the interior of these concavities. The occurrence of a series of notches adjacent to one another has been identified as a denticulate (Chapman 1975: 141). No such distinction is made in this study. Notches occur on various types and forms of flakes.

Retouched and Utilized Flakes. Retouch on these flakes is acute (less than 50)(Movius et al. 1968: figure 6) and is not restricted to any specific area. While the functions of these ubiquitous artifacts is unclear, they apparently served different purposes than steeply retouched flakes (Gould et al. 1971; Wilmsen 1970; Tainter 1979).

Steeply Retouched Flakes. Retouch on these specimens is confined to the dorsal surface and forms a medium (50 - 75) or steep (75 - 80) angle (Movius et al. 1968: figure 6) with the ventral surface. Additional retouch, extending along one or both lateral margins, may be acute (less than 50), medium, or steep. less than 50), medium (50 - 75), or steep (75 - 85).

Bifacial Artifacts

Complete Bifaces. Bifaces are defined as artifacts which exhibit extensive flaking on both the dorsal and the ventral surfaces, but which have not been altered to other specific tool forms. Complete bifaces refer to all such artifacts which have not been broken while being manufactured or used. A number of researchers (e.g. Callahan 1979; Crabtree 1972) have identified different forms produced during various stages of manufacture. A useful identification of such stages is best accomplished when the range of forms produced at each stage is represented by a number of items. The small sample of bifaces present in the assemblages considered here precluded the identification of specific biface reduction stages. Consequently, formal variation was not included as an important variable of this category.

Bifaces Broken in Manufacture. This category includes all bifaces which were broken at some stage of their manufacture. A number of manufacturing failures have been identified by Johnson (1979, 1981), Rondeau (1981), Crabtree (1972), Callahan (1979), among others. The identification of these fracture types on specimens indicates that biface manufacturing was active at the site where the artifacts were found.

Bifaces Broken in Use. The bifaces broken in use may also exhibit distinctive fracture types. Impact fractures are distinguished by flake scars which originate at the distal end (or tip) of the biface (Bradley 1974: 174). Such fractures accompany use of the implement as a projectile. The use of a biface as a cutting tool may also fracture the specimen. Characteristics of these breaks are crushed edges adjacent to the fracture and distinctive fracture profiles.

Complete Hafted Bifaces. Hafted bifaces represent distinctive forms of bifaces. All represent the final stage of biface manufacture and exhibit characteristic basal modifications which may be related to the hafting of the object to a shaft or handle. Variations in the form of the hafting element have been successfully used as spatio-temporal indices of culture change. A recent analysis by Weissner (1983) has pointed out the importance of form as a mechanism for displaying social identity among contemporary !San bushmen. The application of such analysis to prehistoric situations has not, however, been established. Therefore, attributes other than those which are definitive for the class were not recorded.

Hafted Bifaces Broken in Manufacture. Attributes which define this class include those which define complete hafted bifaces and the varieties of fractures found among bifaces broken in manufacture. The presence of these artifacts indicates that hafted bifaces were being made or resharpened at the site where they were found.

Hafted Bifaces Broken in Use. These artifacts exhibit the defining attributes of hafted bifaces and the fracture patterns outlined in the discussion of bifaces broken in use. The occurrence of such hafted bifaces does not indicate their use at the site where they were found. Such items with impact fractures may have been brought in with procured game or retrieved for future repair. Their use, therefore, would have been at localities quite different from where they were found.

Complete Drills. Drills include bifaces whose shafts are narrow and rod-like with a rhomboid cross section. The basal shapes may vary from straight to side- or corner-notched and are not diagnostic attributes. Although this name has distinct functional implications, it is not assumed that these artifacts were used for drilling. The distinctive blade form does, however, suggest that these tools had a rather specific purpose.

Drills Broken in Manufacture. These include items which conform to the definition of a drill but which exhibit fractures distinctive of biface manufacture. Their presence indicates the probable use of the site as a locality for drill manufacture.

Drills Broken in Use. These include items which conform to the definition of a drill but which exhibit fractures distinctive of bifaces broken in use. The narrow blade or shaft of these specimens renders the identification of use fractures very difficult. It is possible, therefore, that the number of items in this category has been underestimated.

Reworked, Hafted Bifaces. These items are bifaces with a well-defined haft area and a steeply (75 - 85) retouched distal end. The haft area may be side- or corner-notched and has led some authors to suggest that these tools were made from broken projectile points/knives (Lewis and Lewis 1961: 49). While this may be true, the absence of intermediary forms precludes this assumption. Therefore, they are considered to be a distinct category.

Groundstone

Atlatl Weights. These objects have been heavily ground and polished to form highly stylized forms. They are characterized by a drilled hole running transversely through the center. Webb (1981) suggested that they served as counterweights in an atlatl projectile system. They have frequently been found in association with bone hooks which may also have been a component of that system (Webb 1974; Lewis and Lewis 1961).

Heavy Groundstone Implements. These include large stones with at least one highly striated and/or polished surface. All of these objects are so heavy that they would not have been very portable for pedestrian hunter-gatherers. Other researchers (e.g. Chapman 1975; Lewis and Lewis 1961) have identified such items as mortars. As such, they may have functioned in the processing of plant material. In this study, mortars and pestles have been defined on the basis of the location and extent of grinding and polishing.

Pecked and Battered Cobbles

Battered Cobbles. Within this category are all cobbles and cobble fragments which exhibit one or more areas of intensive pecking. The concentrated nature of these pecked areas distinguish these artifacts from river-rolled cobbles. These artifacts may have served several purposes in the manufacture of stone tools, or may have been used to crush nuts, seeds, and other plant remains.

Pitted Cobbles. This category includes all cobbles or cobble fragments with one or more pitted areas on one or more surfaces. Neither the shape of the cobble nor the location and number of depressions were included as defining criteria. Although these artifacts have frequently been termed "nutting stones" (Lewis and Lewis 1961) there is no evidence to suggest that they were used to process plant food. Chapman (1975: 162-165) suggested that they were multi-purpose tools, serving as a pitted anvil or hammerstone as well as a nutting stone.

Ground Cannel Coal

Cannel coal is a bituminous coal which occurs naturally in the study area. Pieces of this material noted in the archaeological assemblages are all relatively thin and have been extensively ground around the periphery. They may have been ornaments, or have served a more utilitarian purpose.

Ferrogenous Concretions

These spherical concretions are made from a material with a very high iron content. The pieces are all hollow and cup-like. Some appear to be stained with red ochre, suggesting that they were used as small mortars.

Lithic Material Types

As noted above, the selective use of various types of raw materials is considered to have been an important contributary factor to the variation between assemblages. The lithic material types identified in this study includes quartzite, sandstone, and a number of varieties of chert. Quartzite occurs primarily as waterworn cobbles in the Cumberland and Tennessee rivers and their tributaries. Sandstone, while also often occurring in the major streams, forms a major constituent of a number of local geologic formations. Chert occurs in a number of forms and was used to manufacture the majority of artifacts in the assemblages. Further discussion of the identification of chert varieties is therefore warranted.

The study of the occurrence and availability of chert in the lower drainages of the Cumberland and Tennessee Rivers valleys has been undertaken by Tom Gatus (1979, 1980, 1984; see also Nance 1980, 1984). Utilizing 7.5 minute geological quadrangle maps published by the United States Geological Survey, Gatus initially identified the distribution of chert-bearing geological units in the study area. Subsequent field investigations in 1978 and 1980 were directed toward the collection of representative samples from each of these units and an assessment the tractability of the material. This has resulted in the formation of a comprehensive reference collection of cherts found in the area. The types within this collection have been named according to their geologic formation rather than by their colour (e.g., blue-banded chert). Definitions of these cherts are provided Appendix C.

It is to be expected that not all of the lithic material found within the assemblages will be of local origin. In anticipation of this eventuality, the basic collection provided by Gatus has been augmented with specimens from southern Illinois and northwestern Tennessee. The former includes Burlington chert and Tamms Till. The sample from Tennessee is from the Dover quarry. Rigorous definitions of these materials have not been provided. Instead, the identifications were accomplished solely through a visual comparison of the artifacts and specimens from the reference collection. It is noteworthy that the Dover chert closely resembles chert from the lower St. Louis/Salem member.

One type of material which occurs in a number of assemblages has been termed an "unidentified conglomerate." This is a "metamorphosed macrocrystalline conglomerate of angular and rounded pebbles of quartz and quartzite less than 3 mm in size, set in a fine-grained grey or bluish-grey matrix" (Nance 1981: 15). The source of this material is, at present, not known and it therefore remains "unidentified."

Chapter Summary

The variables considered most important in this study are the types of raw material from which the artifacts were made, the technology used to produce them, and their intended utilitarian purpose. The size, shape and physical properties of the raw material may require that different reduction techniques be required. Technological variations in stone tool production may result in differences in the quantity of output and the form of items within an assemblage. The intended utilitarian use of an object requires the articulation of a suitably formed edge which is strong enough to transmit the required force with an appropriate method of prehension. The inclusion of edge configuration and edge angles as important defining criteria enables a consideration of the broad range of activities undertaken at a site.

CHAPTER VII

SITE DESCRIPTIONS

This chapter provides descriptions of the physical setting, geomorphology (when available), and age of each assemblage of lithic artifacts considered in this study. In addition, the recovery strategies employed at each site will be summarized. Each of these are important variables which may affect differences between assemblage composition. The physical setting and geomorphology of a site will provide a means of relating different assemblages to the local availability of resources which may have been critical to Archaic period hunter-gatherers. A knowledge of the age of the assemblages enables one to assess the influence of diachronic culture change. Differences in tool forms (and the frequencies with which various forms occur) may be expected to vary through time, contributing to differences in assemblage structures. Finally, different recovery strategies may favour different classes of artifacts. The use of fine-mesh screens, for example, may bias an assemblage in favour of smaller tools.

Fifteen assemblages from six sites comprise the samples. These include 10 assemblages from the Morrisroe site, and one assemblage from each of the Trail site, 15Tr50, 15Tr53, 15Tr56, and 40Sw74 (Figure 6). While only the Morrisroe site has been radiocarbon dated, the projectile points from the other sites provide an adequate means of estimating the ages (i.e., Early, Middle or Late Archaic) of the other assemblages.

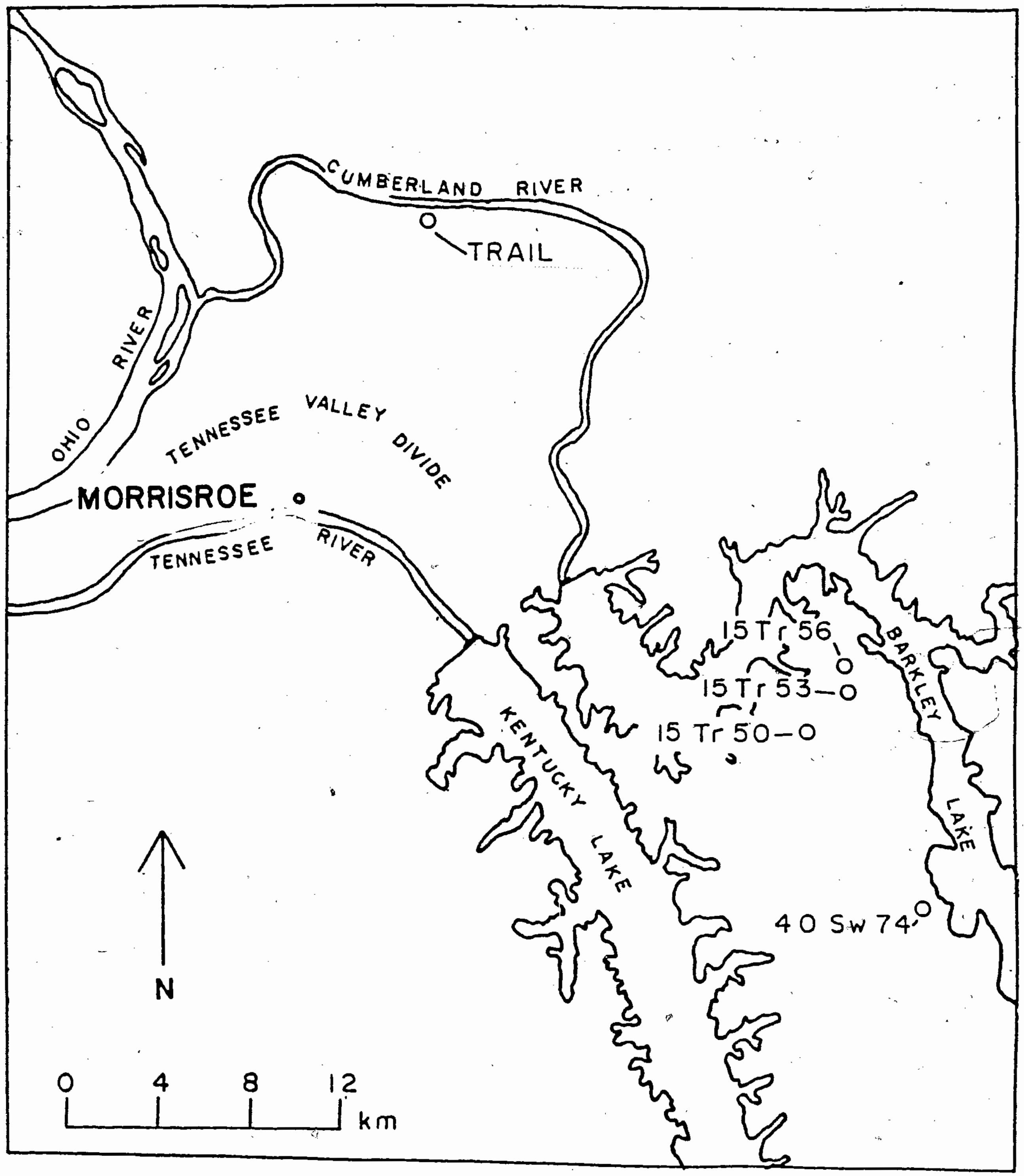


Figure 6. Sites considered in this study.

The Morrisroe Site

Location and Setting. The Morrisroe site lies on the north bank of the Tennessee River in Livingston County, Kentucky. It is approximately 21 km upstream from the mouth of the Tennessee River and 14 km downstream from Kentucky Dam (Figure 7). The confluence of the Lee Creek and the Tennessee River lies 300-400 m upstream from the site. The cultural deposits are over two metres in depth and extend about 120 m east to west, roughly parallel to the river. Other reports on the site are found in Nance (1981), Nance and Conaty (1982) and Conaty and Nance (1983).

This location is at the extreme western edge of a geologic transition between the Mississippian Plateau (east of the Cumberland River) and the northernmost extension of the Gulf Embayment (west of the Tennessee River). The site deposit itself is a floodplain deposit with particle sizes that are consistently within the 7-8 phi range (Nance 1981). The site was apparently not situated on the river bank at the time of occupation, but rather was some distance away from the river (no more than c. 250 m) (Leach 1981:35; 1985).

Field Procedure. Test excavation of the site was initiated in 1980 and completed in 1982. The 1980 field investigations began by locating two 2x2 m units in an area in which the midden deposit was judged to be best represented. The density of the midden exposed in the cutbank and the former presence of human

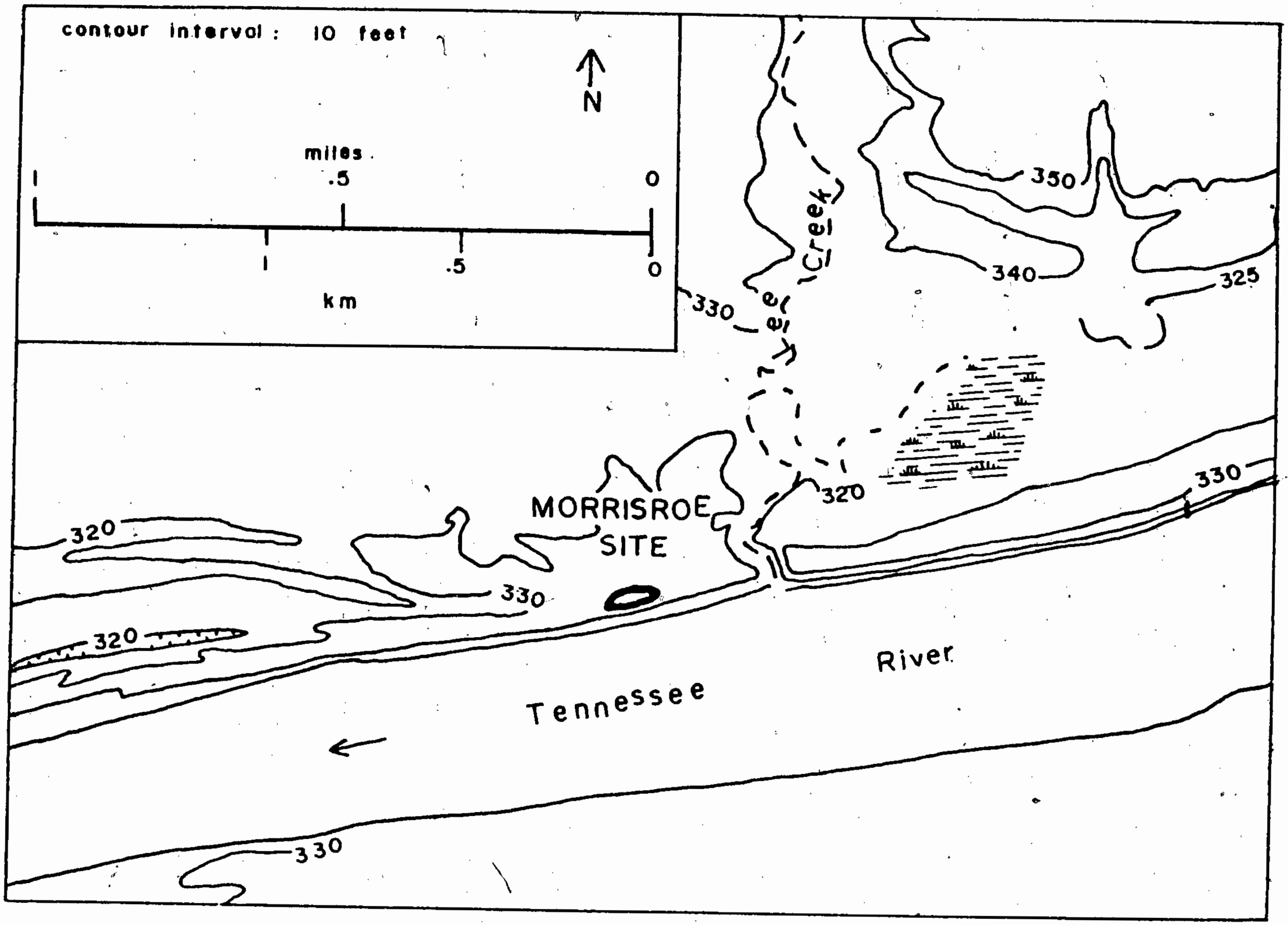


Figure 7. Location of the Morrisroe Site.

burials eroding from the exposure were important factors in evaluating where to place these initial test units. These units were excavated in arbitrary levels (generally 20 cm thick), and a dual recovery strategem was employed. Each arbitrary level was excavated by quadrants: nw, sw, se, ne. In each level a bulk sample of varying volume (depending upon the density of cultural material, but usually 50 cm x 50 cm x 10 cm) was recovered from a selected quadrant. These bulk samples were transported to the field camp where they were water-screened through 1/8 inch mesh. The recovered fraction was then returned to Simon Fraser University for sorting and cataloguing. The botanical remains from alternate levels of both units have been identified by the Ohio State University Ethnobotanical Laboratory (Wymer and Cowan 1982). All other material was passed through a 1/4 inch mesh screen.

Although most of the arbitrary excavation levels were 20 cm thick, a number of exceptions occurred. The first level in unit I, for example, measured only 10 cm thick. This was the first level excavated at the site and therefore represents initial explorations regarding the nature of the deposits. Very little cultural material was recovered from this level and the sediments proved very difficult to excavate and screen. Consequently, the thickness of the levels was increased to 20 cm to ensure that adequate time would be provided for the complete excavation of units I and II.

The excavation of unit II involved a more complex approach. The initial levels (1 and 2) were removed in arbitrary 20 cm thicknesses. At the bottom of the second level the sediments apppeared to become differentiated in colour. Thus, an attempt was made to excavate following the natural/cultural layers of the deposit. This effort proved futile as it became apparent that colour changes represented various mottlings of a sedimentologically homogeneous midden deposit. This excavation strategy was abandoned after approximately 30 cm had been removed and the levels were designated 3i, 3ii, and 3iii.

Between 1980 and 1982 a rotated slump block removed a major section of the densest midden area of the site. The 1982 efforts, therefore, were concentrated in the remaining areas. An initial test unit revealed that over one metre of virtually sterile clay lay above any cultural remains. To expedite the recovery of as much cultural material as possible, a probing program was undertaken. The results yielded subsurface contour maps of each midden horizon. Subsequently, two 2x2 m test units were excavated where these deposits were closest to the surface.

The excavation strategy remained much the same as it had been in 1980. Each unit was excavated in arbitrary levels (10 cm thick), one quadrant at a time. A standardized portion of either the northwest or the northeast quadrant (depending upon the unit) was removed as a bulk sample. This bulk sample was water-screened through a series of 0.5 mm, 1.0 mm, and 5.6 mm mesh screens. The recovered material was then dried and transported to Simon Fraser University where it has been sorted and catalogued. The non-bulk sample was, once more, passed through a 1/4 inch mesh.

Archaeostratigraphy. Four zones were identified on the basis of the colour of the sediments and the density of cultural material, and does not represent separate, distinct occupations. Rather, they provide a means of grouping excavation levels to provide larger samples of some artifact categories. These zones grade into one another and are not as clearly defined as the drawing suggests. The deposits excavated in 1982 revealed a similar profile, but with a thinner cultural deposit and a lighter zone between two dark midden zones. The intact (uneroded) deposits at Morrisroe are undisturbed, except for minor root intrusions.

In general, the deposit grades downwards from light yellowish brown sediments with an apparently low organic content and moderate density of cultural material (Zone I), to a greyish brown sediment with a higher organic content and higher cultural item density (Zone II), then to a dark brown sediment with a high organic content, many large rocks, and very dense cultural material (Zone III). The lowermost deposit (Zone IV) is a light yellowish brown sediment with less organic staining, fewer rocks, and less dense cultural material than the overlying zones. Approximate correlations of arbitrary excavation levels within these zones suggests that the earlier and densest concentration of material is associated with Zone III and the upper part of Zone IV. Zones I and II represent less dense and later occupations. No sterile bands indicating long-term site abandonment have been recognized.

A comparison of the particle size analysis (Leach 1981) of the sediments from units I and II suggests that the uppermost deposits have been eroded at different rates in each of these areas. As a result, the top levels in unit II do not correspond to the top levels in unit I. Rather, a correlation of particle sizes (Nance 1981) indicates that level 1 of unit II is equivalent to level 3 of unit I. Table 4 illustrates the relationship of the arbitrary excavation levels in each of these two units.

<u>Age</u>. Five charcoal samples from the Morrisroe site were submitted for radiocarbon assay. Three of these were from unit II and one was from unit I. The fifth sample was taken from the cutbank near unit II, about one metre below the surface.

The cultural affiliations of the assemblages from the various zones at the Morrisroe site can be determined by an examination of the vertical distribution of hafted bifaces. Table 5 presents the distribution of points in the arbitrary excavation levels in units I and II.

An examination of these data reveal several trends. First, Kirk Stemmed forms, although rare (n=4), occurred in the lowest levels of both units. This stratigraphic position reconfirms their early age.

Table 4. Correlation of excavation levels at the Morrisroe site.

UNIT I	UNIT II	ASSEMBLAGE
Surface		A
Level 1		
Level 2		
Level 3		B
Level 4		C
Level 5	Level 1	D
	Levels 2-3i	
Level 6	Levels 3ii-3iii	E
Level 7	Level 4	F
Level 8	Level 5	G
Level 9	Level 6	H
Level 10	Level 7	I
Level 11	Level 8	J
Level 12	Level 9	
Level 13	Level 10	

Table 5. Age of Hafted Bifaces from the Morrisroe Site.

Assemblage	Type	n	Estimated Age
A	Matanzas (?)	1	Late Archaic
	Ledbetter	1	Late Archaic
	Straight, broad stemmed	1	Late Archaic (?)
B	Kays (?)	3	late Middle Archaic
C	Eva II	1	Middle Archaic
D	Straight, broad stemmed	1	Late Archaic (?)
E	Eva II	2	Middle Archaic
	Straight, broad stemmed	1	Late Archaic (?)
	Matazanas (?)	1	Late Archaic
F	Straight, broad stemmed	1	Late Archaic (?)
	Side-notched	1	?
	Eva II	3	Middle Archaic
	Morrow Mountain II	2	Middle Archaic
	Morrow Mountain I	2	Middle Archaic
	Kirk Stemmed	2	Middle Archaic
G	Eva II	2	Middle Archaic
	Morrow Mountain I	1	Middle Archaic
	Morrow Mountain II	1	Middle Archaic
	Kirk Corner-Notched	7	Middle Archaic
	Kirk Stemmed	2	Middle Archaic
H	Kirk Corner-Notched	2	Middle Archaic
	Kirk Stemmed	2	Middle Archaic
I	Kirk Corner-Notched	2	Middle Archaic
J	Eva II	1	Middle Archaic
	Kirk Stemmed	2	Middle Archaic

Second, of the 45 hafted bifaces assignable to known types. Cypress Creek I and Eva II types predominate. These constitute 43.2% and 24.4%, respectively, of the types of known culture-historical significance. It may be noted that Cypress Creek I points occur deeper, on average, than the Eva II points. Therefore, these levels have been defined as a Cypress Creek I occupation of early Middle Archaic age. The levels above this have been defined as an Eva II occupation of Middle Archaic age. Morrow Mountain I forms are infrequent and co-occur with Eva II types.

Third, the Matanzas, Kays, and Ledbetter styles - that is, the later types - occur in the upper levels of unit I and are absent in unit II. This absence may be a result of the erosion of most of the upper levels of unit II. It is also important to note that the small numbers of these points that were recovered renders their identification tenuous.

Artifact Assemblages. The foregoing analysis suggests two methods of determining meaningful assemblages. On the one hand, all of the material in each of the archaeostratigraphic zones can be combined to form four separate assemblages. Alternatively, the items from each excavation level may be considered as a distinct assemblage. Each approach has advantages and disadvantages.

The four zones, which were defined on the basis of sediment colour and the density of cultural material, appear to represent separate cultural periods. The vertical distribution of hafted biface styles supports this interpretation. Therefore, an examination of long-term culture change may be undertaken by considering each zone as representative of a particular culture-historic period. However, the relatively long time span represented by each zone (zone II, for example, represents over 1,000 years of sediment accumulation) also presents important reasons for defining assemblages in terms of smaller units.

First, the length of time represented in each zone renders comparisons with smaller sites difficult. It may be expected that localities which have been occupied, either continuously or intermittently, for long periods will have larger assemblages of occupational debris than localities which have been occupied for shorter periods. As a result, it will be difficult to distinguish between variability due to cultural factors and those which arise as a result of unequal sample sizes. Second, the long time periods represented by the four zones at the Morrisroe site may mask variations in the depositional rate of artifacts. In zone II, for example, such differences may be very pronounced beween the upper and the lower levels. Such variations, which may have important cultural implications, would go unnoticed if all of zone II were considered as a single unit.

Third, the variability in the types of artifacts present, as well as the implied differences in activities, may be obscured when many levels are grouped together. In effect, one is "averaging" the activities which took place over the entire span of deposition of a given zone. For example, grinding stones may be numerous near the bottom of zone II, but rare in the upper levels. Such information would be lost if all of zone II were considered as a single assemblage.

The definition of assemblages on the basis of cultural material recovered from excavation levels results in smaller samples of artifacts. Comparisons with other assemblages may, therefore, be more meaningful as the time spans of occupations may be more similar. In addition, changes in the intensity of cultural material deposition may be perceived more realistically since the individual levels with large samples will not obscure other levels with a smaller number of items. Similarly, changes in activities within and between zones will be more evident. Unfortunately, there is no assurance that the arbitrary excavation levels reflect discrete site occupation spans. Indeed, it is quite possible that these levels have cut across different episodes, resulting in mixed assemblages. The distribution of hafted biface types throughout these levels, however, indicates that the arbitrary levels have not intermingled assemblages from identifiably different periods (i.e., Middle and Late Archaic hafted bifaces do not occur together).

It is apparent that the definition of assemblages in terms of material from excavation levels requires more assumptions than a definition based on archaeostratigraphic zones. However, the assumptions regarding the contemporaneity of items in a level must also be made with respect to the assemblages from smaller, unstratified sites. Furthermore, the derivation, of more equally-sized samples enables more meaningful interassemblage comparisons. In this analysis, therefore, items from arbitrary excavation levels will generally be considered as individual assemblages. Some exceptions have been made. In unit I material from the surface, level 1 (0-10 cm below the surface), and level 2 (10-30 cm below the surface) were grouped together. The small amount of material from the surface and level 1 provides a sample too small for meaningful comparisons with other assemblages. This may be a result of the shallowness of level 1. By combining this material the abbreviated sample from level 1 is not admitted as an equal sample for comparisons with other assemblages.

Levels 12 and 13 in unit I were also combined. Artifacts were recovered only from the upper part of level 13 and constituted a very small sample (n=24 items). This material probably represents the earliest part of the occupation represented more completely by items from level 12.

The groupings of material from unit II are more complex. As noted previously, part of unit II was excavated in layers believed to reflect distinct cultural events. The groupings of assemblages reflects an effort to integrate material from unit II into assemblages which are comparable to those from unit I. Consequently, items from level 1, 2, and 3i have been combined, as have material from levels 3ii and 3iii. In addition, the lowermost levels - 8, 9, and 10 - have been combined. As with levels 12 and 13 in unit I, it is believed that these represent the initial occupation of this part of the site.

The correlations of assemblages from units I and II are presented in Table 4. The assemblages designated by letters (A-J) are those which will be used in further interassemblage comparisons. It must be re-emphasized that this is not an entirely satisfactory means of determining archaeological assemblages. The procedure implies, among other things, that the arbitrary excavation levels do not interrupt or artificially combine prehistoric living surfaces and their associated refuse deposits. In view of the nature of the site deposits, such distinctions are not possible. It is believed, however, that this method of determining assemblages represents a legitimate compromise between the ideal, fine-grained assemblages reflecting distinct cultural episodes, and the more coarse-grained assemblages indicated by the archaeostratigraphy.

The Trail Site

Location and Setting. The Trail site lies in a plowed field on the floodplain south of the Cumberland River in Livingston County, Kentucky. It is approximately 17 km upstream from the confluence of the Cumberland River and the Ohio River (Figure 8). A backwater channel of Hickory Creek is 100 m east of the eastern edge of the site. The site extends for 60 m east-west

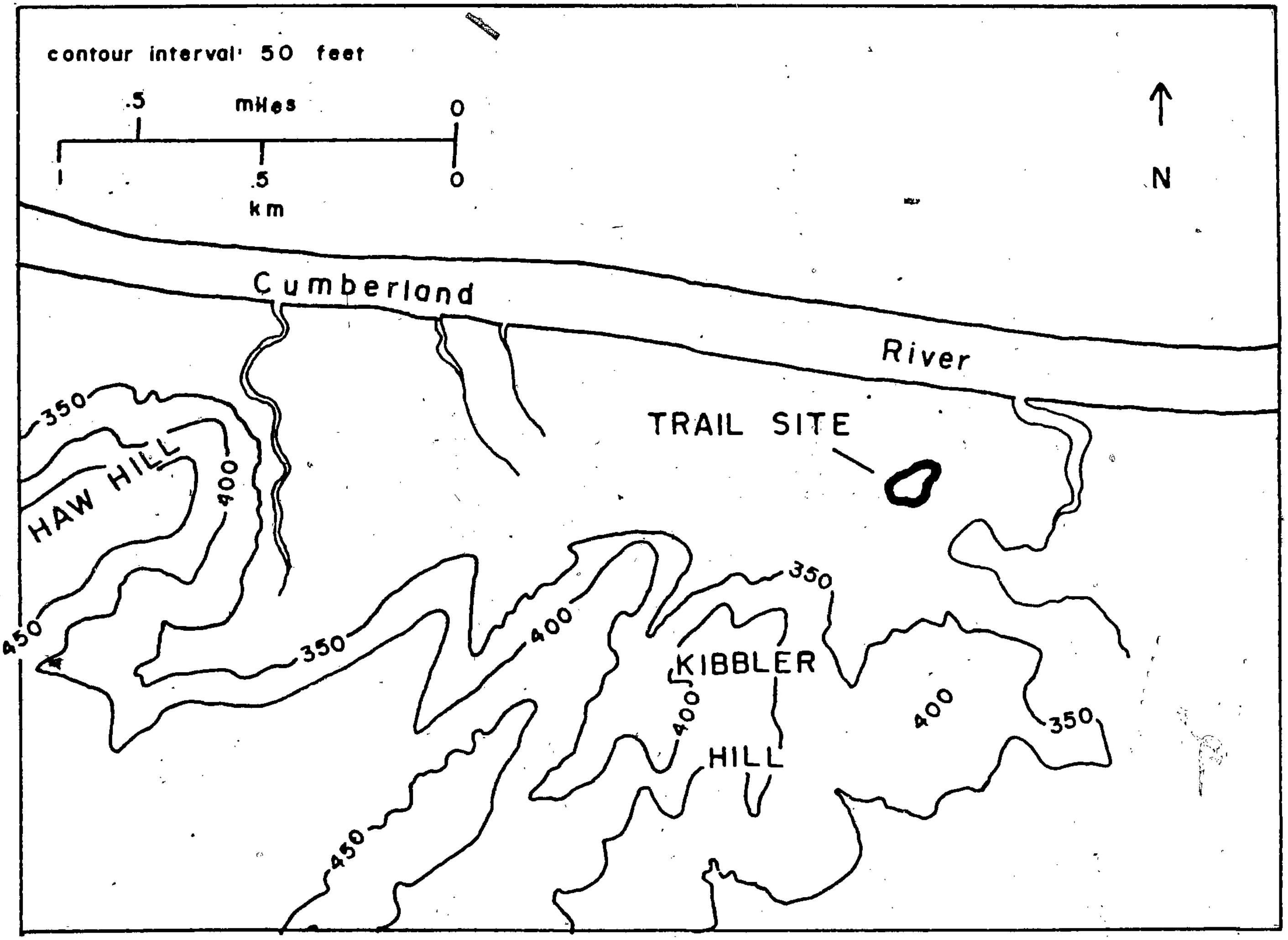


Figure 8. Location of the Trail site.

along a ridge of the 340 foot a.s.l. contour, 40 feet above the present normal stage of the river and 350 m south of the south river bank. While most of the cultural material was scattered along the surface, test pits revealed that artifacts occurred up to 60 cm below the surface. Other reports on this site are found in Nance (1982) and Luke (1982).

This location is near the eastern edge of a geologic transition between the Mississippian Plateau (east of the Cumberland River) and the northernmost extension of the Gulf Embayment (west of the Tennessee River).

Field Procedure. Fieldwork at the Trail site was conducted in 1978, 1980, and 1982. The 1978 investigations were the most intensive and subsequent studies have not substantially altered our understanding of the site. Therefore, only data recovered in 1978 will be considered in this study. The following information is derived from field notes and from J. Nance (personal communication).

The 1978 field procedures included an intensive surface collection of the site, as well as the excavation of eleven 2x2 m test pits. Two surface collection techniques were employed. First, an uncontrolled collection was made in which formed tools (i.e., cores, bifaces, hafted bifaces, hammerstones, etc.) were recovered. Following this, a controlled surface collection strategy was employed in which all material thought to be of cultural origin was flagged. A datum was established and the distance and bearing to each artifact was recorded. Each artifact was then placed in a bag with a card recording its provenience. The large quantity of cultural material prohibited the controlled collection of all of the surface material within the time alloted. In order to augment the sample and to determine the subsurface nature of the deposits, a series of test pits were excavated.

Initially, four test units (A, B, C, and D) were excavated near the north-south and east-west limits of the surface concentrations of cultural material. Six additional units were subsequently excavated in the area between units A and B where the surface concentration was most dense. Finally, an eleventh unit was excavated in a grove of trees east of unit B to determine if the site extended beyond the plowed field. All units were excavated in 10 cm arbitrary levels and the matrix was passed through a 1/4 inch mesh. All material retained in the screen was saved. The depth to which the cultural material extended varied from unit to unit, with the easternmost deposits being more shallow. Table 6 lists the depth of cultural material in each excavation unit.

Table 6. DEPTH OF CULTURAL MATERIAL AT THE TRAIL SITE.

Unit	Maximum Depth Below Surface
A	40 cm
B	20 cm
C	60 cm
D	50 cm
11 - 13W/29 - 31S	50 cm
19 - 21W/29 - 31S	50 cm
19 - 21W/37 - 39S	50 cm
19 - 21W/25 - 27S	60 cm
15 - 17W/29 - 31S	50 cm
19 - 21W/33 - 35S	50 cm
01W - 01E/29 - 31S	30 cm

Archaeostratigraphy. A plowzone, consisting of brown sand, extends from the surface to c. 20 cm below the surface. Underlying this is a zone of yellowish brown sand which varies from 10 cm to 20 cm in thickness. The upper border of this zone is irregular and has been greatly disturbed by plow furrows. The basal zone consists of dark yellowish brown sand. In some sections, a thin (c. 5.0 cm thick) zone of brown sand separates the basal zone from the light yellowish sand zone.

Age. Suitable material for radiocarbon dating has not been recovered from the Trail site. Much of the organic remains from the site occurs within the plowzone and the mixture of recent material with earlier carbon through plowing is a definite possibility. Soil samples retrieved from a single test unit in 1982 were water-screened through a series of 0.5 mm, 1.0 mm, and 5.6 mm mesh screens. The recovered fraction contains only a small amount of carbonized material. Because of this small sample size and the possibility of contamination, no samples have been submitted for radiocarbon assay.

The age and cultural affiliation can, however, be inferred from an examination of the hafted biface styles that are present and from some of the other more well-formed artifacts. The estimated age of the hafted bifaces from the Trail site is presented in Table 7. Many are represented by single individuals, making their identification somewhat tenuous. Nevertheless, several features of the distribution should be noted. First, the great majority can be assigned to the late Middle Archaic Big Sandy type. Second, of the other named types, Kirk Stemmed, Rowan/Brewerton Eared, and Morrow Mountain are the most numerous. Kirk Stemmed forms have been found in Early Archaic situations at the Morrisroe site and in the Carolina Piedmont (Coe 1964). All of the specimens recovered from the Trail site are extremely thin with markedly bevelled blades, suggesting that they were extensively reworked prior to discard. The Morrow Mountain points do not exhibit such marked resharpening. Elsewhere, (e.g. Chapman 1977, 1979; Coe 1964) these points have been found in Middle Archaic associations. Although the Rowan/Brewerton Eared points were all found between 20 - 30 cm below the surface, their presence is consistent with a late Middle Archaic age for this assemblage.

Third, the Quad/Beaver Lake and Cumberland forms are generally believed to be of Paleo-Indian age (Rolingson and Schwartz 1966; Cambron and Hulse 1975). These, like the Kirk

Table 7. Age of Hafted Bifaces from the Trail Site.

Unit	Level	Type	n	Age
Surface		Big Sandy Side-Notched	4	Late Archaic
		Matanzas	1	Late Archaic
		Quad/Beaver Lake	1	PaleoIndian
		Morrow Mountain I	1	Middle Archaic
		Copena	1	Late Archaic
		Guilford	1	Late Archaic
		Sykes	1	Late Archaic
		Kirk Serrated	1	early Middle Archaic
		Strong shouldered, straight stemmed	1	Late Archaic
		McIntire	1	Late Archaic
A	1	Cumberland	1	PaleoIndian
C	3	Rowan	1	Late Archaic
D	1	Merom	1	Late Archaic
	2	Strong shouldered, expanding stemmed	1	?
	3	Big Sandy Side-Notched	1	Late Archaic
11-13W 29-31S	1	Big Sandy Side-Notched	1	Late Archaic
	2	Big Sandy Side-Notched	1	Late Archaic
19-21W 25-27S	1	Morrow Mountain I	1	Middle Archaic
19-21W 33-35S	2	Morrow Mountain I	1	Middle Archaic
	3	Rowan	1	Late Archaic
		Kirk Serrated	1	Early Archaic
		Big Sandy Side-Notched	1	Late Archaic
	4	Big Sandy Side-Notched	1	Late Archaic
19-21W 37-39S	1	Kirk Serrated	1	Early Archaic
	3	Rowan/Brewerton Eared	1	Late Archaic
1W-1E 29-31S	3	Big Sandy Side-Notched	1	Late Archaic

Stemmed examples, have been extensively reworked prior to discard. Finally, the numerous types of shallow side-notched, corner-removed, and stemmed points (all of which occur in small numbers) are consistent with other Late Archaic assemblages (Chapman 1981).

Lewis and Kneberg (1959) considered Big Sandy points to be diagnostic of the Three Mile phase of the Mid-Continental tradition in the Mid-South. Other important elements include stemmed scrapers, and adze-like flint tool, and increase in the number of straight stemmed points over earlier periods, winged, pyramidal, and cylindrical atlatl weights; bell-shaped pestles; antler atlatl hooks; turtle shell rattles; and copper beads. Of these, only Big Sandy points/knives, stemmed scrapers, and straight stemmed points occurred at the Trail site. This may be a result of differing site activities. Lewis and Kneberg (1959) ascribe the Three Mile phase to the period 6000 - 2000 bp. In the absence of any more refined chronology for the Trail site, it may be placed within this general time period; that is, transitional between the Middle and the Late Archaic.

The Dead Beaver Site (15Tr50)

Location and Setting. The Dead Beaver site is situated 20 m east of Crooked Creek and approximately 200 m downstream from its confluence with Grace Creek in Trigg County, Kentucky (Figure 9). The site extends c. 150 m north-south and 40 m east-west in a cleared field which is surrounded by wooded areas. Many of the

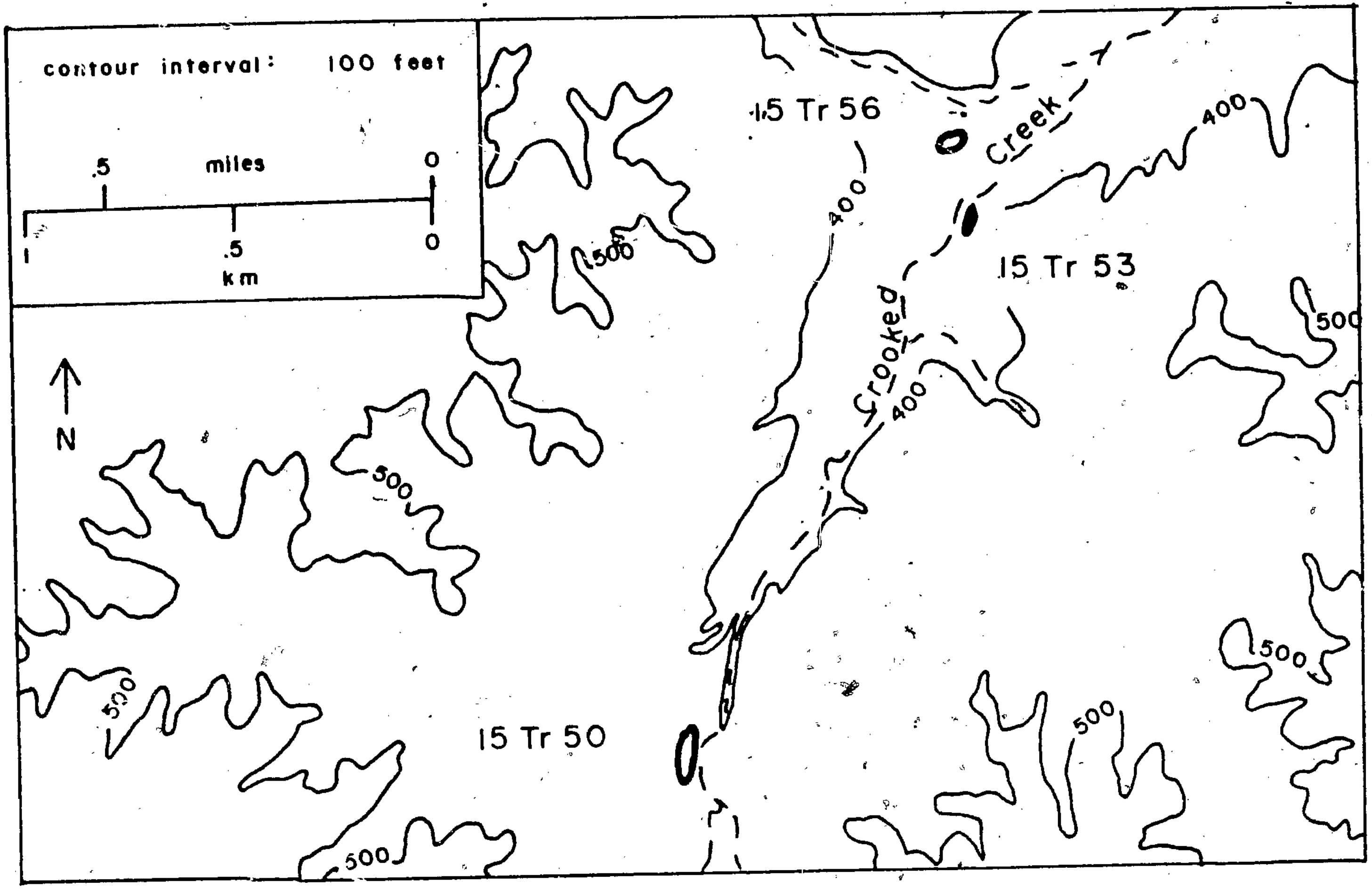


Figure 9. Location of sites 15Tr50, 15Tr53 and 15Tr56.

artifacts were recovered from the surface and excavation revealed that cultural material did not extend below the plowzone (c. 20 m below the surface). Other discussions of this site may be found in Nance (1972, 1976a).

This location is in the dissected upland area between the Cumberland and Tennessee rivers and was formerly some distance from the Cumberland River. Impoundment of the Barkley Lake basin has, however, inundated the lower two-thirds of Crooked Creek. The floodplain of the creek in the vicinity of the site is gently sloping and extends approximately one-half mile in width. The creek heads at a natural spring and does not dry up at any time of the year.

Field Procedures. An uncontrolled surface collection, undertaken by J. Nance in 1972, revealed that a wide range of artifacts existed at the site. These were concentrated in two distinct areas which were separated by a fence-row. North of the fence, the artifact assemblage consisted of relatively large flakes and few finished tools. The flaking debris was less dense in the southern portion of the site, and more tools occurred in that area. A series of 5x5 ft. excavation units were located 100-125 ft. south of the fence-row and 50-75 ft. west of the creek, in an area where surface collections indicated that cultural material was most dense. An additional 5x5 ft. unit was excavated near the northern extremity of the site (c. 25 ft. south of the fence-row and c. 60 ft. west of the creek).

The initial test units were excavated in arbitrary 4 inch thick (c. 10 cm) levels to a maximum depth of 12 inches (c. 30 cm) below the surface. Trowels were used to remove all matrix and the material was passed through a 1/8 inch mesh. As it became apparent that the cultural material represented an unstratified deposit and that the use of a fine-mesh screen did not significantly add to the recovery of artifacts, trowels were abandoned in favour of shovels and a 1/4 inch mesh replaced the 1/8 inch mesh. It was also found that cultural material did not extend below 12 inches below the surface. Therefore, subsequent units were not excavated below 8 inches beneath the surface.

Archaeostratigraphy. A post-hole digger was used to probe the sediments below the base of the excavation units. As a result of the excavation and the probe, a profile extending to a depth of 22 inches below the surface has been described:

> 'Observations revealed the presence of an upper layer (I; 4-6" in depth) of brown clay-loam faintly distinguishable from a lighter brown clay-loam below 6" (Layer II). The darker color of the Layer I is no doubt a result of the application of modern fertilizers. The lighter Layer II began to grade into a clay-sand mixture at 12-14" and finally gave way at 18-22" to the whitish sand-clay hardpan described above. As was mentioned earlier, artifacts were restricted to Layer I and the top 2" of Layer II. Due to the limited depth distribution of materials, no cultural stratigraphy was definable' (Nance 1976a: 27).

It was suggested (Nance 1976c: 25) that the white sand of Layer III represents an early post-Pleistocene stream-laid deposit. The geomorphology of the site, however, has not been intensively investigated.

Age. No material was recovered which could be submitted for radiometric analysis. As a result, the age of 15Tr50 assemblage must be inferred from an analysis of the hafted biface styles that are present. Table 8 summarizes the hafted biface styles recovered from the site, their estimated age, and the number of each type that were recovered. The small number of hafted bifaces that were recovered and the allocation of only a single individual to many categories indicates that this analysis should be regarded with some caution.

The presence of a single Kirk Stemmed hafted bifaces is of interest. The presence of these early styles in a relatively late assemblage is enigmatic. Either 15Tr50 was occupied by Early Archaic groups, or later people were discarding early tool forms at this site. As only one such hafted biface was found, the estimated age of the assemblage need not be affected. That is, the site may be assigned to the Late Archaic.

15Tr53

Location and Setting. Site 15Tr53 is situated east of Crooked Creek, approximately 8,000 ft. downstream from the Dead Beaver site (Figure 9). The confluence of Franklin Creek and Crooked Creek is c. 3,000 ft. downstream from the site. Much of the general locational information provided in the discussion of the Dead Beaver site is applicable to 15Tr53. Other discussions of this site are provided in Nance (1972, 1977). Nance (1972: 31) noted that a road bordering the eastern edge of the site and a

Table 8. Age of Hafted Bifaces from 15Tr50.

Type	n	Estimated Age
Kirk Stemmed	1	Early Archaic
Brewerton Corner-Notched	1	Late Archaic
Lamoka	1	Late Archaic
Ledbetter/Pickwick	1	Late Archaic
Mulberry Creek/Adena	1	Late Archaic
Savannah River	1	Late Archaic
Flint Creek	1	Late Archaic
Contracting Stemmed	1	Late Archaic

Table 9. Age of Hafted Bifaces from 15Tr53.

Type	n	Estimated Age
Smithsonia/Belvedere	1	Late Archaic/ Early Woodland
Adena	2	Late Archaic
Kays/Bare Island	1	Late Archaic

house on the northern extremity have probably contributed to the partial destruction of the site.

Field Procedure. The material recovered from 15Tr53 was obtained through an uncontrolled surface collection and the excavation of three test units in 1972. The surface material was scattered across the entire site area, and no spatial patterning could be discerned. There is no detailed information available regarding the excavation units.

Archaeostratigraphy. The stratigraphy at this site was similar to that at the Dead Beaver site (Nance personal communication 1983).

Age. No material was recovered for radiometric dating. A small number of hafted bifaces were recovered and provide a means of estimating the age of the assemblage. Table 9 lists the types to which they were assigned and the quantity of each type. Although the low frequency of each type suggests that caution should be used in evaluating this assemblage, it is apparent that they are Late Archaic. While Adena types are often described as Early Woodland (e.g. Cambron and Hulse 1975), Kneberg (1956: 26) and Faulkner and McCollough (1976) have suggested that they appeared during the Late Archaic in some areas of the Mid-South.

15Tr56

Location and Setting. Site 15Tr56 is situated west of Crooked Creek, approximately 1,000 ft. downstream from site 15Tr53. The confluence of Franklin Creek and Crooked Creek is c. 2,000 ft. downstream from the site (Figure 9). Much of the general locational information provided in the discussion of the Dead Beaver site is applicable to 15Tr56. Other discussions of this site are provided in Nance (1975, 1977).

Field Procedure. The material recovered from 15Tr56 was obtained through an uncontrolled surface collection and the excavation of three test units in 1973. The sparse surface material was scattered across the entire site area, and no spatial patterning could be discerned. There is no detailed information available regarding the excavation units.

Archaeostratigraphy. The stratigraphy of this site is similar to that of the Dead Beaver site (Nance personal communication 1983).

Age. No material was recovered from this site which could be submitted for radiometric dating. The small number of hafted bifaces which were recovered do provide a means of estimating the relative age of the assemblage. As this sample is very small, the assignment of types must be done with extreme caution. Nevertheless, all points confirm a Late Archaic age for this assemblage.

Summary. 15Tr56 is located near Crooked Creek in the uplands between the Cumberland and Tennessee rivers. A surface collection revealed that the areal extent of the site was small and that the cultural material was not dense. Limited testing of the site increased the sample size of the artifacts. An analysis of the hafted bifaces that were found indicates that the assemblage is Late Archaic in age.

The Bear Creek Ridge Site (40Sw74)

Location and Setting. The Bear Creek Ridge site is situated on a high ridge north of Bear Creek in Stewart County, Tennessee (Figure 10). The channel of the Cumberland River formerly lay 3/4 mile to the east, although inundation has brought the margins of Lake Barkley much closer. This ridge, at river mile 85 of the Cumberland River, is tri-lobate with southern, northern, and central subareas. Cultural material was found scattered across all three lobes with no apparent spatial patterning. Other references to the site are found in Nance (1974, 1977).

This location is at the extreme eastern edge of the dissected uplands that separate the Cumberland and Tennessee River valleys. Unlike the other upland sites examined in this study (the Dead Beaver site, 15Tr53 and 15Tr56), the Bear Creek Ridge site is not near a stream, but rather is approximately 80 ft. above the Bear Creek channel.

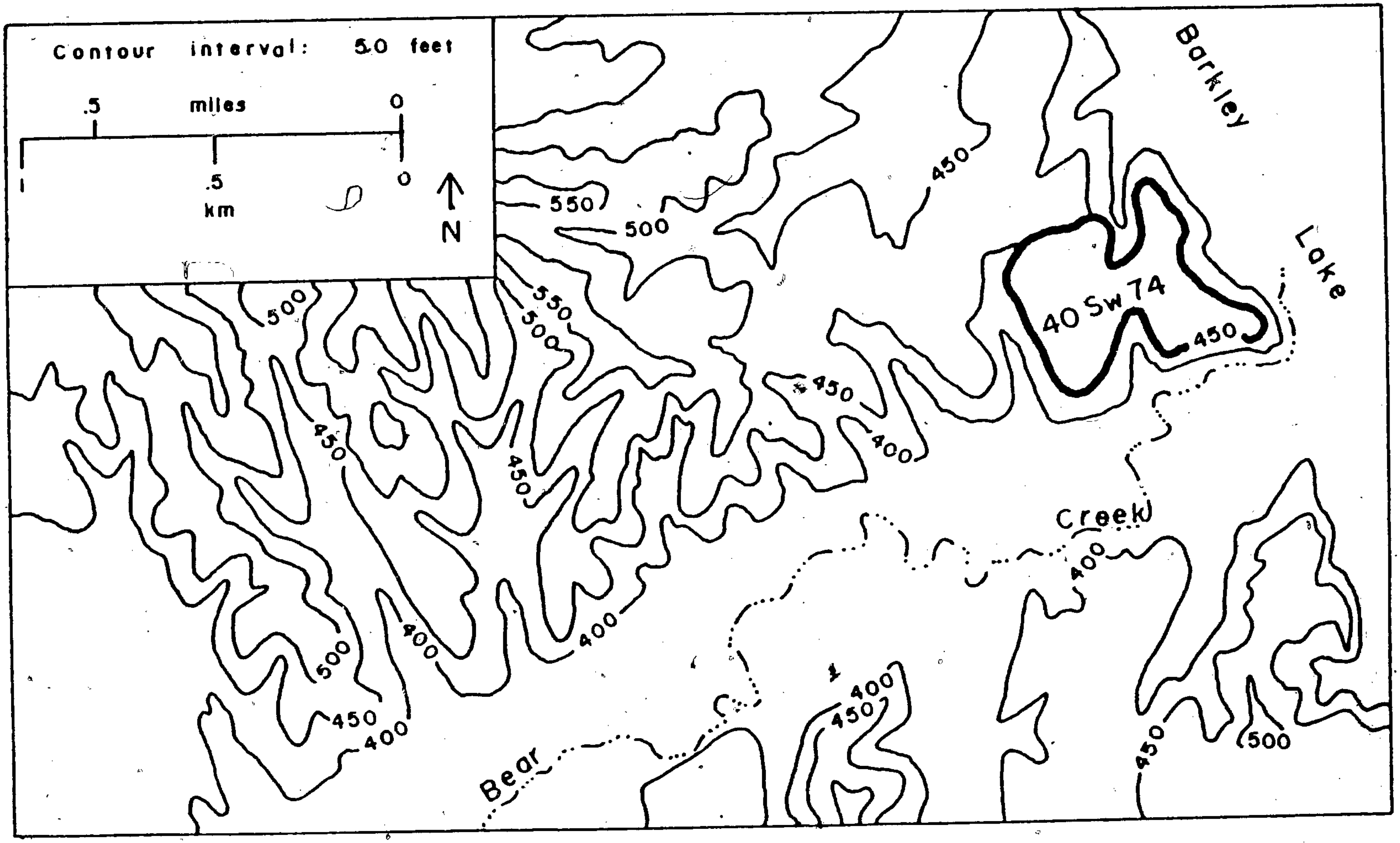


Figure 10. Location of 40Sw74.

Field Procedure. All of the material from the Bear Creek Ridge site was recovered through uncontrolled surface collections under the direction of J.D. Nance. Two collections were made: one in the fall of 1972, and one in the spring of 1973. In both instances "No systematic attempt was made to collect all material from the site surface nor to maintain a record of which areas of the site yielded what kinds of material" (Nance 1974: 4). Furthermore, no test pits were excavated to determine the extent of the subsurface deposits.

Age. No material was recovered from this site which could be submitted for radiometric analysis. The age of the assemblage must, therefore, be estimated from an analysis of the types of hafted bifaces which were recovered.

Table 10 presents the types of points identified, their estimated age, and the number of each type that was identified. Question marks adjacent to a type name indicates a questionable identification. It is apparent from this table that a wide variety of stemmed forms were present at the site and that most types are represented by single individuals. In this regard, the Bear Creek Ridge site point assemblage is similar to that from 15Tr50 and 15Tr53. As Chapman (1981: 71) noted, the stemmed and side-notched hafted bifaces which characterize Late Archaic assemblages are often too variable to be assigned to only a few prescribed types. It is apparent, therefore, that in this regard the Bear Creek Ridge site assemblage is typical of the Late Archaic in the midcontinent.

Table 10. ESTIMATED AGE OF HAFTED BIFACES FROM 40Sw74.

Type	Age	n
Adena	Late Archaic	5
Matanza (?)	Late Archaic	1
broad side-notched	Late Archaic (?)	1
deep corner-notched	Late Archaic (?)	1
Little Bear Creek	Late Archaic	2
undifferentiaed weak shouldered, narrow straight stemmed	Late Archaic (?)	1
weak shouldered, slightly flaring stemmed	Late Archaic	1
tapered shoulder, slightly expanding stem	Early Woodland	1
weak, tapered shoulder, straight base	Early Woodland	1
weak, tapered shoulder, straight stem, convex base	Late Archaic	1
weak shouldered, slightly expanded straight stem	Late Archaic (?)	1
weak shoulder, narrow and slightly expanded base	Late Archaic	2
strong shouldered, narrow straight stem	Late Archaic	1
Benton Stemmed	Late Archaic	1
Kays	Late Archaic	2
Ledbetter (?)	Late Archaic	2
weak shoulder, straight stem, straight base	Late Archaic (?)	1
Carrolton	Late Archaic	1

Chapter Summary

This chapter has presented a description of each of the sites examined in this study. The Morrisroe site is a deeply stratified site on the north bank of the Tennessee River. The four components identified there include a sparse assemblage associated with Kirk Stemmed points, a dense deposit of cultural material associated with Cypress Creek II points, and a less dense assemblage with Eva II and Morrow Mountain points, and another sparse assemblage which contains shallow side-notched points. Material from these components were analyzed in terms of 20 cm arbitrary excavation levels. There appears to have been little commingling of material of different ages. The Trail site, on the south bank of the Cumberland River, is a single component site of late Middle or early Late Archaic age. The other sites (15Tr50, 15Tr53, 15Tr56 and 40Sw74) are all single component sites situated in the uplands between the two rivers. All are Late Archaic in age.

CHAPTER VIII

ANALYSIS OF LITHIC MATERIAL TYPES

The varieties of lithic material from which stone tools were manufactured may provide important information regarding assemblage structure and technological organization. As was noted in the discussion of assemblage structure (Chapter 3), the forms in which the raw material occurs and its suitability for various tasks may condition the formal/functional types of artifacts and the types of debitage which were produced. In Chapter 4 it was suggested that technological systems might be organized to conserve raw material, and that the amount of conservation is jointly linked to the relative mobility of a group and the availability of material which is suitable for tool manufacture. If the analysis of assemblage structure and technological organization is to be seen as indicative of mobility strategies, it must first be shown that differences in the structure and organization are not the result of variations in the use of different raw materials.

An analysis of lithic material types present in an assemblage may provide a means of estimating the mobility of the hunting-gathering group who deposited that assemblage. If assemblages contain debitage and finished tools made from material derived from distant sources, a high degree of mobility is implied. This may be true even if the locally available material is of high quality, since as a group establishes itself at a site it will use, resharpen and discard items manufactured at previous localities.

The following analysis has four objectives. First, the varieties and relative abundance of chert types in each assemblage will be determined. These data provide a basis for future analysis. Second, the cortex types of the chert varieties in the assemblages will be examined. The selection of either stream-rolled material or material with a weathered cortex may indicate whether raw material was being quarried from bedrock sources or gathered more expediently from stream beds. The common occurrence of chert in the upland residuum of the area obscures a clear dichotomy of source selection.

The third concern is with determining the relationship between artifact types and varieties of raw material. This will provide an indication of the degree to which the assemblage structure has been affected by the differential use of lithic materials. Fourth, the geographic distribution of chert types will be examined. The comparison of this distribution with the types of cherts which occur in each assemblage will indicate the relative mobility of the group responsible for the assemblage.

The Sample

The data considered in this analysis consist of samples of artifacts (including manufacturing debris) drawn from each of the assemblages outlined in Chapter 7. The categories into which the items were placed are defined in Chapter 6, as are the lithic types. It is important that enough material be examined to assure that the lithic types identified are representative of those which are present in each assemblage. It is also important that the amount of each lithic type be measured in a way that leads to meaningful inferences regarding prehistoric exploitation strategies. The first obligation was met by examining specimens in every artifact category from each assemblage until the entire category had been enumerated or until 200 items had been examined. Because of the great quantity of material from the Morrisroe site, samples were drawn only from unit II. Useful measures of the amount of lithic material present in each assemblage were derived by counting the number of pieces and by determining their weights.

The identification procedure involved comparing each specimen with Gatus' (1979) descriptions (see Chapter 6) and with samples in the Lower Cumberland Archaeological Project chert reference collection. When identifications were difficult, the specimens were subjected to a microscopic examination using either a 10X hand lens or a stereomicroscope with a maximum 50X magnification. Weights of specimens were determined using an electronic scale accurate to 0.01 gram.

Almost all of the chipped stone artifacts are made of chert, while the great majority of ground, battered, and pecked stone artifacts are fashioned from sandstone and quartzite. As no study has been undertaken to determine the environmental distribution of these latter materials, a detailed analysis was undertaken only for the chipped stone artifacts and the associated debris. In addition, items whose chert type could not be confidently typed (usually because they were too small for accurate diagnosis or had been subjected to substantial annealment) were not included in this analysis. These fragments added to the total counts and weights of the samples, thereby reducing the proportion of each assemblage comprised of identifiable chert types. The inclusion of small, unidentifiable fragments does not, however, contribute to our understanding of prehistoric patterns of chert use.

A major consideration in examining patterns of prehistoric exploitation of lithic resources is the amount of material that was transported. It is important, however, that this quantity be measured in terms that are most likely to have been relevant to the pedestrian hunter-gatherers who transported the material. Counts of items, while providing a straightforward assessment of the amount of material, may be misleading as it fails to account for the size of the items. Weight may provide a more accurate means of determining the importance of material since it is a measure of the burden that would have been incurred on the individuals who transported the materials from the sources. Recently, Bouey (1983) suggested that weight may not reflect changes in reduction processes and is particularly misleading when more than one type of raw material, each with different specific gravities, is included in analysis. He proposed that volume is a better index. His concerns are primarily directed toward analyses in which types of lithic debitage are not differentiated and the raw materials include such different types as chert and obsidian. In the present study, debris has been sorted into a number of types, enabling an assessment of changes in the reduction process. In addition, since most of the material is chert, the specific gravities are not likely to exhibit significant differences between varieties.

Chert Types and Assemblages

Table 11 is a summary of the presence/absence distribution of each chert type in each of the assemblages. Four types of chert are present in all assemblages: upper St. Louis; lower St. Louis/Salem; Fort Payne; and Warsaw. In addition, Ste. Genevieve/Fredonia, Continental Deposits, and the "unidentified conglomerate" occur in the majority of assemblages. The other types are either absent or occur in small numbers. Cherts which are not found in archaeological assemblages have been excluded from the following analysis.

The rank-orders of the chert types in each assemblage are presented in Tables 12 and 13. The former presents the ranks of weights compiled for each sample, while the latter presents the same data for the counts. Spearman rank-order correlations were calculated for weights and counts in each sample to determine if any bias would be introduced by considering one set of data rather than the other. The results of these tests (Table 14) indicate that the rank-order of weights and counts of chert

Table 11. Presence/absence of chert types in assemblages.

Chert Types / Assemblage	Morrisroe Assemblage D	Morrisroe Assemblage E	Morrisroe Assemblage F	Morrisroe Assemblage G	Morrisroe Assemblage H	Morrisroe Assemblage I	Morrisroe Assemblage J
Camden/ Jeffersonville	x	x	x	x	x	x	x
Fort Payne	x	x	x	x	x	x	x
Warsaw	x	x	x	x	x	x	x
lower St. Louis Salem	x	x	x	x	x	x	x
upper St. Louis	x	x	x	x	x	x	x
Glen Dean							
Ste. Genevieve/ Fredonia	x	x	x	x	x	x	
Renault							
Vienna							
Menard							
Clore							
Degonia		x					
Kinkaid					x		
Tuscaloosa			x				
Clayton/ McNairy							
Continental Deposits	x	x	x	x	x	x	x

Table 11. cont.

Chert Types Assemblage	Caseyville/ Lusk	Unidentified Conglomerate	Tamms Till
Morrisroe Assemblage D		x	
Morrisroe Assemblage E			
Morrisroe Assemblage F		x	
Morrisroe Assemblage G		x	
Morrisroe Assemblage H		x	
Morrisroe Assemblage I		x	
Morrisroe Assemblage J		x	x

Table 11. cont.

Chert Types / Assemblage	Trail Site	15Tr50	15Tr53	15Tr56	40Sw74
Camden/ Jeffersonville					
Fort Payne	x	x	x	x	x
Warsaw	x	x	x	x	x
lower St. Louis/ Salem	x	x	x	x	x
upper St. Louis	x	x	x	x	x
Glen Dean					
Ste. Genevieve/ Fredonia	x	x			x
Renault					
Vienna					
Menard					
Clore					
Degonia					
Kinkaid			x		
Tuscaloosa				x	x
Clayton/ McNairy					
Continental Deposits	x	x			x

Table 11. cont.

Chert Types	Caseyville/ Lusk	Unidentified Conglomerate	Tamms Till
Assemblage			
Trail Site		x	
15Tr50			
15Tr53			
15Tr56			
40Sw74			

Table 12. Rank-order of chert types in assemblages (by weight).

Chert Types / Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	2	1	3	4	7	8	8	8	6	5	8
Morrisroe Assemblage E	2	1	3	4	6	9	7	8	9	5	9
Morrisroe Assemblage F	2	1	3	4	8	6	9	9	7	5	9
Morrisroe Assemblage G	2	1	3	5	7	8	8	8	6	4	8
Morrisroe Assemblage H	1	2	4	6	7	8	8	8	5	3	8
Morrisroe Assemblage I	1	2	6	4	7	8	8	8	5	3	8
Morrisroe Assemblage J	1	2	5	4	8	8	8	8	6	3	7

Table 12. cont.

Chert Types Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail Site	1	2	4	5	6	8	8	8	7	3	8
15Tr50	1	4	3	2	6	6	6	6	6	5	6
15Tr53	1	2	3	4	6	6	6	5	6	6	6
15Tr56	1	4	3	2	6	5	6	6	6	6	6
40Sw74	1	2	3	4	8	7	9	9	9	5	9

Table 13. Rank-order of chert types in assemblages (by count).

Chert Types / Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	3	1	2	4	6	8	8	8	7	5	8
Morrisroe Assemblage E	3	1	2	4	5	9	7	8	8	6	9
Morrisroe Assemblage F	2	1	3	4	6	7	9	9	8	5	9
Morrisroe Assemblage G	2	1	3	4	7	8	8	8	6	5	8
Morrisroe Assemblage H	2	1	3	4	7	8	8	8	6	5	8
Morrisroe Assemblage I	2	3	1	5	7	8	8	8	6	4	8
Morrisroe Assemblage J	2	1	5	4	8	8	8	8	6	3	7

Table 13. cont.

Chert Types / Assemblage	Trail site	15Tr50	15Tr53	15Tr56	40Sw74
Tamms Till	8	7	6	6	7
Continental Deposits	3	5	6	6	5
Unidentified Conglomerate	7	7	6	6	7
Kinkaid	8	7	5	6	7
Degonia	8	7	6	6	7
Tuscaloosa	8	7	6	5	6
Ste. Genevieve/ Fredonia	2	6	6	6	6
Warsaw	4	3	3	3	2
Fort Payne	5	2	4	4	4
lower St. Louis/ Salem	2	4	2	2	3
upper St. Louis	1	1	1	1	1

types are highly correlated in all samples. Even the least significant correlation, from assemblage I at the Morrisroe site, is significant. The lower r value for this assemblage is accounted for by the fact that Fort Payne chert is represented by the third largest number of flakes (n=41), which are only sixth in weight. It is apparent that either weights or counts may be used as accurate indices of the relative (ranked) importance of various chert types in these assemblages.

An examination of the rank-order of chert types (Tables 12 and 13) reveals that, in most assemblages, upper St. Louis and lower St. Louis/Salem are the two most important materials. This relationship is maintained regardless of whether weights or counts are considered, although there are fewer exceptions with the former data. It is interesting to note that upper St. Louis chert is ranked first in samples from the Trail site, 15Tr50, 15Tr53, 15Tr56, and 40Sw74 while lower St. Louis/Salem assumes the premier rank in most of the samples from the Morrisroe site.

The proportion of chert types in each assemblage are presented graphically in Figures 11 and 12. Here, the category "other" includes Fort Payne, Warsaw, Ste.Genevieve/ Fredonia, Tuscaloosa, Degonia, Kinkaid, unidentified conglomerate, Continental Deposits, and Tamms Till. These collapsed data sets are presented in Tables 15 and 16. A source of error is introduced by grouping these chert types since, in some instances, one or more of these types may be more plentiful than either upper St. Louis or lower St. Louis/Salem. In the sample

Table 14. Spearman rank-order correlation coeffecients of weights and counts of chert types.

ASSEMBLAGE	r_s	p
Morrisroe Assemblage D	0.981	0.01
Morrisroe Assemblage E	0.968	0.01
Morrisroe Assemblage F	0.973	0.01
Morrisroe Assemblage G	0.991	0.01
Morrisroe Assemblage H	0.943	0.01
Morrisroe Assemblage I	0.857	0.01
Morrisroe Assemblage J	0.991	0.01
Trail site	0.991	0.01
15Tr50	0.999	0.01
15Tr53	0.989	0.01
15Tr56	0.968	0.01
40Sw74	0.995	0.01

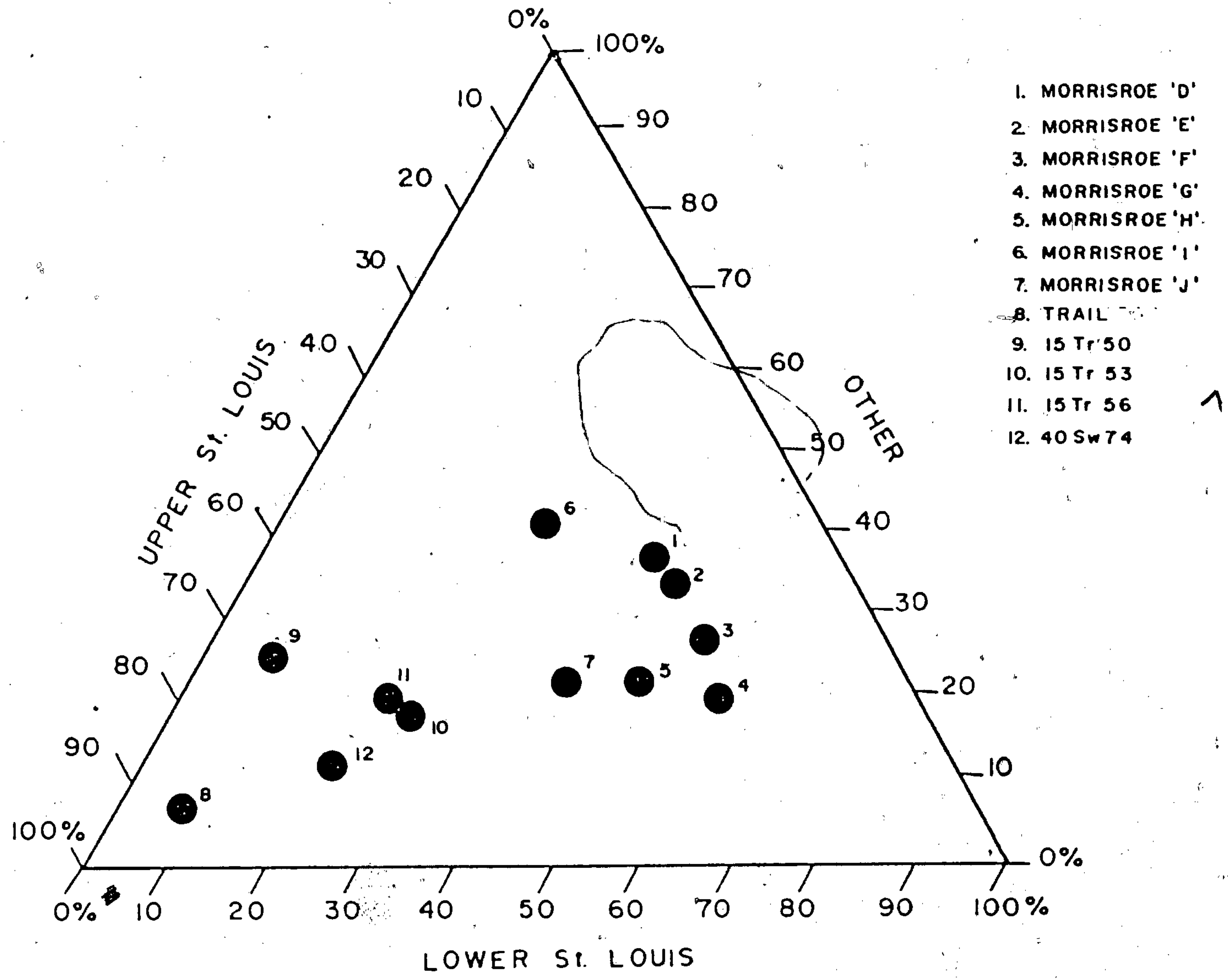


Figure 11. Proportion of chert types in each assemblage (n).

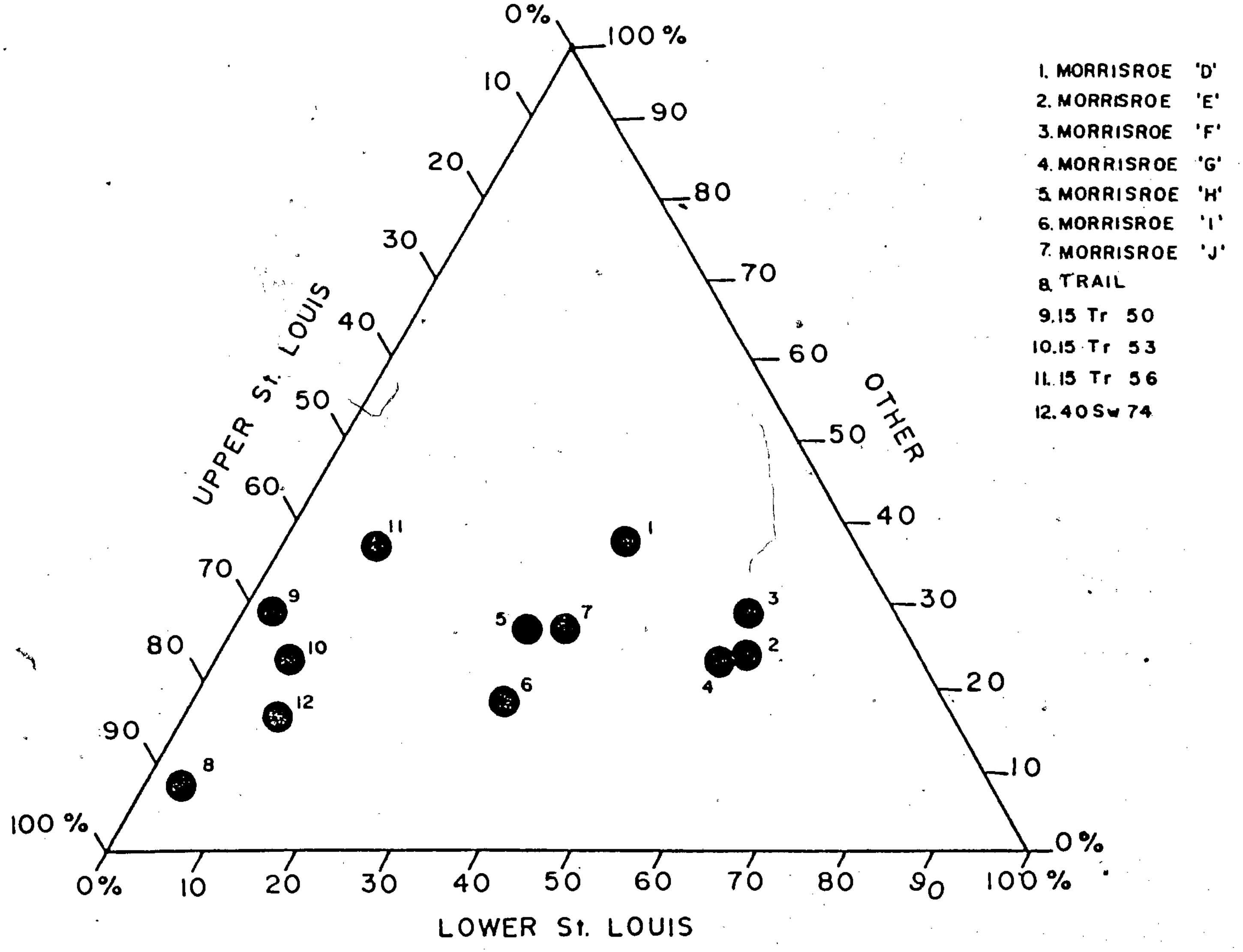


Figure 12. Proportion of chert types in each assemblage (wt.).

Table 15. Chert types in assemblages, collapsed data (counts).

Assemblage	upper St. Louis		lower St. Louis/Salem		Other	
	n	p	n	p	n	p
Morrisroe Assemblage D	191	0.197	422	0.436	355	0.367
Morrisroe Assemblage E	211	0.189	530	0.474	377	0.337
Morrisroe Assemblage F	195	0.189	554	0.538	281	0.273
Morrisroe Assemblage G	226	0.209	643	0.594	213	0.197
Morrisroe Assemblage H	165	0.288	279	0.487	129	0.225
Morrisroe Assemblage I	200	0.303	188	0.285	272	0.412
Morrisroe Assemblage J	242	0.370	274	0.418	139	0.212
Trail site	1 441	0.857	123	0.073	118	0.070
15Tr50	595	0.673	69	0.078	220	0.249
15Tr53	187	0.558	86	0.247	62	0.185
15Tr56	83	0.565	34	0.231	30	0.204
40Sw74	774	0.666	247	0.213	141	0.121

Table 16. Chert types in assemblages, collapsed data (weight).

Assemblage	upper St. Louis		lower St. Louis/Salem		Other	
	g	p	g	p	g	p
Morrisroe Assemblage D	505.4	0.251	750.8	0.372	761.8	0.378
Morrisroe Assemblage E	868.2	0.192	2 547.8	0.564	1 098.5	0.243
Morrisroe Assemblage F	903.2	0.163	3 033.8	0.547	1 609.1	0.290
Morrisroe Assemblage G	1 312.6	0.215	3 374.9	0.553	1 417.7	0.232
Morrisroe Assemblage H	1 839.9	0.405	1 464.5	0.323	1 234.3	0.272
Morrisroe Assemblage I	2 397.9	0.478	1 697.0	0.338	920.2	0.184
Morrisroe Assemblage J	4 867.4	0.365	4 837.9	0.363	3 629.3	0.272
Trail site	9 794.3	0.681	453.0	0.041	870.7	0.078
15Tr50	9 387.5	0.682	375.8	0.027	4 011.6	0.291
15Tr53	2 774.1	0.686	530.0	0.131	742.5	0.184
15Tr56	485.1	0.530	90.8	0.099	340.2	0.371
40Sw74	26 823.2	0.739	3 782.4	0.104	5 687.8	0.157

from site 15Tr50, for example, the second most common chert type (by number of items) is Fort Payne; lower St.Louis/Salem chert is only fourth in abundance. In addition, the grouping of items in this "other" category may result in that class containing the vast majority of items, either by total weight or by total numbers. Thus, this portrayal does not necessarily accurately reflect the first, second, and third most abundant chert types.

In spite of these qualifications, some interesting patterns emerge from an analysis of the distribution of assemblages in these figures. The plot of the proportion of number of items of each chert type present in each sample is shown in Figure 11. The Trail site and sites 15TR50, 15Tr53, 15Tr56 and 40Sw74 comprise a group characterized by large proportions of upper St. Louis chert and moderate-to-low proportions of lower St. Louis/Salem and "other" cherts. All but the lowermost samples from the Morrisroe site exhibit moderate-to-high proportions of lower St. Louis/Salem cherts and lesser amounts of upper St. Louis and "other" chert types. The lowest levels of this site (assemblages I and J) contain more items of upper St. Louis chert than other samples from that site. The large proportion of "other" cherts in the sample from assemblage I reflects the relatively large number of items made of Fort Payne chert.

The distribution of the weight of chert types in these samples presents less cohesive clusters (Figure 12). However, a similar pattern emerges. Once again, the Trail site, 15Tr50, 15Tr53, 15Tr56 and 40Sw74 comprise a cluster defined by large proportions of upper St. Louis chert and moderate-to-low proportions of lower St. Louis/Salem and "other" varieties. The lower levels of the Morrisroe site (assemblages H to J) form a second group with moderate amounts of all three chert types. The middle levels of the Morrisroe site (assemblages E to G) exhibit high proportions of lower St. Louis/Salem and moderate amounts of other types. The upper part of the Morrisroe site (assemblage D) is dominated by lower St.Louis/Salem; moderate amounts of "other" types and relatively small amounts of upper St. Louis chert are present.

Cortex Type and Assemblages

When deriving a model of lithic resource utilization, it is beneficial to identify specific quarry locations as well as the geological origin of the resources. Such analysis, directed toward accurately determining patterns of lithic utilization, may best be achieved through trace element analysis and a variety of other physical techniques. As Leudtke (1976, 1979) noted, however, the range of variation within source localities makes it difficult to interpret the results of such analyses. Although similar studies have been initiated in the lower Cumberland/ Tennessee drainage (Nance 1984), conclusive results are yet not available.

One means of providing a profile of local chert use that is more detailed than the comparison of chert types is to examine the types of cortex present on the sampled specimens. This analysis is directed toward determining if material from stream deposits was selected in preference to the material which occurred in the alluvium or which outcropped.

The specimens included in this analysis were drawn from the sample of cortical flakes identified in the analysis of chert types present in the assemblages. Two types of cortex were identified: weathered and water-rolled. The former is indicative of sources in bedrock outcrops or as pieces which have eroded into the alluvium. Water-rolled cortices reflect stream or river borne deposits.

The types of cherts represented in the sample of cortical flakes are presented in Table 17. The variety of cherts present in this sample is a reduction from those represented in the total samples (see Table 11). Samples from sites 15Tr53 and 15Tr56 are dominated by a single variety, while only three types of chert were identified among the cortical flakes from site 40Sw74. Five varieties (upper St. Louis, lower St. Louis/Salem, Fort Payne, Warsaw, and Continental Deposits) are most common, being present in all but five assemblages. In general, the chert types which were of minor importance in the various assemblages are also poorly represented by cortical flakes.

The proportion of each chert type represented by either weathered or water-rolled cortex in each sample is portrayed graphically in Figure 13. Before proceeding with an analysis of this data, it is important to note the small sizes of the

Table 17. Chert types represented by cortical flakes.

Chert Types Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	x	x	x	x						x	
Morrisroe Assemblage E	x	x	x	x						x	
Morrisroe Assemblage F	x	x	x	x	x	x				x	
Morrisroe Assemblage G	x	x	x	x					x	x	
Morrisroe Assemblage H	x	x	x	x					x	x	
Morrisroe Assemblage I	x	x	x	x					x	x	
Morrisroe Assemblage J	x	x	x	x						x	

Table 17. cont.

Chert Types	Trail site	15Tr50	15Tr53	15Tr56	40Sw74
Assemblage					
Tamms Till					
Continental Deposits	x	x			
Unidentified Conglomerate	x				
Kinkaid					
Degonia					
Tuscaloosa					
Ste. Genevieve/ Fredonia					
Warsaw	x	x			x
Fort Payne	x	x	x		
lower St. Louis/ Salem	x	x		x	x
upper St. Louis	x	x			x

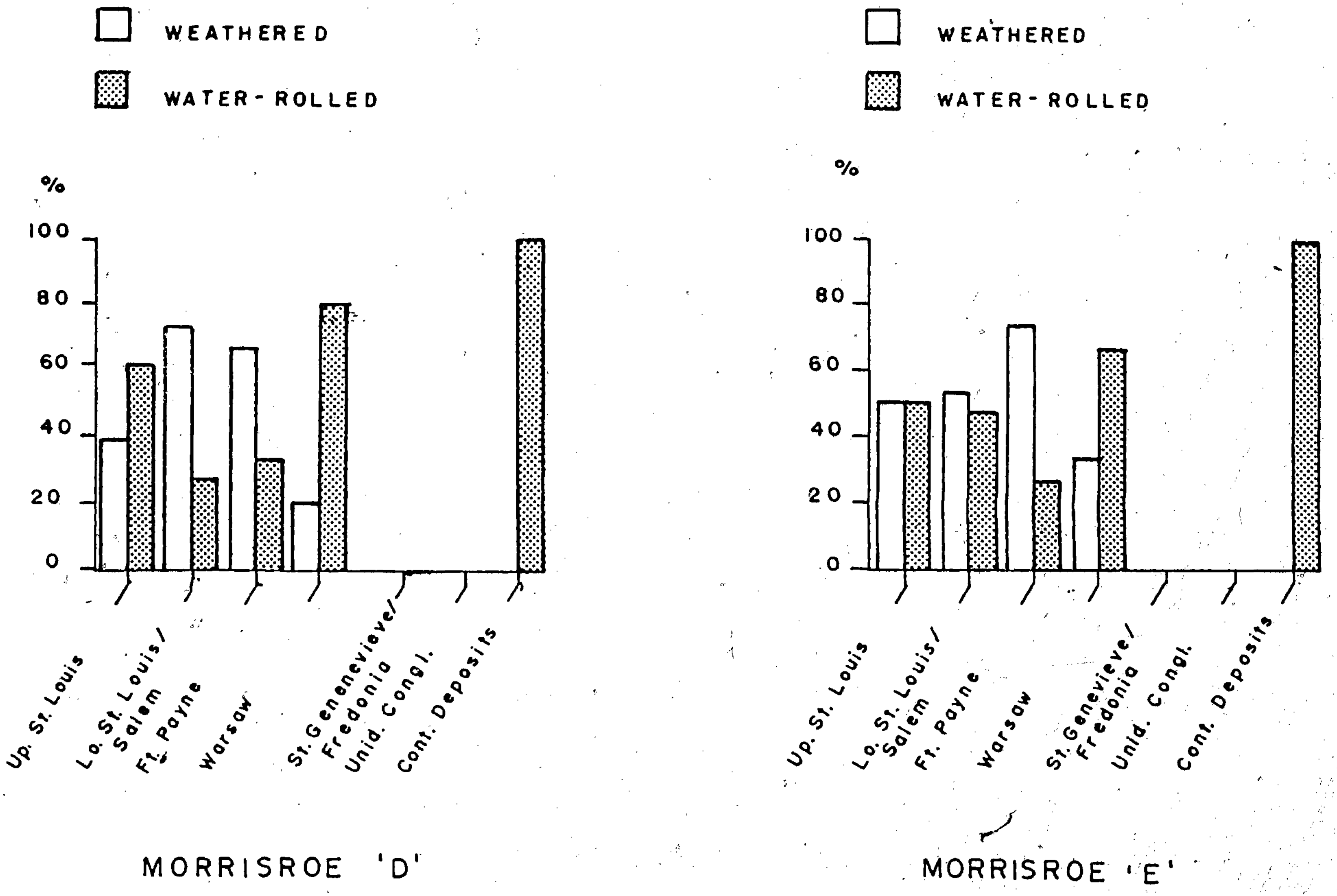


Figure 13. Proportion of chert types with various cortex types.

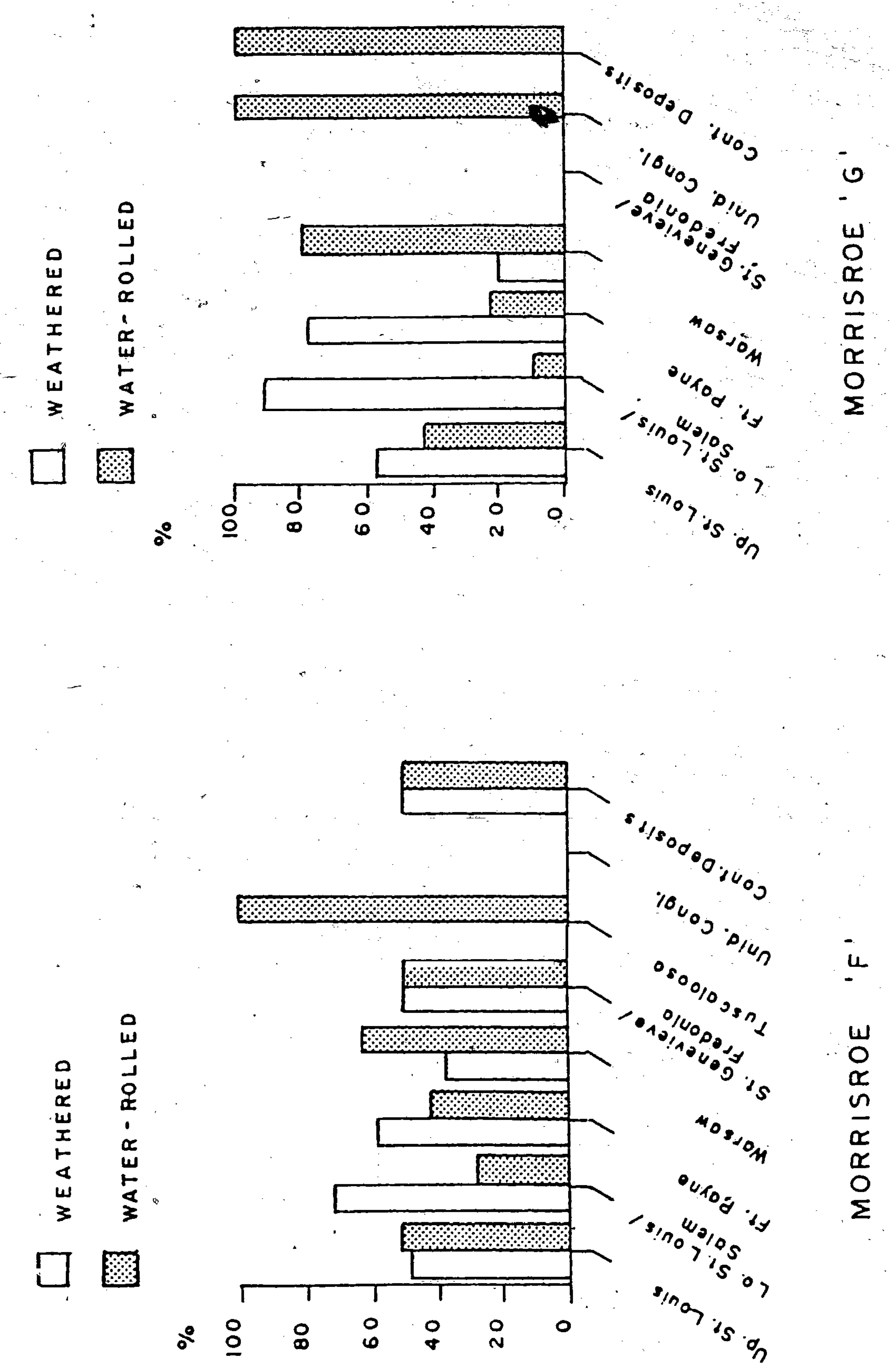
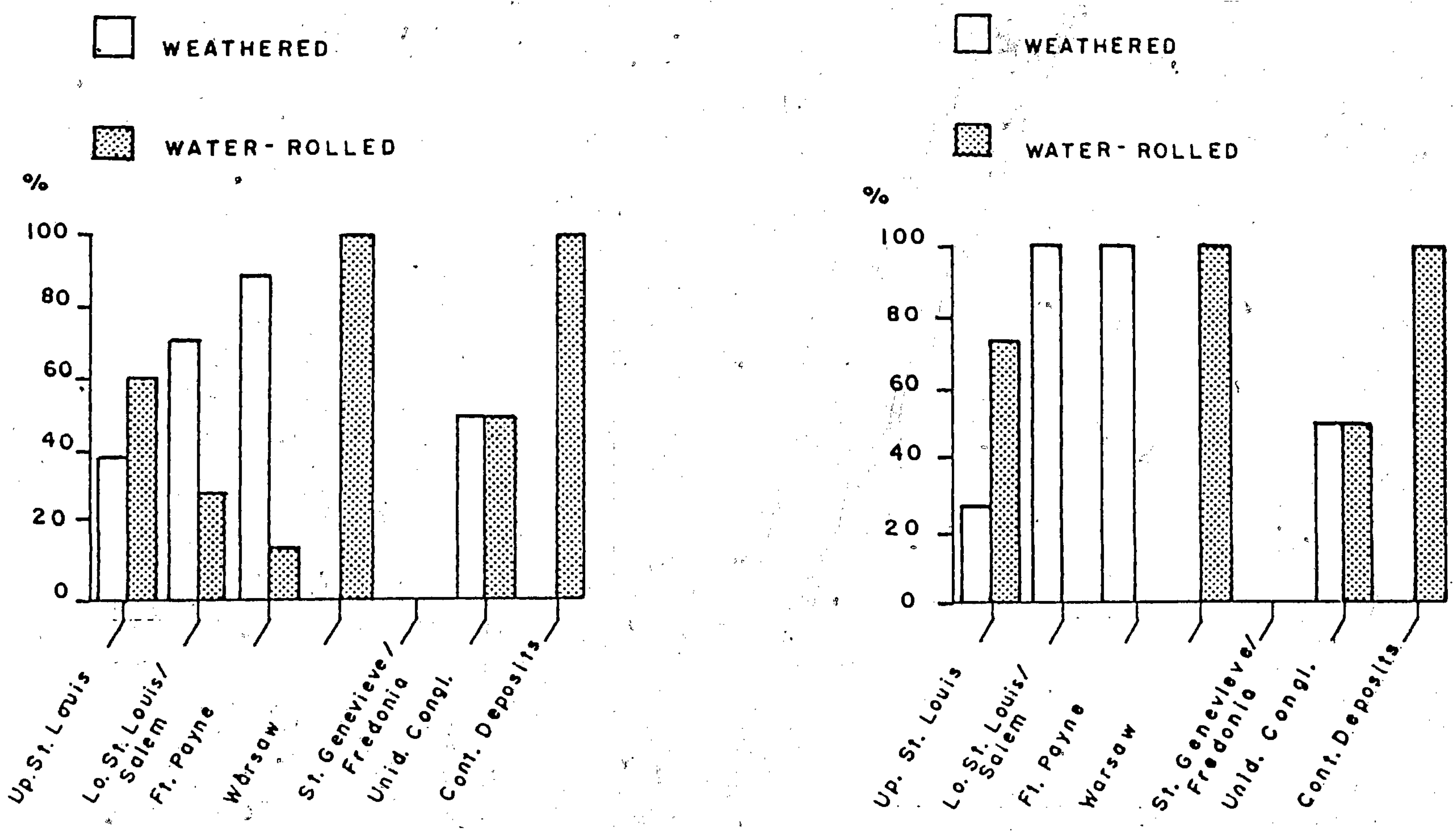


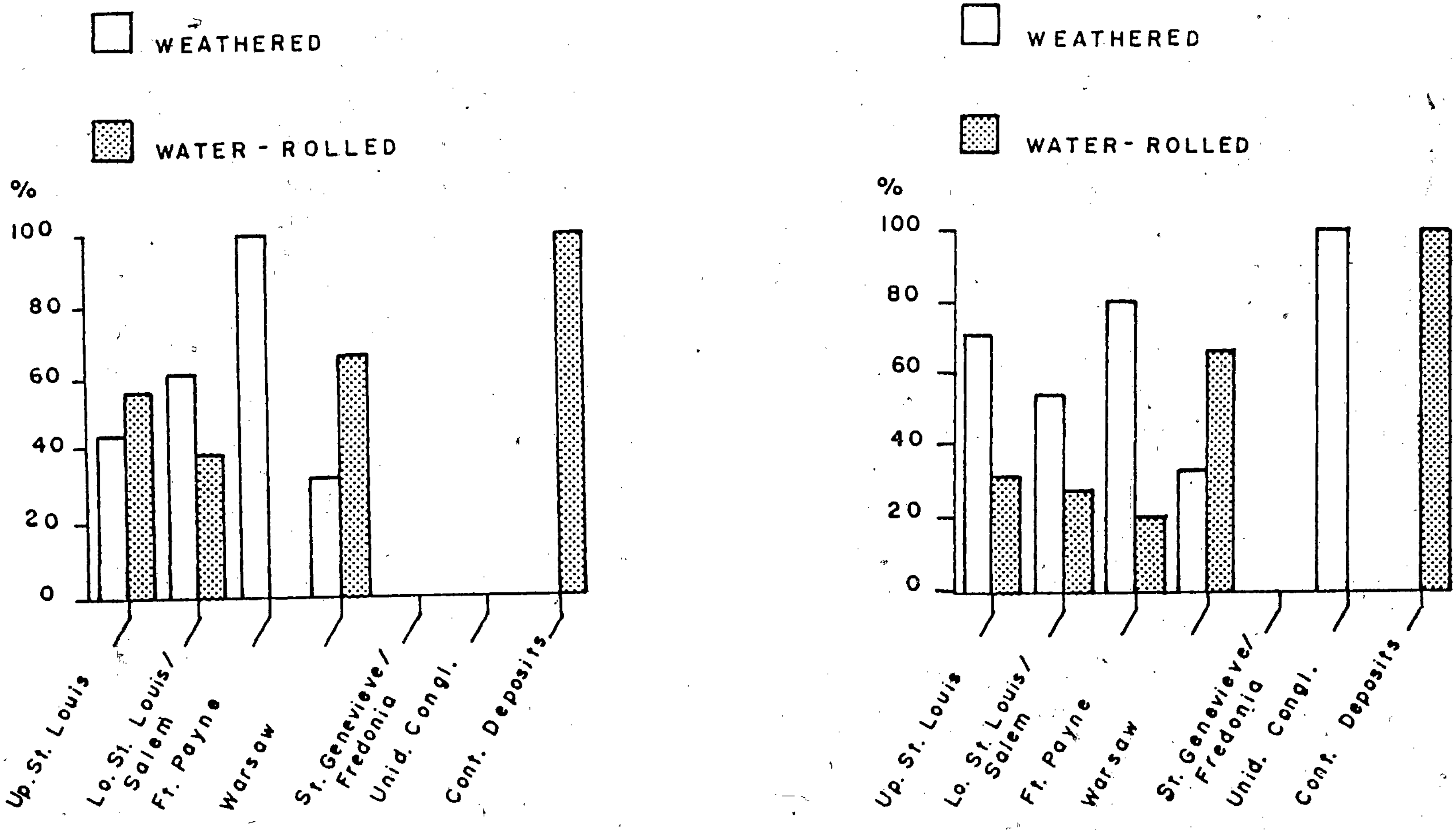
Figure 13. cont.



MORRISROE 'H'

MORRISROE 'I'

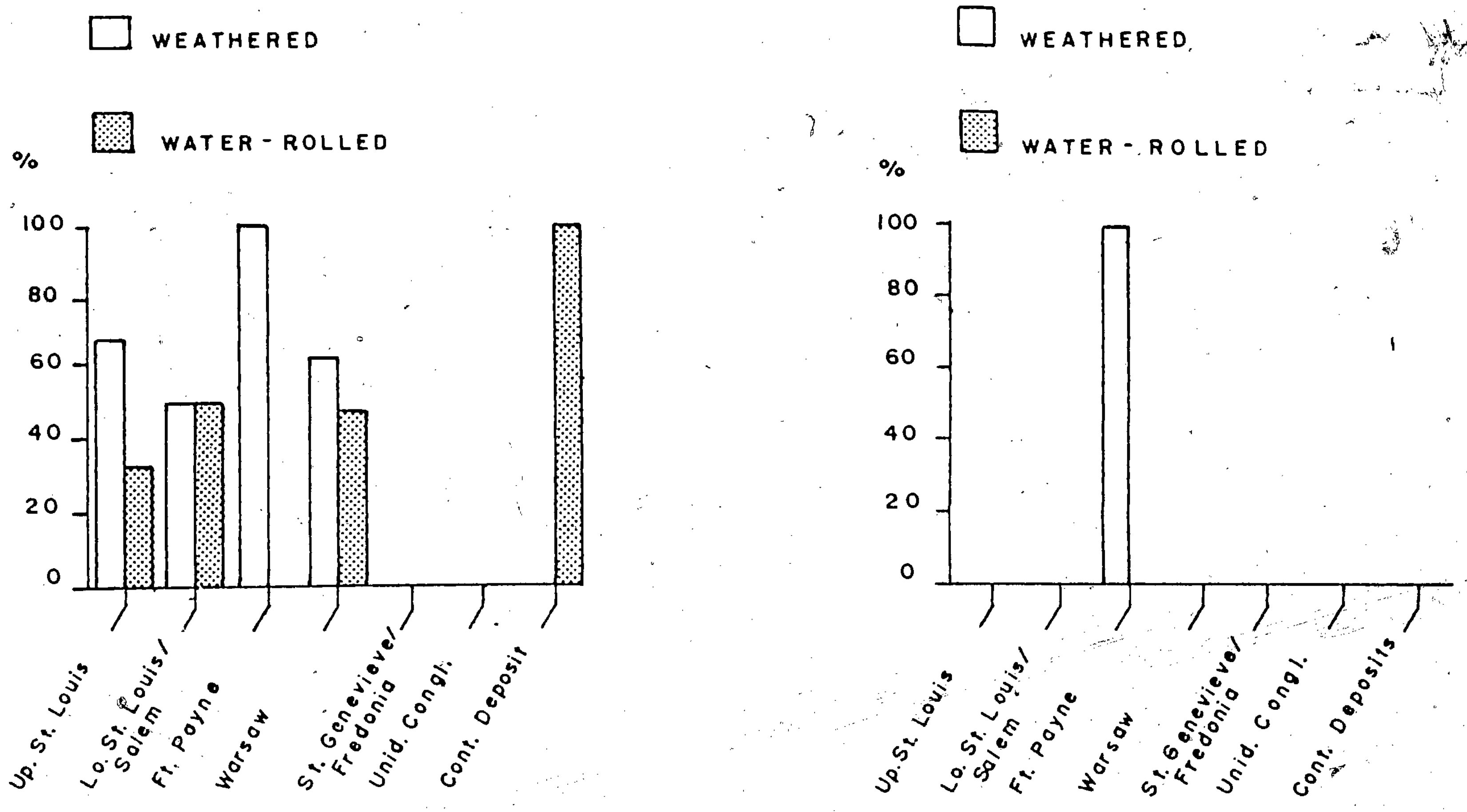
Figure 13. cont.



MORRISROE 'J'

TRAIL

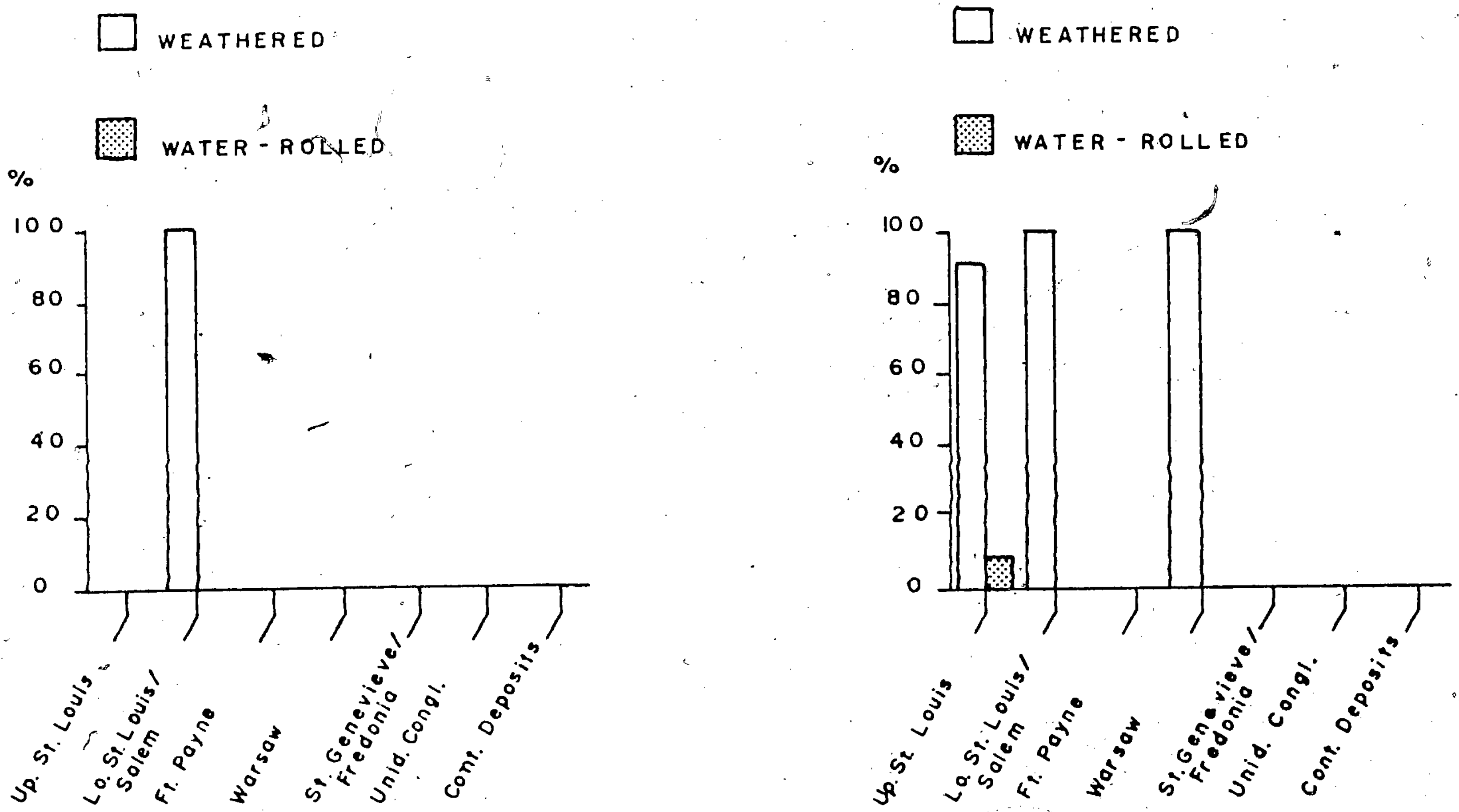
Figure 13. cont.



15 Tr 50

15 Tr 53

Figure 13. cont.



15 Tr 56

40 Sw 74

Figure 13. cont.

samples. Although some types of chert are well represented (e.g. n=224, upper St. Louis from the Trail site), in most cases relatively few pieces have been included. In many instances only a single cortical flake of a given chert type was identified in the entire sample. This greatly limits the inferences that can be drawn from the observed patterns and indicates that any result will be more suggestive than definite.

An examination of Figure 13 indicates that, in general, weathered cortex is more common than water-rolled cortex. In those instances where only a few chert types are present (e.g. assemblages from 15Tr53, 15Tr56 and 40Sw74) weathered cortex is either the only, or by far the predominant exterior surface present. In the other samples, the pattern is more complex as the cortex type often varies with the chert type. Upper St. Louis chert is predominantly represented by weathered cortex in assemblages from 15Tr50 and the Trail site. Water-rolled cortex occurs more often on the chert in Morrisroe assemblages D, H, and I. In the remaining samples (Morrisroe assemblages E, F, G, and J) there are approximately equal proportions of upper St. Louis chert with weathered and water-rolled cortices. Specimens of lower St. Louis/Salem cherts exhibit primarily weathered cortex in all but two samples. Items from 15Tr50 has equal proportions of weathered cortex and water-rolled cortex.

All of the samples which included Fort Payne chert exhibit a dominance of weathered cortex on that chert type. Warsaw chert reflects a different pattern in which water-rolled cortex is more prevalent in all but three samples. Weathered cortex is predominant in the sample from 15Tr50, and all of the Warsaw chert from 40Sw74 exhibits weathered cortex. Cortical flakes of St.Genevieve/Fredonia chert occur only in the samples from level 4 of the Morrisroe site. The weight of the sample is dominated by weathered cortex although the number of specimens with water-rolled cortex is equal to that with weathered exteriors.

Unidentified conglomerate pieces are present in four assemblages: Trail site and Morrisroe assemblages G, H, and I. All of the pieces from the Trail site exhibit a weathered cortex, while all of those from level 5 of the Morrisroe site have water-worn exteriors. The samples from assemblages H and I at the Morrisroe site exhibit more equal proportions of the two cortex types. Continental Deposits are almost exclusively represented by pieces with water-worn cortices. This cortex type is one of the defining features of this chert type and does not necessarily reflect the immediate source from which these pieces were obtained.

Chert Types and Artifact Types

This aspect of the analysis is concerned with determining if some lithic materials were selected for the manufacture of specific tool types. As an alternative to such selection, the occurrence of lithic types in various artifact categories may reflect the general profile of lithic utilization in each sample. The former situation implies some degree of selectivity in the use of available stone, and a concomittant amount of planning to acquire suitable materials. If no selectivity is involved, then the use of lithic material may be considered to have been more expedient.

In compiling the data for this analysis, the chert type and artifact class of each specimen were cross-tabulated. The resulting matrix included many cells which had low frequencies or which were empty. In order to reduce the computational problems resulting from the presence of many empty cells, the artifact types were grouped into three general categories. Bifacial artifacts include bifaces, hafted bifaces, drills and reworked, hafted bifaces. Unifacial artifacts comprise steeply retouched flakes, notches, gravers, perforators, and retouched flakes. The debitage category contains cortical flakes, secondary flakes, biface thinning flakes, microblades, cores, bipolar flakes and split pebbles, and angular fragments. The first two categories may reflect different activities. Bifacial tools may have been used for cutting (as knives) and piercing (hafted bifaces and drills), while unifacial artifacts may have been used for scraping and slicing (steeply retouched flakes, retouched flakes) as well as piercing (perforators). More importantly, the manufacture of bifacial artifacts requires more control in the removal of flakes and therefore demands a more tractable raw material. It may be expected that the frequency of lithic types in the debitage categories will mimic the general profile.

Bifacial Artifacts. The tabulation of bifacial artifacts manufactured from various chert materials is presented in Table 18. The rank-order of the lithic varieties in each assemblage is provided in Table 19. This table can be compared with Table 13, the rank-order of the lithic materials in each sample, not separated by artifact type. Spearman rank-order correlations were calculated for each sample to determine if the use of lithic material in the manufacture of bifacial artifacts differs significantly from the general use of lithic materials. As Table 20 indicates, there is no significant difference between the two sets of data. The selection of material for the manufacture of bifacial artifacts is not different from the general pattern of chert use in each sample.

Unifacial Artifacts. Table 21 presents the number of unifacial artifacts manufactured from various chert types. The rank-orders are presented in Table 22. Again, this table can be compared with the general rank-order of cherts in each sample (Table 13). The results of Spearman rank-order correlations of the overall pattern of chert use and the pattern exhibited by unifacial artifacts is presented in Table 23. It is apparent that there are no significant differences between the general patterns and the patterns exhibited by unifacial tools.

Debitage. The number of items classified as debitage in each sample are cross-tabulated by chert type in Tables 24 and 25. The former presents the frequency and the latter provides the rank-order of these counts. These ranks were compared to the

Table 18. Bifacial artifacts and chert types (counts).

Chert Types Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	6	5	3	2	1						
Morrisroe Assemblage E	5	25	1	1							
Morrisroe Assemblage F	10	37	2	2							
Morrisroe Assemblage G	10	38	2	5					1	2	
Morrisroe Assemblage H	8	12									
Morrisroe Assemblage I	10	10	2	2							
Morrisroe Assemblage J	10	16	1	3						3	

Table 18. cont.

Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail site	79	16	2	5					1	1	
15Tr50	27	1	3	7							
15Tr53	5	2	1								
15Tr56	4	1	1			1					
40Sw74	112	24	14	7							

Table 19. Rank-order of bifacial artifacts and chert types (counts).

Chert Types Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	1	2	3	4	5	8.5	8.5	8.5	8.5	8.5	8.5
Morrisroe Assemblage E	2	1	3.5	3.5	8	8	8	8	8	8	8
Morrisroe Assemblage F	2	1	3.5	3.5	8	8	8	8	8	8	8
Morrisroe Assemblage G	2	1	4.5	3	9	9	9	9	9	4.5	9
Morrisroe Assemblage H	2	1	7	7	7	7	7	7	7	7	7
Morrisroe Assemblage I	1.5	1.5	3.5	3.5	8	8	8	8	8	8	8
Morrisroe Assemblage J	2	1	4.5	4.5	8.5	8.5	8.5	8.5	8.5	3	8.5

Table 19. cont.

Chert Types / Assemblage	Trail site	15Tr50	15Tr53	15Tr56	40Sw74
Tamms Till	9	8	7.5	8	8
Continental Deposits	5.5	8	7.5	8	8
Unidentified Conglomerate	5.5	8	7.5	8	8
Kinkaid	9	8	7.5	8	8
Degonia	9	8	7.5	8	8
Tuscaloosa	9	8	7.5	8	8
Ste. Genevieve/ Fredonia	9	8	7.5	8	8
Warsaw	3	2	7.5	8	4
Fort Payne	4	3	3	3	3
lower St. Louis/ Salem	2	4	2	3	2
upper St. Louis	1	1	1	1	1

Table 20. Spearman rank-order correlation coeffecients of bifacial artifacts and total assemblage.

ASSEMBLAGE	r_s	p
Morrisroe Assemblage D	0.873	0.01
Morrisroe Assemblage E	0.860	0.01
Morrisroe Assemblage F	0.869	0.01
Morrisroe Assemblage G	0.929	0.01
Morrisroe Assemblage H	0.818	0.01
Morrisroe Assemblage I	0.786	0.01
Morrisroe Assemblage J	0.772	0.01
Trail site	0.896	0.01
15Tr50	0.900	0.01
15Tr53	0.801	0.01
15Tr56	0.820	0.01
40Sw74	0.853	0.01

Table 21. Unifacial artifacts and chert types (counts).

Chert Types / Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	3	4	1	1							
Morrisroe Assemblage E	21	25	5	2						1	
Morrisroe Assemblage F	14	36	5	2							
Morrisroe Assemblage G	11	39	3	3							
Morrisroe Assemblage H	15	19	2	1							
Morrisroe Assemblage I	1	9		2						1	
Morrisroe Assemblage J	4	14	1	1						2	

Table 21. cont.

Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail site	482	44	17	14	3					11	
15Tr50	114	16	24	20	2					2	
15Tr53	32	19	2	4							
15Tr56	19	4	6	2							
40Sw74	227	63	19	15						2	

Table 22. Rank-order of unifacial artifacts and chert types (counts).

Chert Types / Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	2	2	3.5	3.5	8	8	8	8	8	8	8
Morrisroe Assemblage E	2	1	3	4	8.5	8.5	8.5	8.5	8.5	5	8.5
Morrisroe Assemblage F	2	1	3	4	8	8	8	8	8	8	8
Morrisroe Assemblage G	2	1	3.5	3.5	8	8	8	8	8	8	8
Morrisroe Assemblage H	2	1	3	4	8	8	8	8	8	8	8
Morrisroe Assemblage I	3	1	8	2	8	8	8	8	8	4	8
Morrisroe Assemblage J	2	1	4.5	4.5	8.5	8.5	8.5	8.5	8.5	3	8.5

Table 22. cont.

Chert Types / Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail site	1	2	3	5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
15Tr50	1	4	2	3	5.5	9	9	9	9	5.5	9
15Tr53	1	2	4	3	8	8	8	8	8	8	8
15Tr56	1	3	2	4	8	8	8	8	8	8	8
40Sw74	1	2	3	4	8.5	8.5	8.5	8.5	8.5	5	8.5

Table 23. Spearman rank-order correlation coeffecients of unifacial artifacts and total assemblage.

ASSEMBLAGE	r_s	p
Morrisroe Assemblage D	0.865	0.01
Morrisroe Assemblage E	0.876	0.01
Morrisroe Assemblage F	0.876	0.01
Morrisroe Assemblage G	0.881	0.01
Morrisroe Assemblage H	0.884	0.01
Morrisroe Assemblage I	0.592	0.05 p 0.01
Morrisroe Assemblage J	0.936	0.01
Trail site	0.750	0.01
15Tr50	0.997	0.01
15Tr53	0.941	0.01
15Tr56	0.907	0.01
40Sw74	0.811	0.01

Table 24. Debitage and chert types (counts).

Chert Types Assemblage	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Morrisroe Assemblage D	182	413	220	89	7				4	27	
Morrisroe Assemblage E	185	480	247	93	16		1			6	
Morrisroe Assemblage F	171	481	177	59	9	3			1	21	
Morrisroe Assemblage G	205	566	157	27	1				4	8	
Morrisroe Assemblage H	142	248	87	19	4				5	9	
Morrisroe Assemblage I	189	169	39	12	2				6	18	
Morrisroe Assemblage J	228	244	33	30					13	42	7

Table 24. cont.

Assemblage	Chert Types upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail site	880	63	10	17					1	36	
15Tr50	297	232	80	78						4	
15Tr53	150	65	23	30				2			
15Tr56	60	29	7	12							
40Sw74	435	70	40	35	1	1				5	

Table 25. Rank-order of debitage and chert types (counts).

Assemblage \ Chert Types	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerates	Continental Deposits	Tamms Till
Morrisroe Assemblage D	3	1	2	4	5	9.5	9.5	9.5	7	6	9.5
Morrisroe Assemblage E	3	1	2	4	5	9.5	7	9.5	9.5	6	9.5
Morrisroe Assemblage F	3	1	2	4	6	7	10	10	8	6	10
Morrisroe Assemblage G	2	1	3	4	7	9.5	9.5	9.5	6	5	9.5
Morrisroe Assemblage H	2	1	3	4	7	9.5	9.5	9.5	6	5	9.5
Morrisroe Assemblage I	1	2	3	5	7	9.5	9.5	9.5	6	4	9.5
Morrisroe Assemblage J	2	1	4	5	9.5	9.5	9.5	9.5	6	3	7

Table 25. cont.

Assemblage / Chert Types	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Unidentified Conglomerate	Continental Deposits	Tamms Till
Trail site	1	2	5	4	9	9	9	9	6	3	9
15Tr50	1	2	3	4	8.5	8.5	8.5	8.5	8.5	5	8.5
15Tr53	1	2	4	3	8.5	8.5	8.5	5	8.5	8.5	8.5
15Tr56	1	2	4	3	8	8	8	8	8	8	8
40Sw74	1	2	3	4	6.5	6.5	9.5	9.5	9.5	5	9.5

general rank-order of chert in each sample (Table 13) using Spearman rank-order correlations. The results (Table 26) indicate highly significant correlations between the two sets of data. It is apparent that the two patterns of lithic utilization are very similar.

Discussion. These analyses indicate that the general profile of chert utilization, in which all of the data in each sample was considered simultaneously, provides an accurate portrayal for each assemblage. Specific types of materials do not appear to have been preferentially chosen for the manufacture of either bifacial or unifacial tools. The result is not surprising, as most of the material identified in this analysis is very tractable and was probably equally suitable for any of the required tasks.

Geographic Distribution of Chert Types

So far, this analysis indicates that most of the lithic material in the chipped stone assemblages occurs in the regional geological formations. The exception is the unidentified conglomerate, the source of which is presently unkown. This section examines the degree to which the pattern of chert availability is reflected in the pattern of prehistoric chert use.

The geographic distribution of chert-bearing geologic formations was determined through an examination of 7.5 minute

Table 26. Spearman rank-order correlation coeffecients of debitage and total assemblage.

ASSEMBLAGE	r_s	p
Morrisroe Assemblage D	0.991	0.01
Morrisroe Assemblage E	0.982	0.01
Morrisroe Assemblage F	0.991	0.01
Morrisroe Assemblage G	1.000	0.01
Morrisroe Assemblage H	1.000	0.01
Morrisroe Assemblage I	0.971	0.01
Morrisroe Assemblage J	0.971	0.01
Trail site	0.738	0.01
15Tr50	0.863	0.01
15Tr53	1.000	0.01
15Tr56	0.942	0.01
40Sw74	0.971	0.01

geologic quadrangle maps available for the area. The distribution of these quadrangles is presented in Figure 14. The regional distribution of chert-bearing geologic units has been discussed previously by Gatus (1979) and Nance (1980, 1984). The present discussion incorporates their results with my own analysis.

The presence/absence of selected chert-bearing formations on various geologic quadrangles is summarized in Table 27. The geologic units do not include all such units present on each map, but rather are those units whose cherts have been identified in the archaeological assemblages (see Table 11). Several points are important regarding the distribution. First, the Smithland and Burna quadrangle contain the greatest variety of chert-bearing deposits. The area contained by these maps includes the lowermost reaches of the Cumberland River and its confluence with the Ohio River (Figure 14). Second, the northernmost areas (i.e., those areas included on the Golconda, Lola, Salem, Smithland, Burna, Dycusburg, Fredonia, and Little Cypress maps) present a different profile of chert types than the other map-areas. While Menard, Degonia, Clore, Vienna and Kinkaid deposits frequently occur in the former areas, they are absent from the more southerly areas.

Third, Continental Deposits occur primarily in map-areas west of the Tennessee River. The Smithland, Burna and Dycusburg quadrangles are exceptions, lying north and east of the Tennessee River and containing Continental Deposits. Fourth,

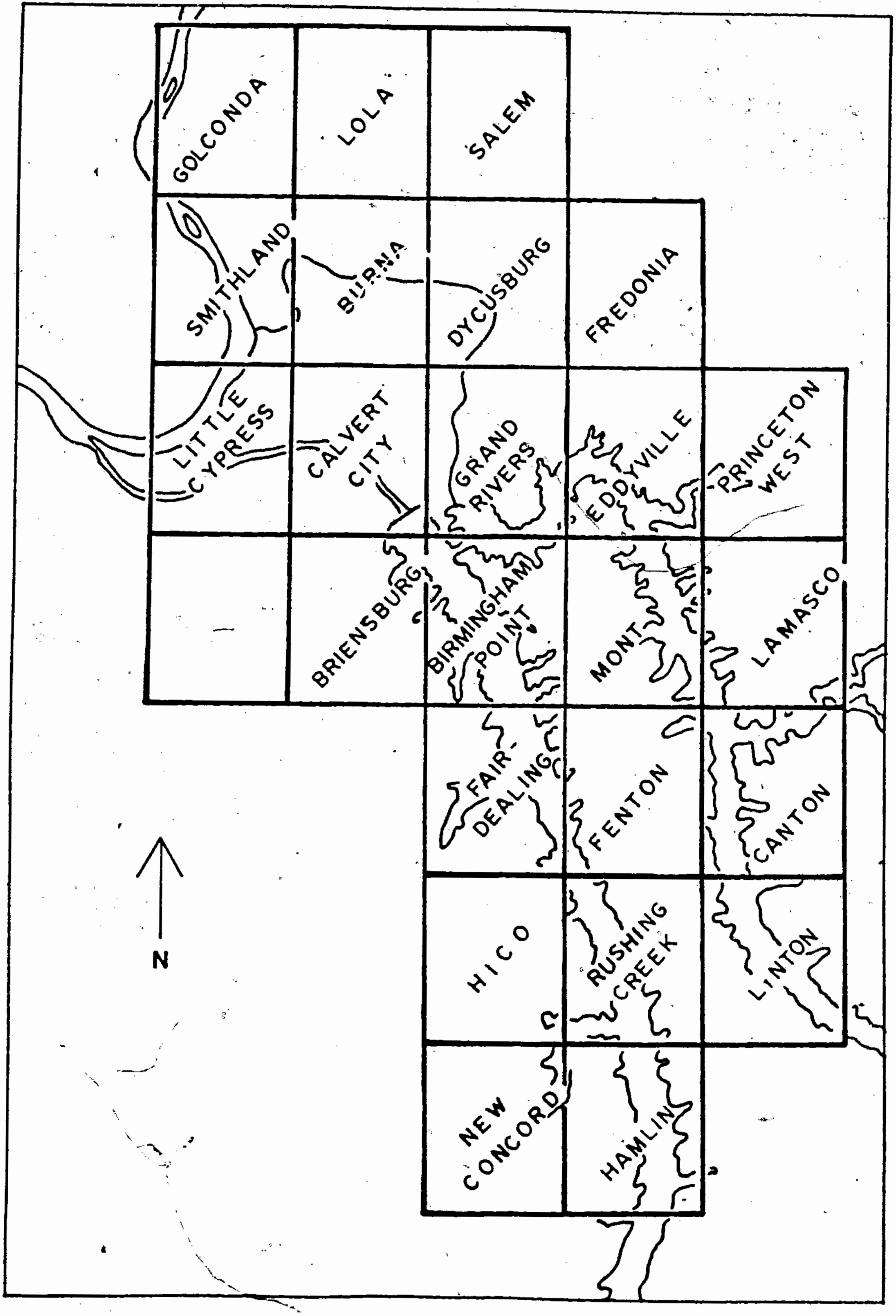


Figure 14. Geologic quadrangles in the study area.

Table 27. Chert-bearing deposits in geologic quadrangle map-areas.

Chert Types / Geologic Quadrangle	upper St. Louis	lower St. Louis/ Salem	Fort Payne	Warsaw	Ste. Genevieve/ Fredonia	Tuscaloosa	Degonia	Kinkaid	Continental Deposits
Golconda							x	x	
Lola	x				x		x		
Salem	x				x				
Smithland	x		x				x	x	x
Burna	x	x	x	x	x	x	x		x
Dycusburg	x	x		x	x				x
Fredonia	x	x			x			x	
Little Cypress			x				x	x	x
Calvert City	x	x	x	x	?	x			x
Grand River	x	x	x	x		x			
Eddyville	x	x	x	x		x			

Table 27. cont.

Chert Types / Geologic Quadrangle	Princeton West	Brienburg	Birmingham	Mont	Lamasco	Fairdealing	Fenton	Canton	Hico	Rushing	Model
Continental Deposits		x				x			x	x	
Kinkaid											
Degonia											
Tuscaloosa	x	x	x	x	x	x	x	x		x	x
Ste. Genevieve/ Fredonia	x										x
Warsaw		x	x	x	x	x	x	x	x	x	x
Fort Payne		x	x			x	x	x	x	x	x
lower St. Louis/ Salem		x	x	x	x	x	x	x		x	x
upper St. Louis	x	x	x	x	x	x	x	x		x	x

Table 27. cont.

Chert Types	Geologic Quadrangle	
	New Concord	Hamlin
Continental Deposits	x	x
Kinkaid		
Degonia		
Tuscaloosa		x
Ste. Genevieve/ Fredonia		
Warsaw		x
Fort Payne	x	x
lower St. Louis/ Salem		x
upper St. Louis		x

upper St. Louis, lower St. Louis, Warsaw, and Fort Payne formations are present on 50 per cent (12 of 24) of the geologic quadrangles examined. Chert from these formations are among those which occur most frequently in the archaeological assemblages. An examination of the distribution of upper St. Louis and lower St. Louis/Salem (generally the first and second most abundant chert types in the archaeological samples) reveals that they are present on 66.67 per cent (16 of 24) of the map-areas.

A comparison of the distribution of locally available chert (Table 27) with the presence/absence of chert types in the archaeological assemblages (Table 11) does not reveal any significant trends. Those chert types found primarily in the northern part of the study area (e.g. Degonia and Kinkaid) are found at sites further south (i.e., 15Tr53). Similarly, while Continental Deposits generally occur west of the Tennessee River, items made of this material occur at the Trail site and at sites 15Tr50 and 40Sw74, all of which are on the Cumberland River side of the divide. It is apparent that cherts occurring in the archaeological assemblages reflect items procured from throughout the study area and that this pattern was maintained during the entire time period examined in this study.

Gatus (1979) has also assessed the forms in which various cherts were available to the prehistoric occupants of the area. The discussion is necessarily limited as substantial environmental alteration has occurred since Archaic times. Most notably, the construction of the Kentucky and Barkley Dams has raised water levels, submerging many gravel bars. River channel maintenance by the Army Corps of Engineers has undoubtedly led to the dredging of other bars and shoals. Nevertheless, a comparison between the potential cortex types and those found in the archaeological samples will permit a refinement of the model of chert procurement.

The forms in which various chert types occur are summarized in Table 28. Weathered surfaces may be expected on specimens obtained from bedrock outcrops or from the residuum. Gravel deposits will have a water-rolled cortex. Table 29 presents the cortex types possible for each of the chert types, and Figure 13 summarizes the cortex types found in the archaeological samples. No cortical flakes were made from either Degonia or Kinkaid chert. Interestingly, while Gatus (1979: 33) suggested that Tuscaloosa chert would be available on exposed hilltops, the archaeological examples exhibit only water-rolled cortex. In general, weathered cortices were found to be more common than water-rolled surfaces. This suggests that items occurring in the residuum or as bedrock outcrops were utilized more frequently than stream deposits. Warsaw chert is an exception to this pattern, with water-rolled surfaces being more common.

Table 28. Cortex types of chert in the study area.

Chert Type	Weathered	Water-Rolled
upper St. Louis	x (?)	x
lower St. Louis/Sale,	x	x
Fort Payne	x	x
Warsaw	x	x
Ste. Genevieve/Fredonia	x	x
Tuscaloosa	x	
Degonia	x	x
Kinkaid	x	
Continental Deposits	x (?)	x

Table 29. Occurrence of chert types (after Gatus 1979).

Chert Type	Occurrence
upper St. Louis	occurs in residuum and probably as bedrock outcrops and stream gravels
lower St. Louis/ Salem	probably avaiable in residuum and in stream gravels
Fort Payne	restricted to Land Between the Lakes area and the Tennessee River; common in residuum and probably the stream gravels as well
Warsaw	most common near rivers where downcutting has exposed the deposits; available in outcrops, residuum and stream gravels
Ste. Genevieve/ Fredonia	only known source is a cave outcrop at the Cox site
Tuscaloosa	probably exposed on hilltops by erosion or denudation
Degonia	probably accessible in residuum and stream gravels
Kinkaid	occurs as bedrock outcrops
Continental Deposits	available on hilltops where erosion exposes deposits

Chapter Summary

The analysis of raw material use does not provide any clear indication of the relative mobility of the various groups. Geologic maps indicate that the material in each assemblage occurs throughout the entire study area, suggesting similar scales of mobility throughout all of the time periods encompassed by this study. Unfortunately, specific source localities have not been identified. Such data are necessary for more precise estimates of mobility.

CHAPTER IX

ANALYSIS OF ASSEMBLAGE STRUCTURES

In this dissertation, the structure of an archaeological assemblage has been defined as the variety of items present, their relative abundance, and their pattern of covariation. In Chapter 5 it was suggested that factors affecting assemblage structures include: the range of activities undertaken at a site; the duration of occupation; the size of the group occupying a site; technological variations; and the use of different types of lithic materials. It was demonstrated in Chapter 8 that the pattern of chert use was similar in each assemblage and, therefore, the differences between assemblage structures cannot be attributed to the use of different varieties of lithic material.

This chapter is concerned with providing a description and analysis of the structure of each of the archaeolgical assemblages examined in this study. The analysis of these structures will aid in determining if the differences between assemblages result from different technological structures, or if they relate to variations in activities, group size, or length of occupation. If the differences between assemblages are due to these latter factors, then they may be interpretted in light of the models of mobility strategies.

Expectations

Three sources of variation in assemblage structure can be identified: differences in technological structures; differences related to the nature of site occupation; and differences resulting from sampling error. The source of differences between assemblage structures may be expected to result in distinctive patternings of those structures. That is, assemblage structures which result from different technological structures will be different from one another in ways which are distinctive from assemblage structures resulting from variations related to duration of occupation or group size. This section outlines the differences which are expected to result from each of these sources of variation. The results of the analysis can be interpreted in light of these expectations.

First, it is expected that if technological structure is a significant source of differences between assemblage structures, then the assemblages will contain complementary sets of tools and debitage. The examination of tool types implies assumptions regarding the functional equivalency of some artifact types. Differences between assemblages are not considered to be indicative of different activities, but rather result from different ways of making tools which would be used for similar purposes. The inclusion of debitage in the analysis may serve to strengthen such an interpretation. Assemblages with distinctive types of debitage would have resulted from different technological structures. Where debitage is similar, it is assumed that differences in technological structure were not important in the formation of the assemblage structure.

Second, it is expected that the structure of assemblages will vary along a continuum from very stable residential bases to less stable residential bases to base camps. Residential bases, whether they were more or less stable, will be identifiable by assemblages which contain the widest variety of items and will not exhibit special associations of certain types. Differences resulting from variations in stability and group size will be expressed in the variety of items present; stable residential bases will have a relatively greater variety of items. Base camps can be expected to differ from residential bases by virtue of generally impoverished assemblages which contain distinctive associations of some tool types. These special associations are expected to reflect the nature of the foraging group's activities.

Third, assemblage structure may vary as a result of sampling bias. The recovery of archaeological data may result in the sampling of areas of sites which do not include equivalent activity areas. This problem is especially important in cases where sites have an internal spatial structure with regard to the distribution of tools and debitage. Assemblages which indicate that sites are quite different may, in fact, reflect sampling biases of sites which are very similar. In addition, it is expected that a greater number of artifact types will be identified in assemblages which have larger numbers of items.

This phenomenon of collector's curves (Pielou 1975) has been widely noted in ecology and paleontology. The interpretation of these curves, when applied to archaeological data, is not straightforward, since the variety of items produced is influenced by a range of cultural factors. Such curves, therefore, are not directly related to the total number of items in an assemblage. The problems imposed by sampling vagaries will be included in a discussion of specific results of the analyses.

Analysis of Assemblage Structure

The presence and absence of each artifact type in each assemblage is presented in Table 30 while Appendix D presents the number of items in each class. Many classes do not appear to vary in their occurrence in various assemblages. Furthermore, the variation which is present appears to be minor. This suggests that similar types of activities were responsible for the formation of each assemblage. It remains to be shown, however, whether or not there is significant variation in the prevalence with which various classes occur. The following comparison of the assemblages using principal components analysis was undertaken in an effort to determine similarities and differences between asssemblages by considering, simultaneously, the entire composition of the assemblages. Two such analyses were undertaken: one includes all lithic material; the other considers only the chipped stone tools and debitage. These complementary analyses examine the effects of including

Table 30. Presence/absence of artifacts in assemblages.

Type Assemblage	cores	angular fragments	bipolar by-products	cortical flakes	secondary flakes	microblades	bifacial thinning flakes	heavy retouched flakes	retouched/ utilized flakes	gravers	perforators
Morrisroe A	x	x	x	x	x		x	x	x	x	
Morrisroe B	x	x	x	x	x		x		x	x	
Morrisroe C	x	x	x	x	x		x		x		
Morrisroe D	x	x	x	x	x		x	x	x	x	
Morrisroe E	x	x	x	x	x		x		x	x	
Morrisroe F	x	x	x	x	x		x		x	x	x
Morrisroe G	x	x	x	x	x		x	x	x	x	x
Morrisroe H	x	x	x	x	x		x		x		
Morrisroe I	x	x	x	x	x		x		x	x	
Morrisroe J	x	x	x	x	x		x		x	x	
Trail site	x	x	x	x	x	x	x	x	x	x	
15Tr50	x	x		x	x	x	x		x		

Table 30. cont.

Type / Assemblage	Morrisroe A	Morrisroe B	Morrisroe C	Morrisroe D	Morrisroe E	Morrisroe F	Morrisroe G	Morrisroe H	Morrisroe I	Morrisroe J	Trail site	15Tr50
battered cobble						x	x		x	x	x	x
pitted cobble					x	x		x	x	x	x	
pestle							x	x	x			
mortar							x					
atlatl weight							x					
reworked hafted bifaces										x	x	
drills	x		x	x		x	x	x	x		x	x
hafted bifaces	x	x	x	x	x	x	x	x	x	x	x	x
bifaces	x	x	x	x	x	x	x	x	x	x	x	x
steeply retouched flakes	x	x	x	x	x	x	x	x	x	x	x	
notches	x	x	x	x	x	x	x	x	x	x	x	x

Table 30. cont.

Table

Assemblage	ground cannel coal	ferrogenous concretions	miscellaneous groundstone
Morrisroe A			
Morrisroe B			
Morrisroe C			
Morrisroe D			
Morrisroe E			x
Morrisroe F			
Morrisroe G		x	
Morrisroe H	x		
Morrisroe I			x
Morrisroe J			x
Trail site 15Tr50			x

Table 30. cont.

Type	Assemblage		
	15Tr53	15Tr56	40Sw74
perforators			x
gravers			x
retouched/ utilized flakes	x	x	x
heavy retouched flakes			
bifacial thinning flakes	x	x	x
microblades	x		x
secondary flakes	x	x	x
cortical flakes	x	x	x
bipolar by-products			
angular fragments	x	x	x
cores	x	x	x

Table 30. cont.

Type Assemblage	notches	steeply retouched flakes	bifaces	hafted bifaces	drills	reworked hafted bifaces	atlatl weights	mortars	pestles	pitted cobbles	battered cobbles
15Tr53	x		x	x	x						
15Tr56	x		x	x							
40Sw74	x	x	x	x		x					x

Table 30. cont.

Type Assemblage	ground cannel coal	ferrogenous concretion	miscellaneous groundstone
15Tr53			
15Tr56			
40Sw74		x	

some artifact classes (groundstone and pecked and battered stone) which have only a very limited distribution among the assemblages.

Principal components analysis is a multivariate statistical technique concerned with defining the major components which account for the variance amongst a set of variables. These factors are then ordered "in terms of the amount of variance they define. The last factors accounting for trivial variance are then ignored in subsequent analysis" (Rummel 1970: 112). Although the principles are similar, factor analysis and principal components analysis differ in their underlying assumptions and therefore require different interpretations. Factor analysis assumes that the variance between variables arises from common and specific sources. Variances which are common are those which are shared with other variables, while specific variances are unique to a particular variable. Thus, factor analysis requires an implicit model of covariance of the variables in the data set. The goal of factor analysis is to isolate the important factors as defined by the covariance.

Principal components analysis requires no assumptions regarding common and unique sources of variance. Rather, "The data are taken as given and the dimensions of space defining these data are determined" (Rummel 1970: 112). There is no need to propose models concerning how some variables may covary with other variables. In the present study, this means that it is not necessary to suggest (or determine) which types of artifacts are most likely to occur together. Instead, principal components analysis is employed as an efficient data-reduction technique which aids in the description of the data and the assessement of models developed outside of the analytic procedure.

The assemblages considered in this study include widely varying numbers of items. Consequently, ~~a direct~~ comparison of the number of items in each class would be significantly biased by the variations in the sizes of the collections. Sneath and Sokal (1973: 152-157; 169-174) discussed a variety of scaling techniques which overcome the biases of variable collection sizes. Johnson (1981: 66-67) compared the effects of using two such methods (proportions and standardization) in an analysis of biface assemblages from northern Mississippi. He concluded that, since standardization is "based on the standard deviation around the mean ... absent and underrepresented classes are emphasized in proportion to the relative density of the assemblage." (Johnson 1981: 67). Standardization removes "the differences in means and deviations between variables from their covariance" (Rummel 1970: 290). Rummel (1970: 292) noted that considerably more information is retained if the "variables (or cases) are centered by subtracting their means." The variability resulting from different deviations about the means is preserved.

The data in this study were transformed by centering before a principal components analysis was applied (Appendix E). Centering involves subtracting the mean value from each variable (or case) to "remove the covariance associated with different means while retaining that resulting from different deviations around the means" (Rummel 1970: 292). A certain amount of information is lost as the mean value of each variable (or case) is removed. However, the calculation of means is, partly, a function of sample size. Since the sizes of the samples examined here vary so greatly, it is desirable to transform the data in such a way as to eliminate as much of this source of error as possible. Variables, rather than cases, were centered since it is the distribution of these variables which is of interest. That is, the focus is on how the occurrence of a given artifact type in a specific assemblage varies from its average occurrence in all assemblages. If centering had been done by case, the resulting matrix would have reflected the dimensions of various debitage classes and the rarity of groundstone in each assemblage.

The two principal components analyses were undertaken using the SPSSX program (SPSS Inc. 1983). In each instance a preliminary analysis was undertaken in which ten components were arbitrarily removed to determine the maximum number of meaningful components to include in a more detailed analysis. Scree diagrams (Rummel 1970: 361) were constructed in which the number of components (abscissa) were plotted against the proportion of total variance (on the ordinate). The point at which the graph levels off provides an indication of the number of appropriate components to be examined. Figures 15 and 16 present scree diagrams for each of the principal components

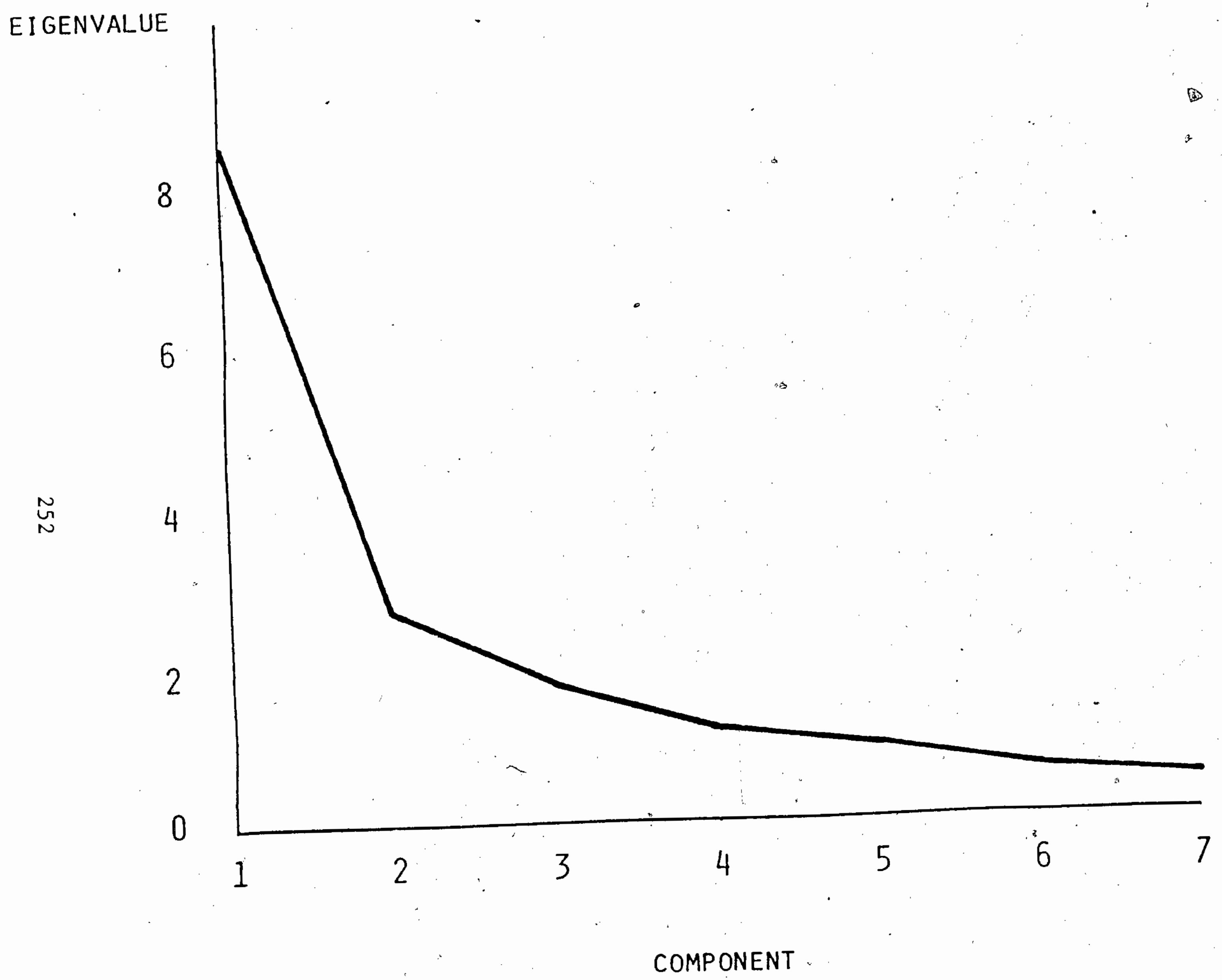


Figure 15. Scree diagram, principal components analysis, chipped stone.

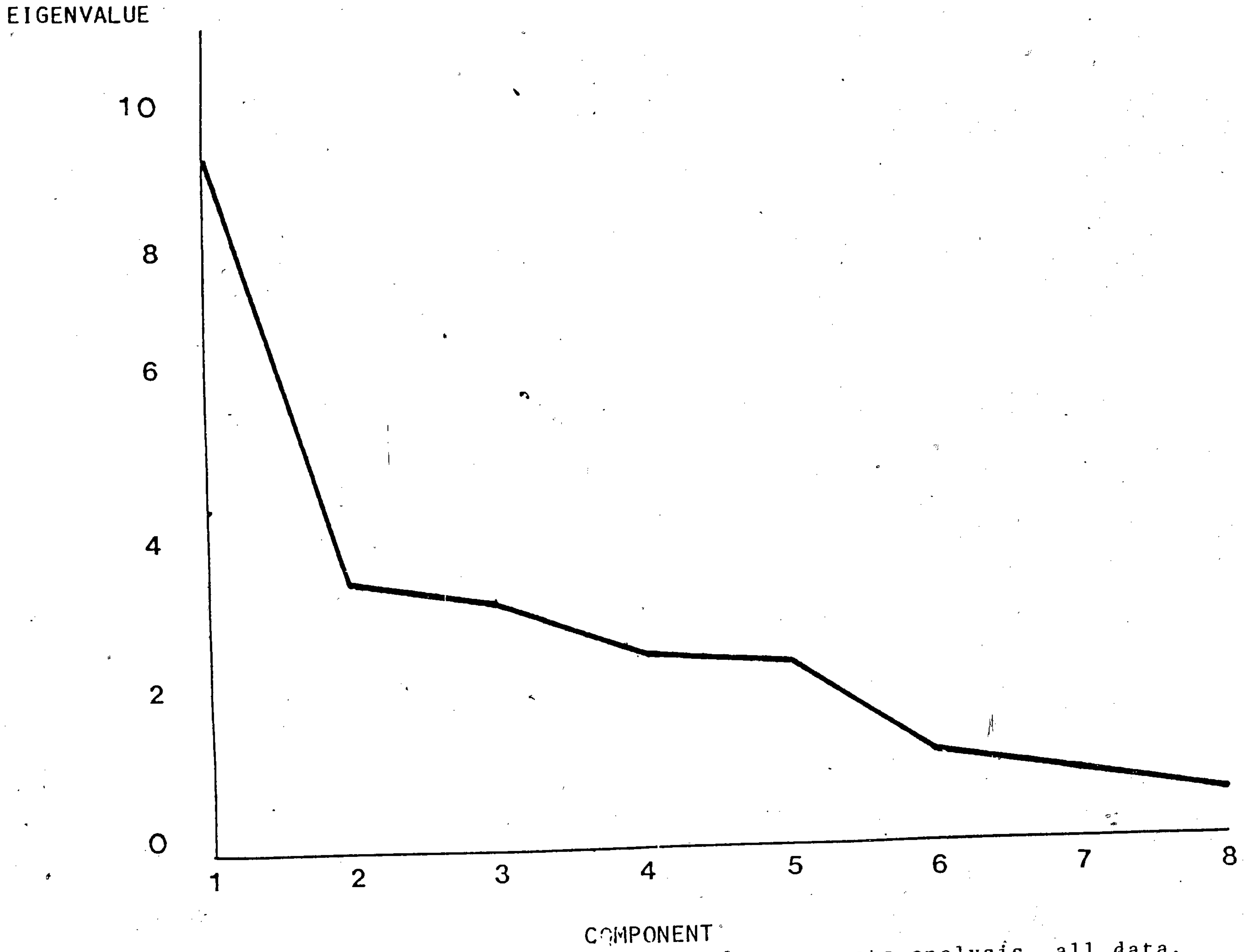


Figure 16. Scree diagram, principal components analysis, all data.

analysis. It is apparent from these that six components are required to adequately account for the variance when all of the lithic material is included, while five components account for variances when only chipped stone artifacts are considered.

Once the initial principal components analyses were completed, the resulting axes were orthogonally rotated using a varimax rotation (Rummel 1970: 391-393). In an unrotated principal components analysis, the first component will be a general one, describing variance amongst a large number of variables. When components are rotated, emphasis is shifted from components which maximize the total variance to components which delineate separate groups of highly covarying variables (Rummel 1970: 377). According to Rummel (1970: 376-380), rotation enables one to define the simple structure of a data matrix, thereby permitting a substantively more interesting interpretation of the principal components analysis. Axes rotation is also more parsimonious, since fewer rotated components are required to define a matrix. The following discussion presents the results of the rotated principal components analysis.

Chipped Stone Assemblages

The results of the rotated principal components analysis of chipped stone assemblages are presented in Table 31. This table presents the cumulative proportion of variance accounted for by each successive component and indicates the eigenvalues of each variable in the definition of each component. Only three rotated

Table 31. Principal components analysis of chipped stone assemblages.

Component	I	II	III	IV	V
Eignevalue	8.5572	2.7451	1.8133	1.2136	1.0110
Proportion of variance	50.34	66.48	77.15	84.29	90.24
cores	.47622	.64758	.50628	.08901	.19762
angular fragments	.58977	-.34656	.16621	.40199	-.34665
bipolar by-products	-.00172	-.52803	.35839	.36857	.52576
cortical flakes	.76562	-.59551	.14791	-.04930	-.12932
secondary flakes	.73036	-.43644	.03262	.05092	-.21689
microblades	.15179	.48076	-.39407	.40534	-.46495
bifacial thinning flakes	.86112	-.03957	-.43958	.02688	-.00421
heavy retouched flakes	.43956	-.17500	-.42667	-.55825	.22930
retouched flakes	.72371	.65045	.08576	.03591	.09617
gravers	.89482	-.01992	-.28752	.08265	.22528
perforators	.41473	.18440	.57752	-.56126	-.29555
notches	.89718	.06143	.40601	.01078	-.00215

Table 31. cont.

Component	I	II	III	IV	V
steeply retouched flakes	.91100	-.31135	.04504	.08346	.14325
bifaces	.89292	-.25948	.10691	.06041	-.09478
hafted bifaces	.87503	.44069	.14423	-.06871	-.00268
drills	.85431	-.13400	-.38382	-.22859	-.02934
reworked hafted bifaces	.69360	.52984	-.27834	.18888	.25508

components are necessary to account for a large amount of the variance.

Component 1. This component is defined by debitage from all stages of lithic reduction, including cortical flakes, secondary flakes, bifacial thinning flakes and angular fragments. A variety of flake tools and more well-formed tools (i.e., steeply retouched flakes, bifaces, drills) are also important. These suggest that this component reflects a wide range of maintenance activities, perhaps associated with the refurbishing of tools. The unimportance of hafted bifaces and reworked hafted bifaces supports this suggestion.

Component 2. This component is distinguished by a general absence of debitage, indicating that lithic reduction is not an important feature. Hafted bifaces and reworked hafted bifaces are common, but evidence of their manufacture (bifacial thinning flakes) is rare. Cores, retouched flakes and gravers also occur. The presence of cores suggests that lithic reduction was important.

Component 3. The third component is defined by the presence of heavy retouched flakes, drills, gravers, and bifacial thinning flakes. These may represent a specialized set of maintenance activities.

Having determined the variables associated with each component, it is now possible to examine which of these components describe the various assemblages. Such an examination will enable a substantive discussion of the similarities and differences between assemblages. The component loadings for each assemblage are presented in Table 32.

Morrisroe Assemblage A. This assemblage is characterized by large, but negative values for Components 1 and 2 and a high, positive loading for Component 3. This suggests that lithic reduction was unimportant and that the general range of activities was limited. The manufacture, use and discard of bifaces, hafted bifaces and reworked hafted bifaces was apparently unimportant. On the other hand, the activities represented by the association of items in Component 3 were important. The restricted range of activities suggests that the assemblage represents a short term occupation.

Morrisroe Assemblage B. This assemblage is characterized by a large negative value for Component 1 and a moderately negative value for the other components. These values suggest that all activities were limited and that the assemblage is defined by a general underrepresentation of all categories of artifacts. This apparent restricted range of activities suggests that the assemblage was formed as the result of short term occupation.

Morrisroe Assemblage C. This assemblage, as with the previous one, is defined by negative values for all of the components. Again, this suggests that the assemblage resulted from a very limited range of activities, perhaps during a short

Table 32. Assemblage loadings on rotated components, chipped stone assemblages.

Assemblage	Component I	Component II	Component III
Morrisroe Assemblage A	-0.98	-.054	+0.96
Morrisroe Assemblage B	-0.66	-0.39	-0.22
Morrisroe Assemblage C	-0.64	-0.40	-0.23
Morrisroe Assemblage D	-0.51	-0.67	+1.01
Morrisroe Assemblage E	+1.83	-0.66	-1.47
Morrisroe Assemblage F	+1.87	-0.51	-0.39
Morrisroe Assemblage G	+0.89	-0.77	+1.41
Morrisroe Assemblage H	-0.06	-0.28	-0.25
Morrisroe Assemblage I	-0.38	-0.36	-0.02
Morrisroe Assemblage J	+0.13	+0.79	-0.99
Trail site	+1.25	+2.02	+2.14
15Tr50	+0.04	-0.02	-0.96
15Tr53	-0.91	-0.38	-0.02
15Tr56	-1.05	-0.38	+0.07
40Sw74	-0.81	+2.54	-1.05

term occupation.

Morrisroe Assemblage D. This assemblage is characterized by a large positive loading on Component 3 and large negative loadings on Components 1 and 2. Lithic reduction was, apparently, not important in the formation of this assemblage and bifaces, hafted bifaces, and reworked hafted bifaces do not form an important constituent of the assemblage. Rather, those activities related to Component 3 were important. This pattern is similar to that of Assemblage A, and a similar interpretation may apply to both assemblages. In both cases, a limited range of activities is indicated.

Morrisroe Assemblage E. This assemblage is characterized by a very large positive value for Component 1 and large or very large negative values for Components 2 and 3. This pattern suggests that the assemblage was formed as the result of a wide range of activities, including all stages of lithic reduction and the discard of a range of expedient flake tools. Specialized activities (defined by Components 2 and 3) were unimportant in the formation of this assemblage. Such a pattern may be indicative of a residential base camp of long duration at which a wide range of activities were undertaken.

Morrisroe Assemblage F. This assemblage is similar to Assemblage E, with a high positive loading for Component 1 and negative loadings for Components 2 and 3. Again, this suggests that the assemblage was formed as the result of a wide range of activities including all stages of lithic reduction. Interestingly, activities represented by artifacts in Components 1 and 2 are not as underrepresented in this assemblage as they are in Morrisroe Assemblage E. This assemblage is interpreted as having resulted from a long term occupation of a residential base.

Morrisroe Assemblage G. This assemblage is characterized by a high positive loading for Component 1, a very high positive loading for Component 3 and a large negative value for Component 2. The high loading for the first component indicates the importance of lithic reduction debitage and flake tools in this assemblage. The high value for Component 3 suggests that some special activities were also being undertaken, while the low values for Component 2 indicates that hafted bifaces, reworked hafted bifaces, cores, and retouched flakes are not as important in this assemblage as they are in some others. This pattern of component loadings is similar to the previous two and, once more, suggests that the assemblage resulted from a relatively long occupation of a residential base.

Morrisroe Assemblage H. This assemblage has moderate negative values for all components. This suggests that the assemblage resulted from a moderately long occupation of a residential camp. The lack of a large positive loading on the first component indicates that there is not a great variety of items in the assemblage. The moderate loadings on Components 2 and 3 indicate that no specialized activities were important in the formation of this assemblage.

<u>Morrisroe</u> <u>Assemblage</u> <u>I</u>. This assemblage exhibits similar component loadings as the previous assemblage. Again, this appears to represent a residential base occupied for a moderate period of time.

<u>Morrisroe</u> <u>Assemblage</u> <u>J</u>. This assemblage is characterized by a moderate loading on Component 1, a high positive loading on Component 2 and a large negative loading on Component 3. The discard of hafted bifaces, reworked hafted bifaces, cores, and retouched flakes was unimportant in the formation of this assemblage. Lithic reduction (Component 1) was moderately important, while activities related to the use and discard of heavy retouched flakes, drills, and gravers were very important. This assemblage may represent a moderately long occupation during which hafted bifaces were repaired and replaced.

<u>Trail</u> <u>site</u>. This assemblage is characterized by very large positive loadings on all three components. This indicates that all stages of lithic reduction were important at the site and that the specialized activities associated with Components 1 and 2 were also important. This pattern is unique, as no other assemblage has such large positive values for all three components. This may, in part, result from the inclusion in the analysis of all hafted bifaces recovered from the site, including those which had been surface collected. Most of the other assemblages include only excavated material. Thus, the

loading on Component 2 may be artificially inflated. The high value for Components 1 and 3, however, are probably accurate. The Trail site assemblage may have resulted from a relatively stable occupation and the performance of some specialized activities.

15Tr50. This assemblage exhibits moderate to low loadings on Components 1 and 2 and a large negative loading on Component 3. This suggests a relatively homogeneous assemblage in which neither lithic reduction nor activities resulting in hafted biface discard were important. The large negative loading on Component 3 indicates that activities related to this component were unimportant. The moderate range of activities represented suggests a short term residential base.

15Tr53. This assemblage exhibits a large negative loading on Component 1 and moderately negative values for the other components. The value for the first component suggests that a limited range of activities contributed to the assemblage and that lithic reduction was particularly unimportant. Such a pattern may indicate a base camp situation rather than a residential camp.

15Tr56. This assemblage has a very large negative value for Component 1 and moderate values for the other components. The pattern is similar to that of 15Tr53, but with even less debitage from lithic reduction. A very short term occupation is suggested.

40Sw74. This assemblage has large negative values for Components 1 and 3 and very large positive values for Component 2. This indicates that lithic reduction contributed little to the assemblage, while flake tools, cores, and hafted bifaces are more common than at other sites. The assemblage may represent a limited range of activities resulting from a relatively short term occupation.

Discussion. The foregoing analysis suggests that some assemblages are more similar than others. In Table 33 the assemblages are presented in rank-order of their loading on the first component. It has previously been suggested that this component is indicative of all stages of lithic reduction and the discard of a variety of expedient flake tools. In Chapter 4 it was suggested that residential stability may be highly correlated with a wide range of activities, especially those related to the manufacture and repair of tools and other equipment. Since these items represent the by-products of a range of manufacturing and maintenance activites, high positive loadings on Component 1 may indicate a relatively stable residential base. Smaller loadings may reflect shorter occupations.

Three distinct groups of assemblages are apparent in Table 33, reflecting large negative loadings, moderate loadings, and large positive loadings. It is interesting that these divisions are also generally related to the age of the assemblage. Those with large negative loadings are, generally, late Middle Archaic

Table 33. Rank-order of assemblage score on Component I (chipped stone assemblages).

Assemblage	Score	Age
15Tr56	-1.05	Late Archaic
Morrisroe Assemblage A	-0.98	Late Archaic
15Tr53	-0.91	Late Archaic
40Sw74	-0.81	Late Archaic
Morrisroe Assemblage B	-0.66	Late Archaic
Morrisroe Assemblage C	-0.64	late Middle Archaic
Morrisroe Assemblage D	-0.51	late Middle Archaic
Morrisroe Assemblage I	-0.38	early Middle Archaic
Morrisroe Assemblage H	-0.06	early Middle Archaic
15Tr50	+0.04	Late Archaic
Morrisroe Assemblage J	+0.13	early Middle Archaic
Morrisroe Assemblage G	+0.88	Middle Archaic
Trail site	+1.25	late Middle Archaic
Morrisroe Assemblage E	+1.83	Middle Archaic
Morrisroe Assemblage F	+1.87	Middle Archaic

and Late Archaic in age. Assemblages with moderate loadings are, generally, the oldest assemblages while those with large positive loadings are, most often, Middle Archaic. This pattern suggests a trend from moderate length of occupation to intense, long term occupation during the Middle Archaic. A general reduction of occupation duration (or intensity) is reflected by Late Archaic assemblages.

A number of important exceptions to this pattern are evident. First, site 15Tr50, a Late Archaic assemblage, has a moderate loading on the first component similar to the earliest assemblages. Second, the late Middle Archaic Trail site has a very large positive loading on the first component, similar to the Middle Archaic assemblages from the Morrisroe site. It is possible, of course, that the Trail site and site 15Tr50 were sampled in such a way that lithic manufacturing debris is overrepresented in the collections. However, the material considered here is derived from test units excavated at each site. Sampling biases are just as likely to have occurred at the other sites. That is to say, with the exception of 40Sw74, all of the Late Archaic material was recovered through the excavation of a portion of each site and in no instance can the excavated portion be said to be more or less representative of the entire site.

Alternatively, these apparent anomalies may reflect the flexibility of Archaic hunter-gatherers. While general trends may be expected, it must also be expected that occasional deviations from those patterns will occur. These deviations reflect the flexibility of hunter-gather adaptive strategies as they adjusted to varying social and environmental conditions.

While the patterns of loadings on the first component suggest changes in the duration of occupation, it is not clear if this reflects changes in mobility strategies or if some sites were the loci of special activities. Components 2 and 3 appear to represent artifact associations which are indicative of a limited range of activities. Assemblages which were formed as a result of a limited range of activities (such as at a base camp) may be expected to have relatively large positive loadings for these components. An examination of Table 32 indicates that four such assemblages exist: Morrisroe Assemblage D (1.01 on Component 3); Morrisroe Assemblage J (0.79 on Component 2); the Trail site (2.02 on Component 2 and 2.14 on Component 3); and site 40Sw74 (2.54 on Component 2). The artifact types associated with the second component suggest the discard of hafted bifaces and a restricted range of flake tools. In Morrisroe Assemblage J this may reflect the general reduction of material from the lower levels of the site. The assemblage from 40Sw74 does, indeed, include an unexpectedly large number of bifaces. The site was surface collected only, and the assemblage may represent the greater visibility of these larger items. As noted previously, the hafted bifaces included in the Trail site assemblage were collected from across the entire surface of the site. The large loading on Component 2 may reflect this sampling bias.

Morrisroe Assemblage D and the assemblage from the Trail site exhibit large positive loadings on Component 3. This component is defined by a covariation of heavy retouched flakes, drills, bifacial thinning flakes and gravers. These appear to represent maintenance tasks, although what those tasks might be is unclear. All, with the exception of heavy retouched flakes, are also elements of Component 1.

In summary, only Component 2 is indicative of items specifically related to extractive activities (i.e., hafted bifaces). Assemblages with high loadings on this component may be indicative of base camps at which a specific suite of tools were maintained and refurbished, but where general manufacturing and processing activities were minimal. Of the three assemblages which have high loadings on this components, two (Trail, 40Sw74) include items collected from across the entire surface of the site and, may therefore, represent sampling errors when compared with excavated samples. The third, Morrisroe Assemblage J, may represent a base camp. However, the (relatively) high loading on Component 1 suggests that this assemblage represents a short term residential base occupation.

The principal components analysis indicates that no assemblage contains a specialized association indicative of a base camp. There does appear to be a general reduction in residential stability as one proceeds from the Middle Archaic to the Late Archaic, with early Middle Archaic assemblages reflecting a pattern between the two extremes. Two Late Archaic assemblages (15Tr50 and the Trail site) exhibit anomalously high positive loadings on the first component. These may reflect a flexible mobility strategy in which sites were occupied for relatively long periods whenever resource availability permitted.

Complete Assemblages

The results of the rotated principal components analysis of all lithic material are summarized in Table 34. This table presents the cumulative proportion of variance accounted for by each successive component and indicates the eigenvalues of each variable in the definition of each component.

Component 1. This component is defined by the presence of a very wide variety of chipped stone artifacts. These include debitage from all stages of lithic reduction and a variety of flake tools and bifacial tools. Groundstone items are not important in defining this component. This association suggests that this component is associated with a range of maintenance activities such as are expected to have taken place at residential bases.

Component 2. This component is defined by an association of gravers, reworked hafted bifaces, hafted bifaces, retouched flakes, cores and microblades. The cores exhibit no specialized form, such as might be expected in a microblade technological

Table 34. Principal components analysis of total assemblages.

Component	I	II	III	IV	V	VI
Eigenvalue	9.3668	3.5668	3.2794	2.5751	2.2662	1.3049
Proportion of variance	37.47	51.73	64.85	75.15	84.22	89.44
cores	.00410	.74851	.41665	.03388	.4367	
angular fragments	.69577	.03106	-.06195	-.01352	.09340	
bipolar by-products	.14991	-.37769	-.21754	-.17971	.76954	
cortical flakes	.93191	-.20018	.20709	.04362	.12004	
secondary flakes	.82229	-.03971	.0641	-.04110	-.02013	
microblades	-.06049	.52520	-.11436	-.10706	-.14681	
bifacial thinning flakes	.95634	.25544	-.10603	.04180	-.06947	
heavy retouched flakes	.64227	.07386	.26062	-.06119	-.18997	
retouched flakes	.31122	.89746	.23110	-.04767	-.00643	
gravers	.82537	.46865	-.12379	-.10311	-.00615	
perforators	.16952	.10772	.95066	-.06872	.00103	
notches	.68863	.43041	.39272	-.05350	.24769	

Table 34. cont.

Component	I	II	III	IV	V
steeply retouched flakes	.92928	.16825	.09414	.03214	.28227
bifaces	.86344	.16792	.24178	.23335	.27618
hafted bifaces	.51584	.73764	.40739	.06311	.08410
drills	.84056	.23328	.15957	.04053	-.18774
reworked hafted bifaces	.39849	.84951	-.11005	-.13361	-.00783
ferrogenous concretions	.04982	.19745	.96039	-.04040	-.02668
mortars	.30292	-.31707	.68664	.34089	-.16001
pitted cobbles	.01175	-.01945	-.12245	.9800	-.00662
battered cobbles	-.01346	.19805	.33404	-.02466	.67495
atlatl weights	-.06847	-.07366	-.07895	-.02830	.92250
ground cannel coal	-.02027	-.04081	-.06709	.95684	-.07569
miscellaneous groundstone	.48094	.27866	-.32965	-.02931	.65842

system. The absence of debitage indicates that lithic manufacturing was not important in defining this component.

Component 3. This component is defined by a covariance of retouched flakes, cores, perforators, bipolar by-products, and ferrogenous concretions. It is not clear if this component represents specialized activities. The association of flake tools and cores may indicate that cores were retained as sources of raw material for expedient tools. The co-occurrence of mortars is enigmatic.

Component 4. The fourth component is defined by groundstone and pecked and battered implements: pitted cobbles, ground cannel coal and pestles. However, the three artifact types may have been used for greatly different purposes. Pitted cobbles may have been anvil stones used in lithic reduction while pestles were probably used in the processing of plant material. The purpose served by the ground cannel coal is unknown.

Component 5. The fifth component is defined by an association of atlatl weights, battered cobbles, miscellaneous groundstone items and the by-products of bipolar reduction. The battered cobbles and bipolar by-products may represent a technological association. Atlatl weights are rare in all of the collections examined in this study and their presence is probably not significant. Similarly, the miscellaneous groundstone may not be substantively important.

Having determined the variables associated with each component, it is now possible to examine which of these components describe the various assemblages. As with the chipped stone assemblages, this will enable a discussion of the similarities and differences between assemblages. The component loadings for each assemblage are presented in Table 35.

Morrisroe Assemblage A. This assemblage is characterized by large negative loadings on Component 1 and 5 and moderately negative loadings on the other components. This suggests a generally small assemblage in which all classes of artifacts are underrepresented relative to their distribution in the other assemblages. The large negative loadings also indicate that items associated with lithic reduction are especially unimportant in this assemblage. This assemblage seems to represent a short term occupation.

Morrisroe Assemblage B. This assemblage is characterized by large negative loadings on Components 1 and 4 and moderately negative loadings on the other components. The pattern is similar to Morrisroe Assemblage A, indicating that the two assemblages resulted from similar activities and, probably, similar types of occupations.

Morrisroe Assemblage C. This assemblage has large negative values for Components 1, 2 and 4. This indicates that lithic reduction was limited and that bifacial tools (including hafted bifaces and drills), cores, retouched flakes and groundstone

Table 35. Assemblage loadings on rotated components, complete assemblages.

Assemblage	Component I	Component II	Component III	Component IV	Component V
Morrisroe Assemblage A	-0.46	-0.43	-0.36	-0.39	-0.47
Morrisroe Assemblage B	-0.54	-0.44	-0.35	-0.45	-0.42
Morrisroe Assemblage C	-0.53	-0.57	-0.40	-0.47	-0.26
Morrisroe Assemblage D	-0.09	-0.48	-0.43	-0.58	-0.44
Morrisroe Assemblage E	+1.45	-0.95	-0.40	-0.19	-0.39
Morrisroe Assemblage F	+1.61	-1.10	+0.39	-0.24	-0.24
Morrisroe Assemblage G	+0.68	-1.01	+2.02	+0.01	-0.09
Morrisroe Assemblage H	-0.16	-0.07	-0.25	+3.52	-0.37
Morrisroe Assemblage I	-0.65	+0.07	-0.32	+0.38	+0.77
Morrisroe Assemblage J	-0.17	-0.36	-0.24	-0.13	+3.39
Trail site	+2.18	+2.42	-0.97	-0.19	+0.03
15Tr50	-1.03	+1.21	-0.42	-0.32	-0.13

Table 35. cont.

Assemblage	Component I	Component II	Component III	Component IV	Component V
15Tr53	-0.84	+0.10	-0.50	-0.40	-0.67
15Tr56	-0.90	+0.04	-0.48	-0.39	-0.66
40Sw74	-0.56	+1.57	+2.67	-0.18	-0.08

items are less common than they are in other assemblages. A pattern of site occupation similar to the previous assemblages is suggested.

<u>Morrisroe</u> <u>Assemblage</u> <u>D</u>. This assemblage has large negative values for Components 2 and 4. The values for the other components are moderately negative. Interestingly, the value for Component 1 is much less negative than it is for the previous assemblages. This pattern suggests that lithic reduction is still relatively underrepresented in this assemblage and that groundstone items are rare.

<u>Morrisroe</u> <u>Assemblage</u> <u>E</u>. This assemblage has a very large positive value for the first component and a large negative value for the second component. Relative to the other assemblages, this one has a large quantity of material associated with the manufacture of lithic artifacts. However, hafted bifaces, reworked hafted bifaces, cores, and retouched flakes are relatively uncommon. This suggests a wide variety of non-specialized activity, perhaps undertaken at a long term residential camp.

<u>Morrisroe</u> <u>Assemblage</u> <u>F</u>. This assemblage is also characterized by a very large positive value for the first component and a large negative value for the second component. Again, this suggests a wide variety of general maintenance activities.

Morrisroe Assemblage G. This assemblage has a very large positive value for Component 2, a high positive value for Component 1 and a very large negative value for Component 2. This suggests that lithic reduction was still relatively more important than in some other assemblages, while activities leading to the discard of hafted bifaces, reworked hafted bifaces, cores and retouched flakes were relatively less important. Activities related to Component 3 were very important. This pattern suggests that generalized maintenance activities were still important in the formation of the assemblage and that some specialized activities were also undertaken.

Morrisroe Assemblage H. This assemblage is characterized by large positive values for Component 4 and moderately negative values for other components. The similarity of most values suggests a generalized assemblage, although the negative values indicate a smaller than average assemblage. The large positive value for Component 4 indicates that pitted cobbles, ground cannel coal and pestles were especially important in this assemblage. Because of their general rarity, the presence of one or two such items will result in large positive values for this component.

Morrisroe Assemblage I. This assemblage exhibits a very large positive value for Component 5, a very large negative value for Component 1 and moderate values for the other components. This suggests that generalized manufacturing activities (indicated by Component 1) were relatively less important contributors to this assemblage, while bipolar manufacturing by-products, atlatl weights, battered cobbles and miscellaneous groundstone items are more common than in most assemblages.

Morrisroe Assemblage J. This assemblage has moderately negative values on most components and a very large positive value for Component 5. The moderate values for most components suggest that the assemblage resulted from a suite of general, maintenance and extractive activities and that the intensity of activity was less than in some assemblages. The large positive value for Component 5 indicates the importance of atlatl weights, battered cobbles, miscellaneous groundstone items and bipolar by-products. The general rarity of these items may have resulted in this large component loading when, in fact, only a few such items were recovered.

Trail site. This assemblage is characterized by very large positive values for Components 1 and 2 and a very large negative value for Component 2. As noted earlier, the large positive value for Component 2 may be the result of a sampling bias. The hafted bifaces included in this assemblage were collected from across the entire surface of the site, while those in other assemblages (except for 40Sw74) were only from the excavated sample. Therefore, hafted bifaces may be overrepresented in the Trail site assemblage. On the other hand, reworked hafted bifaces (which also define Component 2) were generally rare in all assemblages. Their abundance at the Trail site may account for the large positive loading on the component. The very large positive value for the first component suggests that generalized lithic reduction and tool maintenance was important in the formation of this assemblage.

15Tr50. This assemblage is characterized by very large positive values for the second component, very large negative values for the first component, and moderate values for the other components. This pattern suggests that general lithic reduction was relatively less important in the formation of this assemblage while activities related to the discard of items associated with Component 2 were more important. This indicates a relatively reduced set of activities.

15Tr53. This assemblage is characterized by large negative values for Components 1, 3 and 5. The values for the other components are all negative or near zero. This suggests a small assemblage in which general lithic reduction activity and groundstone items are underrepresented.

15Tr56. This assemblage is similar to that from 15Tr53, with large negative values for Components 1, 3 and 5 and negative or near-zero values for the other components. This indicates an assemblage with a relatively low variety of items. Groundstone artifacts appear to have been especially unimportant.

40Sw74. This assemblage is characterized by large positive values for Components 2 and 3 and large negative values for

Component 1. This suggests that general lithic reduction was relatively unimportant, but that items associated with Components 2 and 3 were especially common in this assemblage. Some specialized activities may have contributed to the formation of this assemblage.

Discussion. The second principal components analysis confirms, in general, the results of the first principal components analysis. Table 36 presents the rank-order of the assemblage loadings on the first component. This component may be interpretted as reflecting a wide range of lithic reduction stages and maintenance activities. Three general groupings are evident: those with large negative values, those with moderate values, and those with large positive values. Assemblages in each group reflect a general temporal ordering. Those with large negative values are, generally, the later assemblages while the earliest assemblages have moderate values. The large positive values define Middle Archaic assemblages. Some important exceptions exist and the patterns resulting from the two principal components analyses do exhibit some differences.

Morrisroe Assemblage I, one of the earliest assemblages, has a very large negative value for the first component while Morrisroe Assemblage A has an unexpectedly small negative value. The Trail site assemblage has a very large positive value; much larger than the results of the first analysis. This may, in part, result from the variables which comprise the first component. In the second analysis drills, hafted bifaces and

Table 36. Rank-order of assemblage scores on Component I (complete assemblages).

Assemblage	Score	Age
15Tr50	-1.03	Late Archaic
15Tr56	-0.88	Late Archaic
15Tr53	-0.84	Late Archaic
Morrisroe Assemblage I	-0.65	early Middle Archaic
40Sw74	-0.56	Late Archaic
Morrisroe Assemblage B	-0.54	Late Archaic
Morrisroe Assemblage C	-0.53	late Middle Archaic
Morrisroe Assemblage A	-0.46	Late Archaic
Morrisroe Assemblage J	-0.17	early Middle Archaic
Morrisroe Assemblage H	-0.16	early Middle Archaic
Morrisroe Assemblage D	-0.09	Middle Archaic
Morrisroe Assemblage G	+0.68	Middle Archaic
Morrisroe Assemblage E	+1.45	Middle Archaic
Morrisroe Assemblage F	+1.61	Middle Archaic
Trail site	+2.18	late Middle Archaic

heavy retouched flakes were added to the variables which define this component. The importance (or unimportance) of these items may account for the unexpected loadings of these assemblages.

If the first component indicates assemblages which were formed as a result of a variety of activities, large positive values for the other components indicate the importance of more specialized activities. Table 37 presents the assemblages with large positive loadings on the other components and indicates on which components the loadings are applied. Morrisroe Assemblage G has a large positive loading on Component 3. This component is defined by a covariance of notches, cores, perforators, and mortars. No clear activity-related inferences can be drawn from this component. Morrisroe Assemblage H has a large positive value for Component 4 and Morrisroe Assemblages I and J have large positive values for Component 5. These components are defined by the covariance of groundstone and battered-pecked objects. As these items are generally rare in all of the collections, their presence in these assemblages accounts for the large positive loadings. While they may indicate a certain combination of activities (perhaps the processing of plant foods) or technological structure (the use of groundstone), the sampling bias precludes the identification of these assemblages with special purpose sites (or sites at which only a very limited range of activities were undertaken).

The assemblages from the Trail site and sites 15Tr50 and 40Sw74 all have large positive values for Component 2. This

Table 37. Assemblage loadings on components (other than component 1; complete assemblages).

Assemblage	Component II	Component III	Component IV	Component V
Morrisroe Assemblage G		+2.04		
Morrisroe Assemblage H			+3.52	
Morrisroe Assemblage I				+0.77
Morrisroe Assemblage J				+3.40
Trail site	+2.42			
15Tr50	+1.21			
40Sw74	+1.57			

component is defined by a covariance of gravers, reworked hafted bifaces, retouched flakes, hafted bifaces, cores, and microblades. As noted previously, the value of the Trail site may reflect a sampling bias in the inclusion of surface-collected hafted bifaces. Similarly, since 40Sw74 is a surface collected sample, the sample of hafted bifaces may be biased. The assemblage from 15Tr50, however, is all excavated material and suggests that assemblages with large loadings on Component 2 may, indeed, reflect restricted activity sites. The assemblages from the Trail site and 40Sw74 may also represent such sites.

Discussion

Three expectations were presented at the outset of this chapter. These expectations suggest the ways in which assemblages should vary depending upon whether the source of variation lies in the technological structure, sampling biases, or factors related to the occupation duration, group size and range of activities undertaken at a site. Neither principal components analysis indicated that technological structure was a major source of variation between assemblages. Most cases contained similar types of artifacts, although their frequencies varied. An exception is the restricted occurrence of groundstone items to the Middle Archaic assemblages from the Morrisroe site. These items are rare in all assemblages and occur in only small numbers during the Middle Archaic (see Appendix F). The large values on the components representing groundstone items appears to represent a sampling bias rather than a distinctive technological structure. All of the assemblages appear to represent similar technological structures.

The expectation that the structure of an assemblage will vary along a continuum from those deposited at stable residential bases to those deposited at base camps is based on the model of assemblage formation processes developed in Chapter 4. Assemblages from residential sites are expected to contain the widest variety of material, with many items related to general maintenance activities. More stable residential bases are expected to have larger and more complex assemblages. It is also expected that base camps will have more specialized associations of artifacts. These camps would have been established as temporary residential sites for logistic foraging groups. The specialized artifact associations may be expected to reflect preparations for the special logistic tasks.

The identification of stable residential bases, less stable residential bases and base camps from an analysis of their artifact assemblages is difficult. As all vary along a continuum, there is no absolute criteria which can be used to separate the assemblages from each of these types of sites. Both of the principal components analyses indicate that the assemblages from the Trail site and site 40Sw74 contain an inordinately large quantity of hafted bifaces and reworked hafted bifaces. The principal components analysis conducted on all of the data indicated that the assemblage from 15Tr50 also contains a large number of these artifacts. The analysis which included all of the data indicates that 15Tr50 and 40Sw74 yielded assemblages which are indicative of a restricted range of activities. However, this analysis also indicates that the Trail site assemblage represents a wide range of manufacturing and maintenance activities. Initially it was suspected that the Trail site and site 40Sw74 assemblages represented biased assemblages, since both included hafted bifaces which had been surface collected from across the entire site. After a consideration of the pattern of covariation, however, it appears as though 15Tr50 and 40Sw74 may, indeed, have been the loci of a short term occupation where a limited range of activities were undertaken. Data from the Trail site, however, indicate a longer-term occupation and a wider range of activities.

None of the other assemblages are indicative of specialized activities. Therefore, I suggest that they all represent residential bases of varying stability, occupied by groups of very different sizes. The most stable occupations (or the largest groups) are, in general, represented by the Middle Archaic assemblages from the Morrisroe site (Assemblages D, E, F and G). Late Middle and Late Archaic assemblages indicate more ephemeral occupations. The earliest assemblages from the Morrisroe site (Assemblages H, I and J) seem to be intermediate between the extremes. There thus appears to be a change in mobility strategies from the earliest to the later occupations.

The Middle Archaic seems to be characterized by residential bases typical of a logistic mobility strategy. Later assemblages suggest a more mobile residential strategy in which residential bases were occupied less intensely. The implications of these changes will be discusses further in Chapter 11.

Chapter Summary

This chapter has provided an analysis of the structures of the assemblages examined in this study. Differences in assemblage structures may be a function of different technological structures, sampling biases, or differences in the nature of the site occupation. Expectations were provided regarding the nature of the assemblage structures following from each of these sources of variations. These expectations provided a framework for interpretting the results of the analysis.

The assemblage structures were determined through principal components analysis. Two analyses were undertaken; one included all of the lithic material while the other considered only the chipped stone artifacts. It was felt that, since groundstone material was so rare in the collections, the inclusion of these data may unduly bias the analysis. The data indicate that, although some error was induced, the two analyses produced very similar results. The assemblages from sites 15Tr50 and 40Sw74 were found to be derived from base camps. All other assemblages are believed to have come from residential sites.

A distinct change in mobility strategies is suggested by the assemblage structures. Those from the Middle Archaic period suggest relatively stable sites while the later assemblages indicate greater residential mobility. There appears to have been a change from a logistic mobility strategy to a residential mobility strategy.

CHAPTER X

ANALYSIS OF TECHNOLOGICAL ORGANIZATION

Understanding of technological organization, and changes it may have undergone, provide insights regarding prehistoric hunter-gatherer mobility strategies. It was suggested previously (Chapter 5) that an analysis of the patterns of staging sequences in the manufacturing, use and reworking of bifaces provides an important means of investigating technological organization. Such an analysis is presented in this chapter. Three sets of data are examined for evidence of interassemblage differences. These include the length of bifacial thinning flakes, platform angles of bifacial thinning flakes, and a comparison of the bifaces themselves.

Bifacial Thinning Flakes: Lengths

The items examined in this analysis include all of the complete bifacial thinning flakes identified in each assemblage, with the exception of the sample from the Trail site. Items from this latter assemblage included only material which was recovered from the test units excavated in 1978. The sample of all possible bifacial thinning flakes was further reduced by recording data only for those which exhibited an intact platform and which terminated in a feather fracture (cf. Hayden 1979: 133). These criteria insured that all length measurements would record the maximum value for each item. Maximum lengths were recorded as the longest dimension along an axis perpendicular to the striking platform. All measurements were recorded to 0.05 mm, using a Manostat dial caliper.

The sample sizes from the assemblages are presented in Table 38. The relative size of the sample reflects, generally, the size of the entire assemblage. That is, Morrisroe Assemblages E, F, and G tend to have the greatest total number of items of all classes and Morrisroe Assemblages A, B, and C are among the smallest assemblages. The pattern exhibited by the assemblages from 15Tr53, 15Tr56, and 40Sw74 are exceptions. While assemblages from 15Tr53 and 15Tr56 are small, the occurrence of only one or two complete bifacial thinning flakes must be viewed as a significant underrepresentation of this class. Such underrepresentation is further underscored in the assemblage from 40Sw74, where a single complete bifacial thinning flake was identified in a relatively large assemblage. It is immediately apparent that stages of biface manufacture undertaken (or not undertaken) at these sites are distinctly different from those engaged in at other sites. The small number of complete bifacial thinning flakes present precludes the inclusion of these assembalges in further analysis of bifacial thinning flake lengths.

A less clear pattern emerges from the comparison of bifacial thinning flake lengths in the other assemblages. Table 39 presents the proportion and cumulative proportion of items in length intervals. These data are presented as ogives in Figure 17. It is apparent that the shapes of the curves for assemblages

Table 38. Number of complete bifacial thinning flakes in each assemblage.

Assemblage	Complete Bifacial Thinning Flakes	Total Number of Bifacial Thinning Flakes
Morrisroe A	11	108
Morrisroe B	11	16
Morrisroe C	16	46
Morrisroe D	165	485
Morrisroe E	435	1182
Morrisroe F	588	1286
Morrisroe G	443	1097
Morrisroe H	308	504
Morrisroe I	150	295
Morrisroe J	47	141
Trail site	807	3016
15Tr50	99	244
15Tr53	1	9
15Tr56	2	3
40Sw74	1	4

Table 39. Cumulative proportions of bifacial thinning flake lengths.

Assemblage	Interval (mm)	n	p	Cumulative p
Morrisroe A	0.05 - 5.00	-	0.0000	0.000
	5.05 - 10.00	2	0.1818	0.1818
	10.05 - 15.00	2	0.1818	0.3636
	15.05 - 20.00	3	0.2727	0.6363
	20.05 - 25.00	2	0.1818	0.8181
	25.05 - 30.00	-	0.0000	0.8181
	30.05 - 35.00	2	0.1818	0.9999
Morrisroe B	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	-	0.0000	0.0000
	10.05 - 15.00	3	0.2727	0.2727
	15.05 - 20.00	3	0.2727	0.5454
	20.05 - 25.00	2	0.1818	0.7272
	25.05 - 30.00	1	0.0909	0.8181
	30.05 - 35.00	2	0.1818	0.9999
Morrisroe C	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	-	0.0000	0.0000
	10.05 - 15.00	1	0.0625	0.0625
	15.05 - 20.00	1	0.0625	0.1250
	20.05 - 25.00	5	0.3125	0.4375
	25.05 - 30.00	6	0.3750	0.8125
	30.05 - 35.00	2	0.1250	0.9375
	35.05 - 40.00	-	0.0000	0.9375
	40.05 - 45.00	1	0.0625	1.0000

Table 39. cont.

Assemblage	Interval (mm)	n	p	Cumulative p
Morrisroe D	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	4	0.0242	0.0242
	10.05 - 15.00	27	0.1636	0.1879
	15.05 - 20.00	31	0.1879	0.3758
	20.05 - 25.00	29	0.1758	0.5515
	25.05 - 30.00	30	0.1818	0.7333
	30.05 - 35.00	17	0.1030	0.8364
	35.05 - 40.00	16	0.0970	0.9333
	40.05 - 45.00	6	0.0364	0.9697
	45.05 - 50.00	3	0.0182	0.9879
	50.05 - 55.00	-	0.0000	0.9879
	55.05 - 60.00	1	0.0061	0.9940
	60.05 - 65.00	1	0.0061	1.0000
Morrisroe E	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	11	0.0251	0.0251
	10.05 - 15.00	62	0.1416	0.1667
	15.05 - 20.00	78	0.1781	0.3448
	20.05 - 25.00	70	0.1598	0.5046
	25.05 - 30.00	81	0.1849	0.6895
	30.05 - 35.00	48	0.1096	0.7991
	35.05 - 40.00	48	0.1096	0.9087
	40.05 - 45.00	22	0.0502	0.9589
	45.05 - 50.00	11	0.0251	0.9840
	50.05 - 55.00	5	0.0114	0.9954
	55.05 - 60.00	2	0.0046	1.0000

Table 39. cont.

Assemblage	Interval (mm)	n	p	Cumulative p
Morrisroe F	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	5	0.0085	0.0085
	10.05 - 15.00	31	0.0527	0.0612
	15.05 - 20.00	74	0.1259	0.1871
	20.05 - 25.00	102	0.1735	0.3605
	25.05 - 30.00	85	0.1446	0.5051
	30.05 - 35.00	96	0.1633	0.-684
	35.05 - 40.00	79	0.1344	0.8027
	40.05 - 45.00	48	0.0816	0.8844
	45.05 - 50.00	29	0.0493	0.9337
	50.05 - 55.00	19	0.0323	0.9660
	55.05 - 60.00	11	0.0187	0.9847
	60.05 - 65.00	4	0.0068	0.9915
	65.05 - 70.00	1	0.0017	0.9932
	70.05 - 75.00	3	0.0051	0.9983
	75.05 - 80.00	-	0.0000	0.9983
	80.05 - 85.00	1	0.0017	1.0000
Morrisroe G	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	4	0.0090	0.0090
	10.05 - 15.00	29	0.0655	0.0745
	15.05 - 20.00	55	0.1242	0.1987
	20.05 - 25.00	64	0.1445	0.3431
	25.05 - 30.00	85	0.1919	0.5350
	30.05 - 35.00	71	0.1603	0.6953
	35.05 - 40.00	62	0.1340	0.8352
	40.05 - 45.00	39	0.0880	0.9233
	45.05 - 50.00	16	0.0361	0.9594

Table 39. cont.

Assemblage	Interval (mm)	n	p	Cumulative p
Morrisroe G	50.05 - 55.00	5	0.0113	0.9707
	55.05 - 60.00	9	0.0203	0.9910
	60.05 - 65.00	3	0.0068	0.9977
	65.05 - 70.00	1	0.0023	1.0000
Morrisroe H	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	5	0.0162	0.0162
	10.05 - 15.00	26	0.0844	0.1007
	15.05 - 20.00	24	0.0779	0.1786
	20.05 - 25.00	43	0.1396	0.3182
	25.05 - 30.00	53	0.1721	0.4903
	30.05 - 35.00	47	0.1526	0.6429
	35.05 - 40.00	35	0.1136	0.7565
	40.04 - 45.00	29	0.0942	0.8505
	45.05 - 50.00	28	0.0909	0.9416
	50.05 - 55.00	14	0.0455	0.9870
	55.05 - 60.00	1	0.0033	0.9903
	60.05 - 65.00	-	0.0000	0.9903
	65.05 - 70.00	-	0.0000	0.9903
	70.05 - 75.00	1	0.033	0.9935
	75.05 - 80.00	2	0.0065	1.0000
Morrisroe I	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	1	0.0067	0.0067
	10.05 - 15.00	4	0.0267	0.0333
	15.05 - 20.00	6	0.0400	0.0733
	20.05 - 25.00	17	0.1133	0.1867

Table 39. cont.

Assemblage	Interval (mm)	n	p	Cumulative p
Morrisroe I	25.05 - 30.00	24	0.1600	0.3467
	30.05 - 35.00	25	0.1670	0.5133
	35.05 - 40.00	24	0.1600	0.6733
	40.05 - 45.00	21	0.1400	0.8133
	45.05 - 50.00	14	0.0933	0.9067
	50.05 - 55.00	7	0.0467	0.9533
	55.05 - 60.00	3	0.0200	0.9733
	60.05 - 65.00	3	0.0200	0.9933
	65.05 - 70.00	-	0.0000	0.9933
	70.05 - 75.00	-	0.0000	0.9933
	75.05 - 80.00	1	0.0067	1.0000
Morrisroe J	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	-	0.0000	0.0000
	10.05 - 15.00	2	0.0426	0.0426
	15.05 - 20.00	3	0.0638	0.1064
	20.05 - 25.00	6	0.1277	0.2340
	25.05 - 30.00	6	0.1277	0.3617
	30.05 - 35.00	5	0.1064	0.4681
	35.05 - 40.00	9	0.1915	0.6596
	40.05 - 45.00	7	0.1489	0.8085
	45.05 - 50.00	6	0.1277	0.9362
	50.05 - 55.00	1	0.0213	0.9575
	55.05 - 60.00	1	0.0213	0.9787
	60.05 - 65.00	1	0.0213	1.0000

Table 39. cont.

Assemblage	Interval (mm)	n	p	Cumulative p
Trail site	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	142	0.1760	0.1760
	10.05 - 15.00	338	0.4188	0.5948
	15.05 - 20.00	167	0.2069	0.8017
	20.05 - 25.00	92	0.1140	0.9157
	25.05 - 30.00	41	0.0508	0.9665
	30.05 - 35.00	16	0.0198	0.9864
	35.05 - 40.00	8	0.0099	0.9963
	40.05 - 45.00	2	0.0025	0.9988
	45.05 - 50.00	1	0.0012	1.0000
15Tr50	0.05 - 5.00	-	0.0000	0.0000
	5.05 - 10.00	10	0.1010	0.1010
	10.05 - 15.00	30	0.3030	0.4040
	15.05 - 20.00	25	0.2525	0.6565
	20.05 - 25.00	14	0.1414	0.7980
	25.05 - 30.00	8	0.0808	0.8788
	30.05 - 35.00	7	0.0707	0.9495
	35.05 - 40.00	1	0.0101	0.9596
	40.05 - 45.00	4	0.0404	1.0000

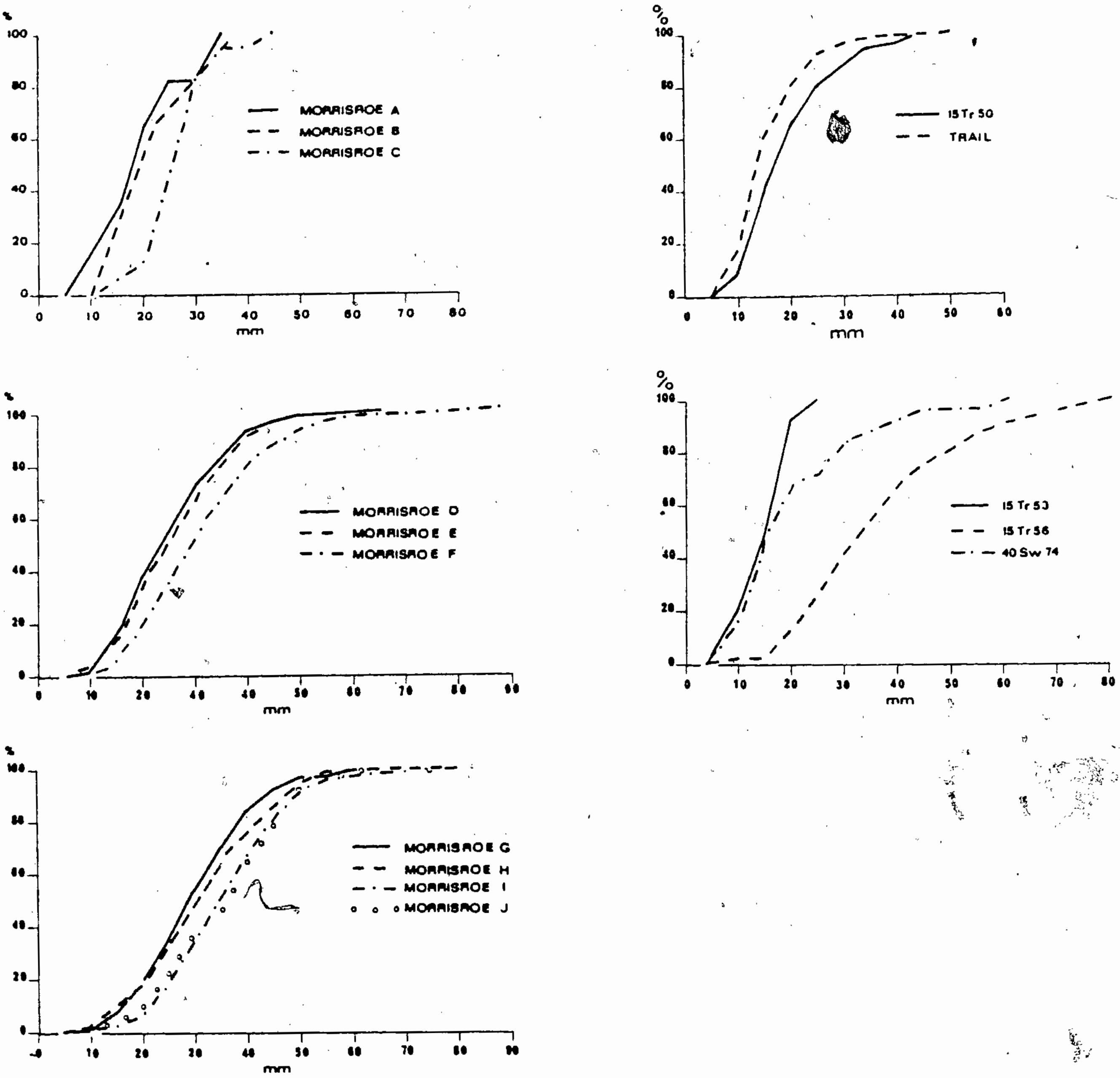


Figure 17. Ogives of bifacial thinning flake lengths.

from the middle and lower levels of the Morrisroe site are very similar. The assemblages from 15Tr50 and from the Trail site also resemble Morrisroe Assemblages D to J, but have been truncated near the longer end of the scale. Items from Morrisroe Assemblages A, B, and C provide very distinctive curves which appear to lie in an intermediate position between the other Morrisroe assemblages and those from 15Tr50 and the Trail site.

In order to determine how similar or different these curves are, a series of analysis of variance (ANOVA) tests were applied to a sample of complete bifacial thinning flakes from each assemblage. The sample size ($\underline{n}$=40) was determined following the procedure discussed by Sokal and Rohlf (1969: 246-248). As the data had already been recorded for the entire collection, the sample information was obtained through a systematic sample of the data records for each assemblage. Thus, for example, it was determined that at least every fourteenth item from Morrisroe Assemblage F must be included in a sample of forty individuals. A number between one and fourteen was then drawn from a table of random numbers (say nine) and every nth (ninth) item was included in the sample. Half of the items in samples from the Morrisroe assemblages were selected from unit I and half came from unit II. When the number of items in an assemblage did not equal or exceed the required sample size, the entire assemblage was included. The reduced size of the samples facilitated the computation of the ANOVAs. As the original data had not been recorded in a systematic fashion (such as small flakes followed by progressivley larger flakes), the samples are probably unbiased.

In Table 40 the assemblages are rank-ordered on the basis of the mean length of the complete bifacial thinning flakes. From this it is apparent that, while a few assemblages (Morrisroe I, J, and H) have very long flakes and some (15Tr50, Morrisroe A, the Trail site) have very short flakes, the lengths are generally very similar. In order to assess if these differences are significant (and if the similarities are, in fact, real) a sum of squares simultaneous test procedure (SS-STP) was undertaken. This procedure, outlined by Sokal and Rohlf (1969: 236-237) begins by calculating an ANOVA to determine if a members of a group of means are significantly different from one another. If they are judged to be similar, successive means can be compared to the group in tests for significant differences. As a result, assemblages which contribute significant sources of variation can be isolated from assemblages which are more similar to one another.

The vertical lines adjacent to the assemblages in Table 40 indicate the results of the SS-STP. Morrisroe Assemblages J, H, F, G, E, C, D and B were all found not to be significantly different from one another. Morrisroe Assemblage I was found to be similar to the other assemblages from the site which were stratigraphically close to it (i.e., Morrisroe Assemblages J, H, F, and G), but dissimilar from all later assemblages. The assemblages from 15Tr50, the Trail site and Morrisroe assemblage

Table 40. Rank-order of assemblages by mean bifacial thinning flake length.

Assembalge	$\bar{x}$	Rank
Morrisroe I	34.05	1
Morrisroe J	32.95	2
Morrisroe H	32.86	3
Morrisroe F	30.17	4
Morrisroe G	29.64	5
Morrisroe E	25.62	6
Morrisroe C	25.40	7
Morrisroe D	24.91	8
Morrisroe B	20.66	9
15Tr50	19.40	10
Morrisroe A	18.48	11
Trail site	14.63	12

'cluster' based on anova for unequal sample sizes (Sokal and Rohlf 1969: 206 ff.)

A were each significantly different from all other assemblages. An ANOVA for cases with unequal sample sizes (Sokal and Rohlf 1969: 206-210) indicated that there are no significant differences among these three assemblages.

Discussion. In Chapter 5 it was noted that experimental evidence indicates that bifacial thinning flakes tend to decrease in length as the biface reduction process reaches completion. The present analysis of bifacial thinning flake length indicates that the assemblages may be combined to form four groups. The assemblages from 15Tr50, the Trail site and Morrisroe Assemblage A provide a unique group with the smallest average flake lengths. These may represent the final stages of biface manufacture or the occurrence of resharpening activities. The majority of assemblages from the Morrisroe site (Assemblages B, D, C, E, G, F, H, and J) form a second group, perhaps indicative of the middle stages of reduction. Morrisroe Assemblage I is distinguished by a larger mean flake length which may reflect a focus on the early stages of reduction. The similarity between Morrisroe Assemblage I and Morrisroe Assemblages J, H, F, and G suggests that some early, as well as middle, reduction stages are represented in the latter assemblages.

An examination of the ogives substantiates much of this inferred reduction strategy. The cumulative frequency curves for most of the Morrisroe assemblages are very similar, encompassing a very wide range of flake sizes. The presence of both very large and small flakes suggests that these were sites where long trajectories, including most reductive stages, were undertaken. In contrast, the ogives for the Trail site and for 15TR50 assemblages are abruptly truncated, substantiating the claim that most of the reduction at these sites was restricted to the final stages. Morrisroe Assemblage A is similarly truncated, as are assemblages B and C from that site. This suggests that all three assemblages represent short trajectories. The small sizes of the assemblages may account for some of the disparity between the ANOVA and the graphical interpretations. Interestingly, Morrisroe Assemblage I provides an ogive that is very similar to most of the other Morrisroe assemblages. Thus, while the average bifacial thinning flake may be longer in this assemblage, a long reduction trajectory is indicated.

It may be argued that bifacial thinning flake length is, at least in part, a function of the size of the initial piece of raw material. Furthermore, it has been shown (Chapter 8) that artifacts from 15Tr50 and the Trail site were manufactured primarily from upper St. Louis chert. The argument might be proposed that the predominance of short bifacial thinning flakes in these assemblages is indicative of the predominant use of a nodular source of raw material than of the stage of biface manufacture.

A comparison of the results of the analysis of chert use and the examination of the bifacial thinning flake lengths indicates that differences in raw material use provides an unsatisfactory explanation for the differences in average flake length. It is true that the assemblages from 15Tr50 and the Trail site, which have similar flake lengths (Table 40) are dominated by upper St. Louis cherts (Figures 13 and 14). However, the raw material in Morrisroe Assemblages I and J also have large quantities of upper St. Louis chert. Table 40 indicates that these assemblages contain bifacial thinning flakes which are, on average, among the largest. Thus, while the nature of the raw material may have some bearing on the average size of bifacial thinning flakes, it is clearly not the primary determining factor. Stages in the biface reduction process are of major importance.

The pattern which emerges has diachronic implications. All of the Middle Archaic assemblages are characterized by long trajectories. The short trajectory assemblages are late Middle or Late Archaic in age. Morrisroe Assemblages B and C (late Middle to Late Archaic) also appear to represent short trajectories, perhaps during the middle stages of reduction.

Bifacial Thinning Flakes: Platform Angles

Striking platform angles were recorded for all of the bifacial thinning flakes included in the examination of flake length. The angles were measured using a Ward's contact goniometer and all measurements were rounded off to the nearest degree. The angle measured lies between the main plane of the platform surface and the main plane of the dorsal surface.

The distribution of platform angles in each assemblage are summarized in the ogives presented in Figure 18. These graphs are derived from data provided in Table 41. The similarity between these ogives precludes a visual distinction between patterns from each assemblage. All are characterized by normal curves with platform angles ranging from very acute (15° to 20°) to perpendicular. A comparison of bifacial thinning flake platform angles on secondary flakes from 15Tr53, 15Tr56 and 40Sw74 (Figure 18) reveals a distinction between the two types of flakes. Platform angles on secondary flakes tend to be steeper.

The patterns exhibited by these graphs were tested for significant similarities and differences between the assemblages. A sample was taken of all complete bifacial thinning flakes, as well as all complete secondary flakes from 15TR50, 15Tr53 and 40Sw74. The sample size ($\underline{n}$=35) was determined following the method outlined by Sokal and Rohlf (1969: 246-248). The data were then selected following the procedure used in obtaining the flake length sample data. The samples from most of the Morrisroe assemblages were split between unit I ($\underline{n}$=17) and unit II ($\underline{n}$=18).

The samples from each assemblage are rank-ordered in Table 42 according to their mean platform angle. The similarity between assemblages was assessed using a sum of squares simultaneous test procedure (SS-STP; Sokal and Rohlf 1969: 236-237). The vertical lines in Table 42 indicate the

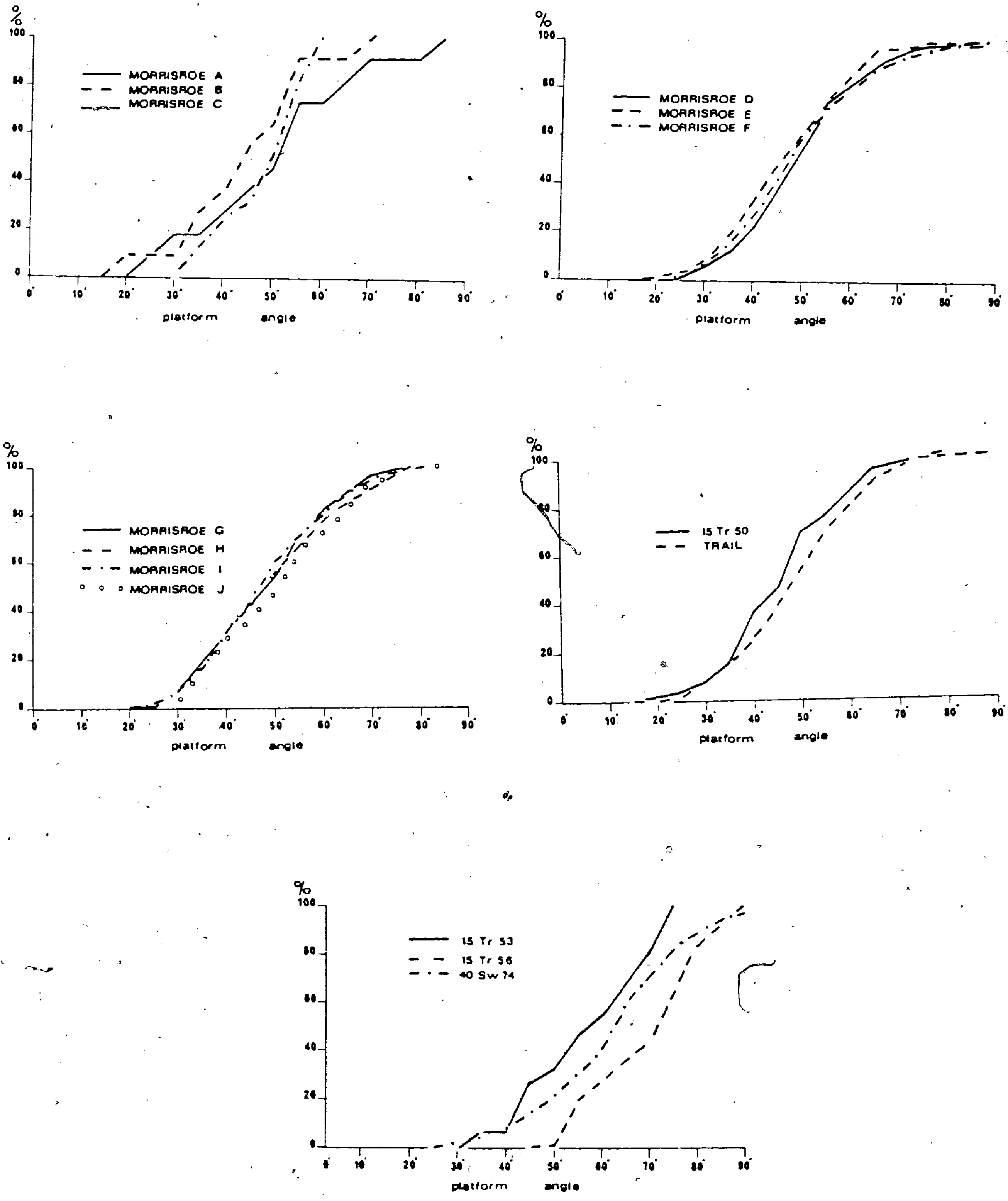


Figure 18. Ogives of flake platform angles.

Table 41. Cumulative proportions of flake platform angles.

Assemblage	Interval	n	p	Cumulative p
Morrisroe A	16°- 20°	-	0.0000	0.0000
	21°- 25°	1	0.0909	0.0909
	26°- 30°	1	0.0909	0.1818
	31°- 35°	-	0.0000	0.1818
	36°- 40°	1	0.0909	0.2727
	41°- 45°	1	0.0909	0.3636
	46°- 50°	1	0.0909	0.4546
	51°- 55°	3	0.2727	0.7273
	50°- 60°	-	0.0000	0.7273
	61°- 65°	1	0.0909	0.8185
	66°- 70°	1	0.0909	0.9091
	71°- 75°	-	0.0000	0.9091
	76°- 80°	-	0.0000	0.9091
	81°- 85°	1	0.0909	1.0000
Morrisroe B	16°- 20°	1	0.0909	0.0909
	21°- 25°	-	0.0000	0.0909
	26°- 30°	-	0.0000	0.0909
	31°- 35°	2	0.1818	0.2727
	36°- 40°	1	0.0909	0.3636
	41°- 45°	2	0.1818	0.5455
	46°- 50°	1	0.0909	0.6364
	51°- 55°	3	0.2727	0.9091
	56°- 60°	-	0.0000	0.9091
	61°- 65°	-	0.0000	0.9091
	66°- 70°	1	0.0909	1.0000

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe C	16° - 20°	-	0.0000	0.0000
	21° - 25°	-	0.0000	0.0000
	26° - 30°	-	0.0000	0.0000
	31° - 35°	2	0.1250	0.1250
	36° - 40°	2	0.1250	0.2500
	41° - 45°	1	0.0653	0.3125
	46° - 50°	3	0.1875	0.5000
	51° - 55°	5	0.3125	0.8125
	56° - 60°	3	0.1875	1.0000
Morrisroe D	16° - 20°	-	0.0000	0.0000
	21° - 25°	2	0.0121	0.0121
	26° - 30°	7	0.0424	0.0546
	31° - 35°	13	0.0789	0.1333
	36° - 40°	16	0.0970	0.2303
	41° - 45°	24	0.1455	0.3758
	46° - 50°	30	0.1818	0.5576
	51° - 55°	30	0.1818	0.7394
	56° - 60°	14	0.0849	0.8243
	61° - 65°	9	0.0546	0.8788
	66° - 70°	12	0.0727	0.9515
	71° - 75°	6	0.0364	0.9879
	76° - 80°	1	0.0061	0.9939
	81° - 85°	1	0.0061	1.0000

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe E	16° - 20°	1	0.0023	0.0023
	21° - 25°	10	0.0228	0.0251
	26° - 30°	26	0.0594	0.0845
	31° - 35°	33	0.0753	0.1598
	36° - 40°	49	0.1119	0.2717
	41° - 45°	69	0.1575	0.4292
	46° - 50°	76	0.1735	0.6027
	51° - 55°	64	0.1461	0.7489
	56° - 60°	47	0.1073	0.8562
	61° - 65°	39	0.0890	0.9452
	66° - 70°	8	0.0183	0.9635
	71° - 75°	9	0.0206	0.9840
	76° - 80°	3	0.0069	0.9909
	81° - 85°	3	0.0069	0.9977
	86° - 90°	1	0.0023	1.0000
Morrisroe F	16° - 20°	-	0.0000	0.0000
	21° - 25°	15	0.0255	0.0255
	26° - 30°	29	0.0493	0.0748
	31° - 35°	61	0.1034	0.1786
	36° - 40°	92	0.1565	0.3350
	41° - 45°	90	0.1531	0.4881
	46° - 50°	63	0.1071	0.5952
	51° - 55°	70	0.1191	0.7143
	56° - 60°	56	0.0952	0.8095
	61° - 65°	42	0.0714	0.8810
	66° - 70°	29	0.0493	0.9303
	71° - 75°	20	0.0340	0.9643

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe F	76° - 80°	12	0.0204	0.9847
	81° - 85°	4	0.0068	0.9915
	86° - 90°	2	0.0034	0.9949
	91° - 95°	3	0.0051	1.0000
Morrisroe G	16° - 20°	1	0.0023	0.0023
	21° - 25°	5	0.0113	0.0135
	26° - 30°	31	0.0700	0.0835
	31° - 35°	47	0.1061	0.1896
	36° - 40°	54	0.1219	0.3115
	41° - 45°	56	0.1264	0.4380
	46° - 50°	48	0.1084	0.5463
	51° - 55°	74	0.1670	0.7133
	56° - 60°	45	0.1016	0.8149
	61° - 65°	33	0.0745	0.8894
	66° - 70°	27	0.0610	0.9503
	71° - 75°	15	0.0339	0.9842
	76° - 80°	4	0.0090	0.9932
	81° - 85°	2	0.0045	0.9977
	86° - 90°	1	0.0023	1.0000
Morrisroe H	16° - 20°	-	0.0000	0.0000
	21° - 25°	6	0.0195	0.0195
	26° - 30°	15	0.0487	0.0682
	31° - 35°	32	0.1039	0.1721
	36° - 40°	40	0.1299	0.3020
	41° - 45°	42	0.1364	0.4383

Table 41. cont.

Assemblage	Interval	*n*	*p*	Cumulative *p*
Morrisroe H	46° - 50°	41	0.1331	0.5714
	51° - 55°	32	0.1039	0.6753
	56° - 60°	33	0.1071	0.7825
	61° - 65°	21	0.0682	0.8507
	66° - 70°	19	0.0617	0.9123
	71° - 75°	18	0.0584	0.9708
	76° - 80°	8	0.0260	0.9968
	81° - 85°	-	0.0000	0.9968
	86° - 90°	1	0.0033	1.0000
Morrisroe I	16° - 20°	-	0.0000	0.0000
	21° - 25°	2	0.0133	0.0133
	26° - 30°	10	0.067	0.0800
	31° - 35°	14	0.0933	0.1733
	36° - 40°	13	0.0867	0.2600
	41° - 45°	27	0.1800	0.4400
	46° - 50°	26	0.1733	0.6133
	51° - 55°	14	0.9330	0.7067
	56° - 60°	16	0.1067	0.8130
	61° - 65°	10	0.0667	0.8800
	66° - 70°	9	0.0600	0.9400
	71° - 75°	4	0.0267	0.9667
	76° - 80°	2	0.0133	0.9800
	81° - 85°	1	0.0067	0.9867
	86° - 90°	1	0.0067	0.9933
	90° - 95°	1	0.0067	1.0000

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe J	16° - 20°	-	0.0000	0.0000
	21° - 25°	-	0.0000	0.0000
	26° - 30°	1	0.0213	0.0213
	31° - 35°	7	0.1489	0.1702
	36° - 40°	5	0.1064	0.2766
	41° - 45°	4	0.0851	0.3617
	46° - 50°	5	0.1064	0.4681
	51° - 55°	8	0.1702	0.6383
	56° - 60°	4	0.0851	0.7234
	61° - 65°	5	0.1064	0.8298
	66° - 70°	4	0.0851	0.9149
	71° - 75°	2	0.0426	0.9575
	76° - 80°	1	0.0213	0.9787
	81° - 85°	1	0.0213	1.0000
Trail site	16° - 20°	3	0.0037	0.0037
	21° - 25°	15	0.0186	0.0223
	26° - 30°	49	0.0607	0.0830
	31° - 35°	58	0.0719	0.1549
	36° - 40°	87	0.1078	0.2627
	41° - 45°	104	0.1289	0.3916
	46° - 50°	123	0.1524	0.5440
	51° - 55°	116	0.1437	0.6877
	56° - 60°	86	0.1066	0.7943
	61° - 65°	75	0.0929	0.8872
	66° - 70°	51	0.0632	0.9504
	71° - 75°	23	0.0285	0.9789
	76° - 80°	7	0.0087	0.9876

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
Trail site	81° - 85°	5	0.0062	0.9938
	86° - 90°	4	0.0050	0.9988
	+ 90°	1	0.0012	1.0000
15Tr50	16° - 20°	2	0.0202	0.0202
	21° - 25°	2	0.0202	0.0404
	26° - 30°	4	0.0404	0.0808
	31° - 35°	8	0.0808	0.1616
	36° - 40°	22	0.2222	0.3839
	41° - 45°	17	0.1717	0.5556
	46° - 50°	13	0.1313	0.6869
	51° - 55°	6	0.0606	0.7475
	56° - 60°	10	0.1010	0.8485
	61° - 65°	9	0.0909	0.9394
	66° - 70°	2	0.0202	0.9596
	71° - 75°	3	0.0303	0.9899
	76° - 80°	1	0.0101	1.0000
15Tr53	16° - 20°	-	0.0000	0.0000
	21° - 25°	-	0.0000	0.0000
	26° - 30°	-	0.0000	0.0000
	31° - 35°	1	0.0667	0.0667
	36° - 40°	-	0.0000	0.0000
	41° - 45°	3	0.2000	0.2667
	46° - 50°	1	0.0667	0.3333
	51° - 55°	2	0.1333	0.4667
	56° - 60°	1	0.0667	0.5333

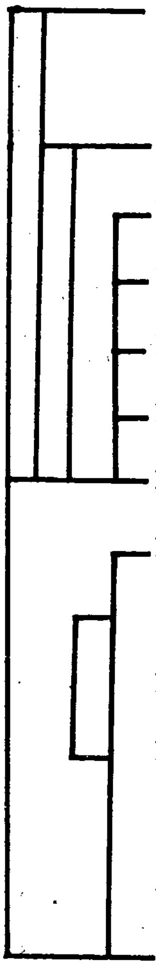
Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
15Tr53	61° - 65°	2	0.1333	0.6667
	66° - 70°	2	0.1333	0.8000
	71° - 75°	3	0.2000	1.0000
15Tr56	16° - 20°	-	0.0000	0.0000
	21° - 25°	-	0.0000	0.0000
	26° - 30°	-	0.0000	0.0000
	31° - 35°	-	0.0000	0.0000
	36° - 40°	-	0.0000	0.0000
	41° - 45°	-	0.0000	0.0000
	46° - 50°	2	0.0800	0.0800
	51° - 55°	3	0.1200	0.2000
	56° - 60°	2	0.0800	0.2800
	61° - 65°	2	0.0800	0.3600
	66° - 70°	2	0.0800	0.4400
	71° - 75°	5	0.2000	0.6400
	76° - 80°	5	0.2000	0.8400
	81° - 85°	2	0.0800	0.9200
	86° - 90°	1	0.0400	0.9600
	+ 90°	1	0.0400	1.0000
40Sw74	16° - 20°	-	0.0000	0.0000
	21° - 25°	-	0.0000	0.0000
	26° - 30°	4	0.0230	0.0230
	31° - 35°	5	0.0287	0.0517
	36° - 40°	5	0.0287	0.0805
	41° - 45°	12	0.0690	0.1494

Table 41. cont.

Assemblage	Interval	n	p	Cumulative p
40Sw74	46° - 50°	13	0.0747	0.2241
	51° - 55°	14	0.0805	0.3046
	56° - 60°	16	0.0920	0.3966
	61° - 65°	31	0.1782	0.5747
	66° - 70°	21	0.1207	0.6954
	71° - 75°	22	0.1264	0.8218
	76° - 80°	12	0.0690	0.8908
	81° - 85°	8	0.0460	0.9368
	86° - 90°	6	0.0345	0.9713
	+ 90°	5	0.0287	1.0000

Table 42. Rank-order of assemblages by mean bifacial thinning flake striking platform angle.



Assemblage	$\overline{x}$	Rank
Morrisroe C	43.25	1
15Tr50	43.89	2
Morrisroe B	44.36	3
Morrisroe G	45.37	4
Morrisroe F	46.69	5
Morrisroe H	47.74	6
Morrisroe D	48.09	7
Morrisroe E	48.46	8
Morrisroe A	50.09	9
Trail site	50.23	10
Morrisroe I	50.91	11
Morrisroe J	51.37	12
15Tr53 *	57.73	13
40Sw74 *	62.49	14
15Tr56 *	70.20	15

* not bifacial thinning flakes

** similarity asses by anova for unequal sample sizes (Sokal and Rohlf 1969: 206 ff.)

similarities between assemblages and groups of assemblages. The pattern of similarities is less distinct than that based upon flake length. The assemblages from the middle levels of the Morrisroe site (Assemblages G, F, H, D, and E) form a distinct group. Morrisroe Assemblage B is similar to this group and the assemblage from 15Tr50 is similar to the larger group formed by Morrisroe Assemblages B, G, F, H, D, and E. The data from Morrisroe Assemblage C is significantly different from the other Morrisroe assemblages, although the variance introduced by the inclusion of the assemblage from 15Tr50 enables the inclusion of the Morrisroe Assemblage C within this larger group.

There is a marked difference between the initial group (Morrisroe Assemblages G, F, H, D, and E) and Morrisroe Assemblages A, I, J and the assemblages from the Trail site, 15Tr53, 15Tr56, and 40Sw74. An ANOVA for samples of unequal sizes (Sokal and Rohlf 1969: 206-210) indicated that there is no significant difference ($p<0.05$) between these latter assemblages. As the initial group was expanded, and the within group variance increased, assemblages from the Trail site, 15Tr56, and Morrisroe Assemblages I and J were judged to be not significantly different from this larger group. Morrisroe Assemblage A and assemblages from 15Tr53 and 40Sw74 remained significantly different ($p>>0.05$).

Discussion. These patterns of similarities and differences are difficult to interpret, especially in light of the patterns indicated by the bifacial thinning flake length. The similarity between the middle assemblages from the Morrisroe site (D, E, F, G and H) is confirmed by both analyses, substantiating the suggestion that the biface reduction trajectories of these assemblages are similar. In addition, the similarity between Morrisroe Assemblage A and the Trail site material is substantiated by both analyses. Furthermore, it is not surprising that no significant differences were noted between 15Tr53, 15Tr56 and 40Sw74, none of which represent measurements made on bifacial thinning flakes. It is surprising that Morrisroe Assemblage A and the material from the Trail site exhibit least differences with 15Tr53, 15Tr56 and 40Sw74. The examination of flake length indicated that the former represented short trajectories, near the final stage. It was expected that these assemblages would be least similar to 15Tr53, 15Tr56 and 40Sw74 with respect to their platform angles. In addition, the similarity between platform angles in Morrisroe Assemblage A and the Trail site and those from Morrisroe Assemblage I and J are the converse of that indicated by flake length.

Although it was argued that the type of the raw material had a minimal effect on bifacial thinning flake length, it may be an important factor influencing platform angles. Morrisroe Assemblages I and J and assemblages from the Trail site and from 15Tr53, 15Tr56 and 40SW74 all contain large amounts of upper St. Louis cherts. Items in the middle assemblages from the Morrisroe site (G, F, H, D, and E) are mostly made of lower St.

Louis/Salem materials. Although substantiating experimental evidence does not exist, the dichotomy between predominant chert types and platform angles is certainly suggestive. The overall similarity indicates that prehistoric techniques of stone tool production required that a limited range of platform angles be maintained throughout various stages of biface manufacture (and other stages of lithic reduction).

Biface Width/Thickness Ratio

The bifaces in each of the assemblages were compared as a third means of identifying differences in the staging of biface manufacture. Other researchers (e.g. Johnson 1981; Thomas 1983b) have identified biface reduction stages by the expression of a variety of morphological characteristics (edge shape, cross-section, flake scar pattern, etc). This has enabled the comparison of the relative abundance of specimens representing each production stage. The definition of these stages requires extensive samples which provide an indication of the range of variation to be found within each stage. Ideally, replicative data should be available to confirm expressions within stages. The application of these definitions requires relatively large samples of complete bifaces. Incomplete specimens, especially if they are small in size, will reduce the ability to identify edge shapes, flake scar patterns, and other definitive criteria.

The sample included in this analysis consists of bifaces from each of the fifteen assemblages. Drills were excluded because of their specialized form. Hafted bifaces also represent specialized items and, therefore are not necessarily indicative of the reduction stages undertaken at a site. The number of remaining items in each assemblage are summarized in Table 43. Fewer than 10 per cent of the bifaces from any one assemblage are complete specimens. This significantly reduces the assurance with which manufacturing stages can be identified within each of the samples.

As an alternative, a ratio of maximum width:maximum thickness was calculated for each biface in each assemblage. Distal fragments and items with longitudinal fractures were excluded from this analysis, since the measurements recorded for these items were not felt to be representative of the entire item. Data recorded for the remaining individuals are summarized in Table 44, where the number of individuals in each interval class, the proportion of the assemblage, and the cumulative proportions are presented. These data are portrayed graphically in Figure 19. These ogives form the basis for comparisons of the relative importance of various manufacturing stages in different assemblages.

The calculation of maximum width:maximum thickness ratios for bifaces does not necessarily provide an accurate means for assessing the manufacturing stage. It is assumed that, as a biface reaches completion, its thickness will be reduced to a greater extent than its width. However, a functional biface requires that a certain width:thickness ratio not be exceeded in

Table 43. Bifaces in each assemblage.

Assemblage	Bifaces Complete	Bifaces Manufacture Fracture	Bifaces Use Fracture
Morrisroe A	-	2	-
Morrisroe B	-	1	-
Morrisroe C	1	7	-
Morrisroe D	1	17	-
Morrisroe E	7	44	-
Morrisroe F	6	67	-
Morrisroe G	12	70	-
Morrisroe H	5	43	-
Morrisroe I	3	34	-
Morrisroe J	11	42	1
Trail site	5	93	2
15Tr50	9	17	-
15Tr53	2	4	-
15Tr56	3	2	-
40Sw74	20	122	2

Table 44. Cumulative proportions of biface maximum width:maximum thickness ratio.

Assemblage	Interval	n	p	Cumulative p
Morrisroe A	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	-	0.000	0.000
	2.10 - 3.00	1	0.500	0.500
	3.10 - 4.00	-	0.000	0.500
	4.10 - 5.00	1	0.500	1.000
Morrisroe B	(3.4054)			
Morrisroe C	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	1	0.125	0.125
	2.10 - 3.00	3	0.375	0.500
	3.10 - 4.00	1	0.125	0.625
	4.10 - 5.00	2	0.250	0.875
	5.10 - 6.00	1	0.125	1.000
Morrisroe D	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	-	0.000	0.000
	2.10 - 3.00	2	0.133	0.133
	3.10 - 4.00	7	0.4667	0.600
	4.10 - 5.00	5	0.333	0.933
	5.10 - 6.00	1	0.067	1.000
Morrisroe E	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	2	0.041	0.041
	2.10 - 3.00	9	0.184	0.225
	3.10 - 4.00	27	0.551	0.776

Table 44. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe E	4.10 - 5.00	9	0.184	0.959
	5.10 - 6.00	2	0.041	1.000
Morrisroe F	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	1	0.015	0.015
	2.10 - 3.00	12	0.018	0.194
	3.10 - 4.00	35	0.522	0.716
	4.10 - 5.00	11	0.164	0.881
	5.10 - 6.00	5	0.074	0.955
	6.10 - 7.00	1	0.015	0.970
	7.10 - 8.00	-	0.000	0.970
	8.10 - 9.00	1	0.015	0.985
	9.10 - 10.00	-	0.000	0.985
	10.10 - 11.00	-	0.000	0.985
	11.10 - 12.00	1	0.015	1.000
Morrisroe G	0.01 - 1.00	1	0.015	0.015
	1.10 - 2.00	5	0.076	0.091
	2.10 - 3.00	13	0.197	0.288
	3.10 - 4.00	27	0.409	0.697
	4.10 - 5.00	14	0.212	0.909
	5.10 - 6.00	5	0.076	0.985
	6.10 - 7.00	-	0.000	0.985
	7.10 - 8.00	1	0.015	1.000

Table 44. cont.

Assemblage	Interval	n	p	Cumulative p
Morrisroe H	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	1	0.025	0.025
	2.10 - 3.00	12	0.300	0.325
	3.10 - 4.00	11	0.275	0.600
	4.10 - 5.00	9	0.225	0.825
	5.10 - 6.00	7	0.175	1.000
Morrisroe I	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	1	0.036	0.036
	2.10 - 3.00	5	0.179	0.214
	3.10 - 4.00	19	0.679	0.893
	4.10 - 5.00	2	0.071	0.964
	5.10 - 6.00	1	0.036	1.000
Morrisroe J	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	4	0.089	0.089
	2.10 - 3.00	14	0.311	0.400
	3.10 - 4.00	18	0.400	0.800
	4.10 - 5.00	9	0.200	1.000
Trail site	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	7	0.103	0.103
	2.10 - 3.00	18	0.265	0.368
	3.10 - 4.00	28	0.412	0.779
	4.10 - 5.00	12	0.177	0.956
	5.10 - 6.00	2	0.029	0.985
	6.10 - 7.00	1	0.015	1.000

Table 44. cont.

Assemblage	Interval	n	p	Cumulative p
15Tr50	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	5	0.217	0.217
	2.10 - 3.00	11	0.478	0.696
	3.10 - 4.00	6	0.261	0.957
	4.10 - 5.00	-	0.000	0.957
	5.10 - 6.00	-	0.000	0.957
	6.10 - 7.00	-	0.000	0.957
	7.10 - 8.00	-	0.000	0.957
	8.10 - 9.00	1	0.044	1.000
15Tr53	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	-	0.000	0.000
	2.10 - 3.00	3	0.600	0.600
	3.10 - 4.00	2	0.400	1.000
15Tr56	0.10 - 1.00	-	0.000	0.000
	1.10 - 2.00	1	0.200	0.200
	2.10 - 3.00	2	0.400	0.600
	3.10 - 4.00	1	0.200	0.800
	4.10 - 5.00	-	0.000	0.800
	5.10 - 6.00	-	0.000	0.800
	6.10 - 7.00	-	0.000	0.800
	7.10 - 8.00	-	0.000	0.800
	8.10 - 9.00	1	0.200	1.000
40Sw74	0.10 - 1.00	1	0.008	0.008
	1.10 - 2.00	17	0.143	0.151

Table 44. cont.

Assemblage	Interval	n	p	Cumulative p
40Sw74	2.10 - 3.00	45	0.378	0.529
	3.10 - 4.00	37	0.311	0.840
	4.10 - 5.00	13	0.109	0.950
	5.10 - 6.00	3	0.025	0.975
	6.10 - 7.00	-	0.000	0.975
	7.10 - 8.00	-	0.000	0.975
	8.10 - 9.00	-	0.000	0.975
	9.10 - 10.00	-	0.000	0.975
	10.10 - 11.00	-	0.000	0.975
	11.10 - 12.00	-	0.000	0.975
	12.10 - 13.00	2	0.017	0.992
	13.10 - 14.00	1	0.008	1.000

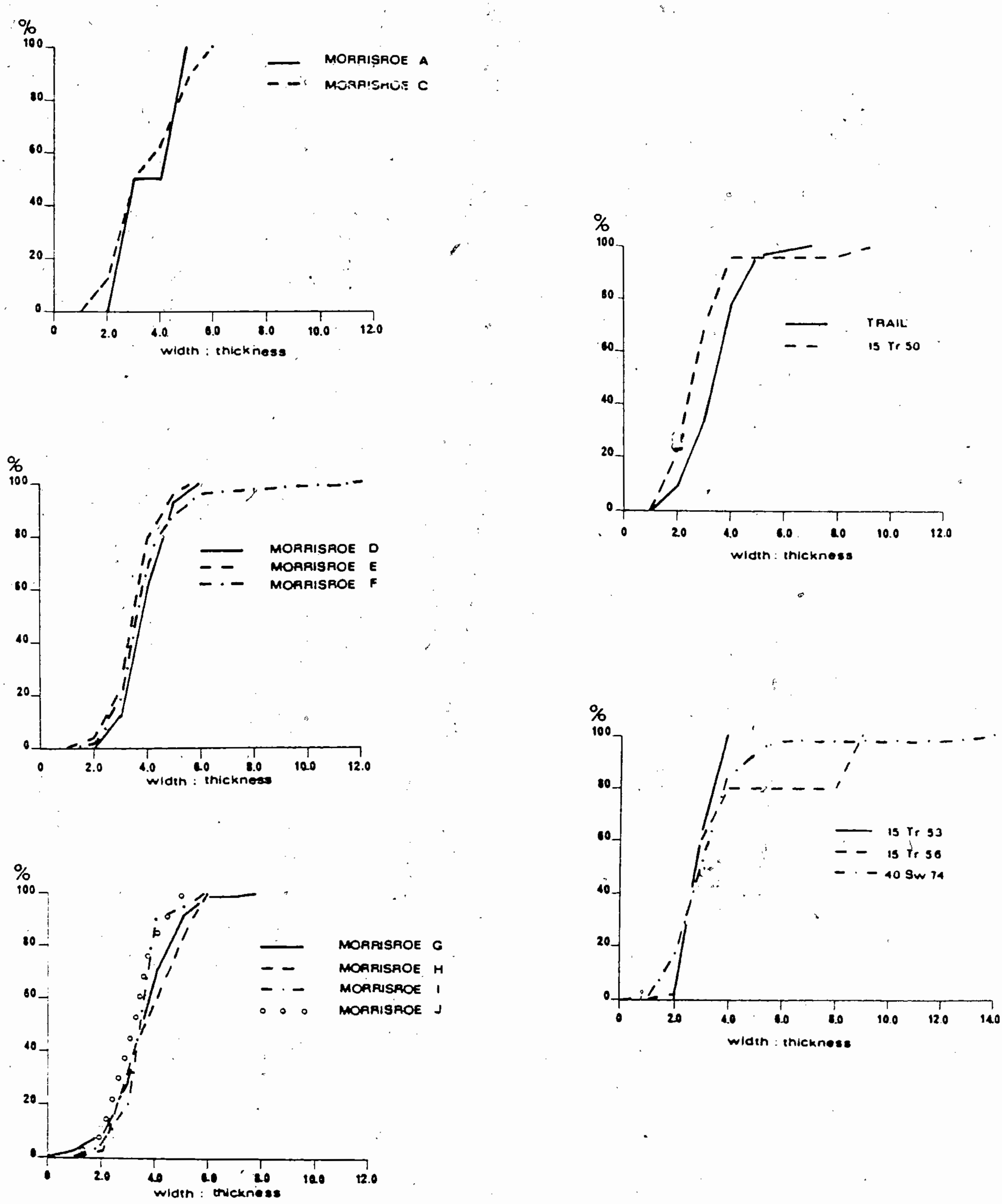


Figure 19. Ogives of biface maximum width: maximum thickness ratio.

order that the edge be buttressed to absorb stress induced by use. Critical ratios will have been determined by the nature of the raw material, the nature of the tasks, and the design of the tool system (including method of hafting). The following analysis was undertaken with these qualifications in mind.

A visual comparison of the ogives for bifaces in each assemblage underscores the similarities and differences noted in the analysis of bifacial thinning flake lengths and platform angles. Most of the assemblages from the Morrisroe site are extremely similar to one another, with items distributed in the same proportions between ratios of 2.0 and 6.0. Morrisroe Assemblages F and G differ somewhat, as both contain items with maximum width:maximum thickness ratios considerably greater than 6.0 In both cases, the extremely narrow values are represented by only one (Assemblage G) or two (Assemblage F) items. It should also be noted that both of these assemblages contain more bifaces than other assemblages from the Morrisroe site. Sample size, therefore, may contribute to the observed pattern.

The uppermost assemblages from the Morrisroe site, while exhibiting distinctively shaped curves, exhibit a similar range of values for the maximum width:maximum thickness ratios. The unique shape of these ogives is a result of the very small numbers of bifaces occurring in these assemblages.

It will be recalled that the assemblages from the Trail site and from 15Tr50 contained bifacial thinning flakes that were smaller, on average, than those found in most of the Morrisroe assemblages. An examination of the ogives for the biface maximum width:maximum thickness ratios from these sites add some support to the apparent uniqueness of these assemblages. In both cases, the curves extend past the 6.0 limit reached by most of the Morrisroe items. However, both of these extensions result from the presence of only a single item with a large ratio value. These extensions of the curves beyond a limit reached by other assemblages do not, therefore, indicate that the assemblages from the Trail site and 15Tr50 are significantly different from the Morrisroe site assemblages.

The ogives representing the maximum width:maximum thickness ratio of bifaces from 15Tr53, 15Tr56 and 40Sw74 are considerably different from those for other assemblages. The distinctive forms representing 15Tr53 and 15Tr56 are probably a result of the small number of bifaces (_n_=5) in those assemblages. The elongated section of the curve for 40Sw74 suggests that very thin bifaces were found within this assemblage. However, the area between ratios of 6.0 and 14.0 represents only 2.52 per cent (_n_=3) of the assemblage. As with all other assemblages, the steepest part of the curve (and hence, the majority of the sample) lies between the 2.0 and 6.0 values.

Discussion. The analysis of the cumulative frequency curves for biface maximum thickness:maximum width ratios does not provide a means for distinguishing between the stages of biface manufacturing activities represented in each assemblage. All of the curves are extremely similar and indicate that ratio values between 2.0 and 4.0 describe the majority of specimens. A few items in each case lie above or below these values. The reason for these similarities lies in the nature of the collection of bifaces. Table 44 summarizes the numbers of bifaces in each assemblage and identifies whether the items were complete, broken in manufacture, or broken in use. (These items include distal fragments and bifaces with longitudinal fractures. The sample is, therefore, larger than that used to compile the ogives.) It is clear from an inspection of this table that the vast majority of bifaces in each assemblage was broken during manufacture. The cumulative frequency distribution of biface maximum width:maximum thickness ratios may be a reflection of this fracture pattern. That is, bifaces with a ratio between 2.0 and 4.0 tend to break more easily as reduction continues.

The predominance of broken bifaces in these assemblages underscores an important source of bias in this analysis. The items which were recovered are primarily those which could not successfully be reduced beyond a critical maximum width:maximum thickness ratio. Bifaces which may have been reduced further would represent more "finished" specimens and may have been conserved (or curated sensu Binford) for use and/or deposition at locations not considered in this study. Thus, while the final stages of biface reduction may have taken place at a given site, the finished product may not be present in the assemblage from that site. However, it is expected that the debitage will remain as evidence of these activities.

The small number of bifaces with maximum width:maximum thickness ratios smaller that 2.0 may be interpreted in two ways. First, the intial stages of reduction may generally have been undertaken at quarry localities. The resulting specimens may already have been shaped into crude bifaces with a definitive maximum width:maximum thickness ratio. If none of the assemblages represents quarry activities, then these very early stages will not be represented in the collections. Second, if the complete reduction sequence is represented in an assemblage, the majority of bifaces appear to have been successively reduced beyond the early manufacturing stages. In either instance, the collection of bifaces in each assemblage will exhibit an underrepresentation of items with low values for the maximum width:maximum thickness ratio.

Chapter Summary

This chapter examined aspects of each assemblage for evidence of differences in the staging of biface manufacturing trajectories. The data examined include: bifacial thinning flake length; striking platform angles on bifacial thinning flakes; and maximum thickness:maximum width ratios of bifaces. The results, while somewhat contradictory, indicate that some of the assemblages differ in the stages of the manufacturing trajectory which are present.

The examination of bifacial thinning flake lengths demonstrated distinct differences between late Middle - Late Archaic and Middle Archaic assemblages. Morrisroe Assemblage A and the assemblages from 15Tr50 and the Trail site are distinguished by short flakes. Those from Morrisroe Assemblages B to J have larger flakes, with the earlier Assemblages (H, J, and I) exhibiting the longest average flake length. Furthermore, flakes from Morrisroe Assemblages B-J exhibit a greater range of lengths while those from 15Tr50 and the Trail site show less variation. Interestingly, the assemblages from 15Tr53, 15Tr56 and 40Sw74 contained too few complete flakes for comparative purposes. Based on these results, it is suggested that the assemblages from 15Tr50 and the Trail site and Morrisroe Assemblage A represent short reduction trajectories, probably from the final manufacturing/reworking stages. The Morrisroe Assemblages B to J contain refuse from longer trajectories, including early, middle and late stages of reduction. If the near absence of complete bifacial thinning flakes from 15Tr53, 15Tr56 and 40Sw74 is indicative of the paucity of these items in those assemblages, (and is not a sampling error) then these sites were either not the loci of biface reduction or they reflect very short trajectories encompassing only the very early reduction stages. These stages may have produced debitage which did not include bifacial thinning flakes.

This pattern was examined further in a comparison of the striking platform angle on bifacial thinning flakes. The pattern which emerged from this analysis was less clear. Although most of the Middle Archaic assemblages from the Morrisroe site were found to be similar, some of the Late Archaic and late Middle Archaic assemblages appeared different from other assemblages of similar ages. In addition, the earliest Morrisroe assemblages (I and J) were more similar to late Middle and Late Archaic samples than they were to other Middle Archaic assemblages. The inclusion of samples of non-bifacial thinning flakes from 15Tr53, 15Tr56 and 40Sw74 did not clarify the results. These latter were found not to be significantly different from assemblages the Trail site and Morrisroe Assemblage A. The analysis of flake length had indicated that these assemblages should represent opposite ends of the biface manufacturing sequence; it was expected that the platform angle would be significantly different.

A comparison of the results of the platform angle analysis and the use of chert types indicated that the two may be related. The assemblages which exhibited the least acute striking platform angles (on average) were those in which upper St. Louis chert is the predominant type of raw material. Assemblages in which lower St. Louis/Salem chert prevails exhibit more acute platform angles. This relationship may be related to the form in which the material generally occurs (nodular upper St. Louis; tabular lower St. Louis) or the tractability of the chert. It is important to note that this pattern is weak, and the significant differences between

Morrisroe Assemblage B, the assemblages from 15Tr53, and the other late Middle - Late Archaic assemblages remains enigmatic.

The examination of maximum width:maximum thickness ratios for bifaces did not support either of the patterns exhibited in the other analysis. Rather, all assemblages were found to be extremely similar. The small differences which did occur were attributed to vagaries in the data due to small sample sizes. The observed homogeneity was attributed to the sampling bias inherent in the nature of the data. As the vast majority of the bifaces had been broken during manufacture, it was suggested that the observed maximum width:maximum thickness ratio represents a critical threshhold. Further reduction leads to material failure and the disposal of the broken items. When subsequent thinning is successful, the item is conserved (or curated) for use elsewhere. The assemblages examined in this study apparently represent the disposal of unwanted items, rather than the caching of useful goods.

The virtual absence of bifaces indicative of the early reduction stages is also a problem. It may be that initial reduction was undertaken at specific quarry locations and that items broken early in the manufacturing process were left at those sites. The general absence of very large bifacial thinning flakes substantiates this suggestion. On the other hand, the early reduction stages may have been successfully completed in most instances. Thus, few broken specimens from the initial reduction stage would have been discarded. A sample of material from quarry sites is necessary to determine the validity of these interpretations.

As a result of these analyses it is concluded that the technological organization represented in the Middle Archaic assemblages is different from that indicated by the late Middle - Late Archaic assemblages. The former are represented by long biface reduction trajectories which include most stages of the manufacturing process. In contrast, the later assemblages exhibit short trajectories. The Trail site, 15Tr50 and Morrisroe Assemblages A and B evince later stages of biface reduction. Sites 40Sw74, 15Tr53, and 15Tr56 have relatively few bifacial thinning flakes and may represent the earlier phases of biface manufacture.

CHAPTER XI

SUMMARY AND DISCUSSION

This chapter summarizes the substantive aspects of this dissertation, compares the results with other studies of Middle and Late Archaic mobility strategies in the mid-continent, and outlines the ways in which elements of the biophysical and social environment may have affected the observed patterns of mobility. While it is difficult to isolate specific reasons for changes in mobility strategies within the lower Cumberland/Tennessee valley, the general pattern of change suggests that these developments reflect a fundamental change in Eastern Woodlands prehistory.

Summary of Substantive Results

In Chapter 3 it was suggested that the analysis of archaeological sites and assemblages may be profitable when the environmental context is included as an important variable. Elements of the environment are not evenly distributed in space and time but, rather, occur in patches. The distribution of these patches, in turn, may vary with environmental fluctuations (both long term and short term).

Biotic populations adapt to the patchy distribution of resources with either a fine grained or a coarse grained response. A fine grained response utilizes patches in the same proportion in which they occur, while a coarse grained response implies a disproportionate use of a restricted number of patches. The size and general mobility of human hunter-gatherers indicates that they exploit resource patches in a fine grained manner. That is, they move easily from one patch to the next as resources are depleted or become too "expensive" to exploit. These movements may entail the frequent resettlement of the entire residential group or they may involve the dispatching (or refuging) of special foraging groups. The two patterns have been termed, respectively, residential mobility and logistic mobility.

Residential mobility implies the frequent relocation of residential bases as locally available resources become depleted. The duration of occupation, distance between site locations and the size of the residential group are dependent, in part, on the patchiness of the resources. When these resources are more clumped, the group size and the length of occupation may increase. A logistic mobility strategy includes a relatively stable residential base supported by a network of smaller, more specialized sites. Among these smaller sites will be base camps from which the foraging group provisions itself for short periods of time while undertaking rather specialized procurement activities. It is important to note that the dichotomy between residential and logistic mobility strategies has been made artificially distinct in this description. In reality, groups are likely to vary along a continuum between the extremes.

A number of criteria may be used to separate sites formed within a residential mobility strategy and those formed within a logistic mobility strategy. The size of the residential base, while varying with the abundance of resources, will generally be larger within a logistic mobility strategy. Those formed within a residential mobility strategy will be smaller and more dispersed across the landscape. While only residential bases will be archaeologically visible within a residential mobility strategy, a logistic mobility strategy will include both residential sites and smaller base camps. Biotic remains will vary among the three types of sites as the variety of exploited resources differ. In addition, the more stable sites may be expected to reflect a spatial organization as items are stored in pits and refuse is allocated to special disposal areas. Unfortunately, the sites considered in this study afford little information regarding these criteria. Biotic preservation is negligible and the excavated portions do not represent an equal sampling of each site. As a result, no information is available regarding the use of various resources or the spatial organization within the sites. Nevertheless, an examination of the lithic assemblages does provide a means of investigating the nature of the occupations they represent.

The composition of lithic assemblages are affected by the range of activities undertaken at a site, the duration of occupation and the size of the residential group. The effects of these variables will be reflected in the structure of the assemblage and in the technolgical organization. It has been suggested that as each of these variables increases (i.e., more activities; longer occupation; larger groups) a wider variety of lithic reduction activities will have been undertaken and the structure of the assemblage will appear more complex. Associations of artifacts which indicate specialized activities (such as hunting or plant processing) are more likely to be found at sites which were occupied as base camps by logistic foraging groups. In addition, the manufacture of relatively complex items such as hafted bifaces, would have been accomplished in a series of stages. As the stabilty of a site increases, and/or the size of the group increases, a greater number of stages will be reflected in the debitage from these sites. Finally, it was suggested that as the range of the foraging group increases, the variety of lithic material from distant sources would also increase. Accordingly, the analysis of the lithic assemblages focused on the varieties of lithic material present, the structure of the lithic assemblage, and the organization of the biface manufacturing trajectories.

The analysis of lithic raw materials indicates that the great majority of the material was derived from local sources. Assemblages from the Cumberland River side of the uplands exhibited greater proportions of upper St. Louis and Ste. Genevieve cherts while those from the Tennessee River side had greater proportions of lower St. Louis/Salem types. Other chert varieties were of minor importance and it was found that most assemblages contained varieties that outcropped in very distant parts of the study area. Cherts from outside of the study area constituted a very minor part of the assemblages. It was also found that no chert type was procured for use as specific tool forms. These results suggest an expedient use of materials.

The analysis of assemblage structures was undertaken through a principal components analysis. The results suggest a general distinction between the Middle Archaic assemblages from the Morrisroe site and all of the later assemblages. The Middle Archaic assemblages are characterized by a large amount of debitage from all stages of lithic reduction and do not contain any special associations of artifacts. Groundstone and pecked-battered artifacts are relatively more common in these assemblages, but this may reflect the general rarity of these items. The later assemblages generally have fewer than average items from lithic reduction and a more restricted range of flake tools.

Three sites, 15Tr50, 40Sw74 and the Trail site, have an overabundance of hafted bifaces. In the case of 40Sw74 and the Trail site this may reflect a sampling error as these items represent a surface collection from across the entire surface of the site. In the case of 15Tr50, this indicates that the site may have been occupied as a restricted range of activities were undertaken. It is perplexing that the Trail site also exhibits a very large association of items from all stages of lithic reduction and a wide variety of flake tools. This suggests a residential stability similar to that indicated by the Middle Archaic assemblages. Similarly, some Middle Archaic assemblages seem to indicate less stable occupations than expected. These exceptions reflect the adaptability of hunter-gatherer mobility strategies and emphasize that the dichotomy between logistic and residential mobility is arbitrary.

The analysis of technological organization supports the results of the analysis of technological structure. Focusing on attributes of bifacial thinning flakes and of the bifaces themselves, it was found that the Middle Archaic period assemblages reflect longer manufacturing trajectories than the later assemblages. This pattern is most evident when bifacial thinning flake lengths were considered and was more weakly expressed in the analysis of the other attributes. Nevertheless, this does suggest that the later sites were occupied for shorter periods of time and that residential mobility increased during the later part of the Archaic period.

Comparisons with Other Areas

As a first step in determining the substantive significance of these results, and as a means of understanding the apparent change in mobility strategies, comparisons will be made with other Middle Archaic and Late Archaic assemblages elsewhere in the mid-continent. These comparisons will indicate if the perceived changes were a local phenomena or if they were more widespread. If the results indicate a localized phenomena, then local causes must be found and the analytical procedure must be reevaluated. If similar changes are found to occur elsewhere, then the procedure may be accepted and more general causes of culture change must be sought. Five studies will be reviewed and compared with the lower Cumberland/Tennessee valley material. These include data from the Eva site, the Black Earth site, Modoc Rockshelter, the Koster site, and the Salt River valley. All but the Eva site are located north of the Ohio River and lie within, or adjacent to, the prairie penninsula. Consequently, mid-Holocene climatic fluctuations may have had a greater effect on the environment than in the lower Cumberland/Tennessee drainage.

Eva site. The Eva site was located adjacent to the Tennessee River in northwestern Tennessee (Lewis and Lewis 1961). Flooding, which followed the construction of the Kentucky Dam, has submerged the site. The three components recognized at the site include the Middle Archaic Eva component and later Archaic Three Mile and Big Sandy components. Analysis of lithic and bone artifacts and faunal remains indicated a distinct change in the nature of the occupation of the site. There appears to have been a great reduction in the intensity with which the site was occupied, with much less animal bone occurring in the upper strata. At the same time, there was an increase in fish remains and in the amount of shellfish remains. Lewis and Lewis (1961: 20) suggested that a combination of human exploitation and environmental change brought about by the Hypsithermal reduced the availability of deer and forced a greater reliance on aquatic resources.

Black Earth site. The Black Earth site is located in Saline County, southern Illinois (Jefferies and Butler 1981; Jefferies 1983). There, a distinct change was observed between an intensive deposition of material and the accumulation of an organic-rich midden deposit during the Middle Archaic and a less intense occupation during the subsequent periods. Jefferies (1983: 203-204) attributed the intense Middle Archaic occupation to:

> the unique complex of nearby aquatic habitats. As the Hypsithermal effects became more widespread during this period, reducing the reliability or availability of subsistence resources in the uplands, the lake-swamp system and surrounding area assumed an increasing significance by offering the necessary diversity, density and predictability of food resources to allow localization of activities and population aggregation.

Thus, environmental change is assumed to have been a paramount causal factor in the perceived changes in the nature of the occupation.

Modoc Rockshelter. Modoc Rockshelter is a deep, stratified site in Randolph County, west-central Illinois (Fowler 1959; Styles et al. 1981). Comparisons of artifacts from throughout the deposits indicated that the nature of the activities at the site changed considerably through time. During the Middle Archaic, the total assemblage reflected a variety of manufacturing and domestic activities and the faunal remains indicated that a variety of animals were procured. Fowler (1959:

56) interpreted these patterns as indicative of a general habitation site. Following this period, from c. 5,500 bp to 4,000 bp, the faunal remains and artifact assemblage suggested that the site was used as a specialized hunting camp (Fowler 1959: 57). Fowler (1959: 57; 1957) noted that most Late Archaic assemblages in western Kentucky and southern Illinois represent specialized activity sites. This development was interpretted as:

> demonstrating that the seasonal cycle of exploitation of environmental resources was fully developed by this time, 3500 - 2000 B.C. (Fowler 1959: 57)

This development was viewed as a part of the more general trend towards Primary Forest Effeciency outlined by Caldwell (1958).

Koster site. The Koster site is situated in the lower Illinois River valley, in east-central Illinois. While numerous reports have been provided by the research at this site, those which are most pertinent to this discussion are by Hill (1975), Carlson (1979), Lurie (1982) and Brown and Vierra (1983). These authors have all agreed that there was a significant change in the nature of the occupations between the Middle Archaic and the later levels of the site. The Middle Archaic levels are represented by a greater depositon rate of cultural material, a more pronounced spatial organization of this material, and a technological economy indicative of a very stable residential base. Patterns in the later assemblages suggest much less organization and a reduced rate of artifact depostion. This change seems to represent a trend towards less intense occupations during the later periods. Carlson (1979: 396-398) suggested that the more intense Middle Archaic occupations reflected a "pull" of populations into river valley localities as the Hypsithermal resulted in an impoverished upland biota. Brown and Vierra (1983) disagreed with such a model, suggesting instead that social dynamics may have led to a change in mobility strategies.

Salt River. Sites located within the Cannon Reservoir, in northeastern Missouri, provided data upon which models of changing hunter-gatherer mobility strategies could be developed and tested (O'Brien et al. 1982). Extensive analyses of vegetation patterns and site distributions were interpretted within the context of a model linking mobility strategies to variations in resource availability and distribution. The results indicated that the Middle Archaic sites served as residential camps within a residential mobility strategy. Site distributions were restricted to areas along river valleys, perhaps in response to narrowing ecological zones during the Hypsithermal (Warren 1982: 365-366). Late Archaic - Woodland period sites retained this pattern, but also reflected the development of more specialized-activity sites. This suggests a pattern of more stable residential bases maintained by logistic task forces (Warren 1982: 366).

In general, these studies confirm the changes in mobility strategies suggested by the data from the lower Cumberland/Tennessee drainages. That is, there appears to have been a change from relatively stable residential bases during the Middle Archaic to much less stable occupations during the Late Archaic. The occurrence of this pattern across such a wide area indicates that it represents a substantial change in prehistoric economies, settlement patterns and subsistence systems. It also suggests that the underlying causes for these changes are to be found in widespread social and biophysical environmental developments rather than in variations in local conditions.

Mobility Strategy Change in Western Kentucky: Possible Causes

In Chapter 3 a model was developed in which mobility strategies were linked to the patchiness of the distribution of resources. It was suggested that if resources are clumped, they may be most effectively harvested by relatively large groups. At the same time, clumped resources can support larger groups for longer periods and, therefore, enable an increase in the groups size and residential stability. Resources which are more dispersed may impose greater constraints on the size of the foraging group. The changes in resource distribution which accompanied the changes in mobility strategies remain to be demonstrated.

Paleoenvironmental evidence from the mid-continent indicate a significant drying trend throughout the mid-Holocene. This Hypsithermal coincides, approximately, with the Middle Archaic period. In many areas of the Midwest, this climatic episode seems to have been accompanied by a general expansion of grasslands and a contraction of arboreal species to areas within the river valleys. The effect was a compaction of a number of biotic associations within relatively small distances. Within a given area, the environment became more patchy and the distribution of resources were spatially clumped. As a result, residential bases may have been maintained for longer periods and may have supported larger numbers of people. This result follows for two reasons. First, the range of exploitable resources near sites in the river valleys was increased. Second, logistic task groups would have had to journey relatively short distances to exploit new patches of resources. As a result, the need to move a residential base would have occurred with less frequency.

Following the Hypsithermal, the arboreal elements apparently expanded beyond the river valleys, although not as far as their previous range. As a result, patches of distinct resource association would have been further apart. Seasonal exploitation patterns and the consumption of resources near residential sites would have required more frequent moves of the residential bases. Logistic groups would have had to travel greater distances before encountering new resource patches. Evidence indicates that population growth during this period may have limited the area available for exploitation by any one group (cf. Walthall 1980).

The effects of the Hypsithermal on the biota of western Kentucky are much less clear. Both the Cumberland and the

Tennessee rivers drain from southern areas. Consequently, their water levels may have been largely unaffected by the mid-Holocene drying trend. Areas in the uplands between the rivers are more dependent upon local rainfall. Prolonged dry periods may have resulted in an expansion of the Barrens and a contraction of arboreal species to areas near the river valleys. With the return of more moist conditions, these biota may once more have expanded. A changing pattern of mobility strategies similar to those observed in other areas may have resulted.

This "environmental model" of mobility strategy change seems to account reasonably well for the observed changes in the archaeological record. However, it serves as a prime-mover model and therefore ignores the interrelationship of other variables such as population growth and technological change. A model developed by Harris (1977) illustrates how a variety of factors may interact to affect changes in mobility strategies. He noted that a change from logistic to residential mobility may be accompanied by an increase in the population growth rate as males and females spend more time together. Increased population, in turn, may limit the size of territories available for exploitation. This may lead to the exploitation of types of resources previously considered undesirable or "second-line". The initial change from logistic to residential mobility strategies, however, remains linked to environmental change.

So far in this dissertation the economies of the Middle and Late Archaic periods have been discussed as though they were very similar. In fact, growing evidence suggests that, during the Late Archaic, experiments with plant husbandry and horticulture were undertaken in a number of areas of the mid-continent (Crawford 1982; Crawford and Chomko 1981; Watson and Marquardt 1983). Extensive exchange networks also became established during the Late Archaic and cultural interaction appears to have become more complex (Bender 1984; Walthall et al. 1982). It is interesting that while the Tennesse River may have been a major conduit through which galena and copper were passed (Walthall et al. 1982), sites along these rivers do not suggest the presence of major trading centers. In view of these significant social developments during the Late Archaic, it is likely that changes in the mobility strategy were responses to more than just changes in the environmental conditions. However, until more is known about the social dynamics of the Late Archaic and Early Woodland periods, an elaboration of the social mechanisms underlying changes in mobility strategies is not possible.

Appendix A. Silvics of plants potentially found in the study area (data from Kuchler 1964; Fowells 1965).

I. Oak-Hickory Forest

Species	Habitat	Life History
Carya cordiformes (butternut hickory)	restricted in site location; thrives in bottomlands of the lower Ohio Valley;	nuts dispersed Sept.-Oct.; good crop every 3-5 years; nuts generally distasteful to wildlife;
Carya ovata (shagbark hickory)	grows chiefly on north and east slopes of fertile land in Ohio Valley; prevalent on moist soil of alluvial origin;	nuts dispersed Sept.-Dec.; good crops every 1-3 years; nuts are important for red squirrel, eastern grey squirrel, eastern fox squirrel, eastern chipmunk, racoon; wild turkey and deer also occasionally eat the nuts;
Quercus alba (white oak)	grows on deep, well-drained loamy soils; grows on all upland aspects and slope positions and on ridge tops; not found on extremely dry, shallow-soil ridges;	acorns drop Sept.-Oct.; good crop every 3-4 years (extremely variable); acorns are important for many animals;
Quercus rubra (red oak)	grows on all types of soil; found most frequently on northerly and easterly aspects, lower and middle slopes, coves and ravines, and valley floors;	acorns drop Sept.-Oct.; good crop every 2-5 years; acorn yield/tree is extremely variable;
Quercus velutina (black oak)	commonly found on dry, sandy, or rocky ridges and upper slopes; grows best on lower slopes and coves;	acorns produced Sept.-Oct. and drop before Dec.; good crop every 2-3 years;

Species	Habitat	Life History
Carya glabra (pignut hickory)	found on dry ridges and hillsides in well-drained uplands;	fruit dispersed Sept.-Dec.; good crop every 2-3 years; nuts eaten by red squirrel, grey squirrel, eastern fox squirrel, chipmunk and racoon;
Carya tomenata (mockernut hickory)	ridge and hilside sites;	fruit dispersed Sept.-Dec.; good seed crop every 2-3 years; eaten by racoon, red squirrel, eastern grey squirrel, eastern fox squirrel, and eastern chipmunk;
Fraxinus americana (American ash)	best development on moderately drained soils;	seeds eaten by woodduck, bobwhite, purple finch, pine grosbeak and fox squirrel; foilage eaten by deer; bark eaten by rabbits;
Julgans nigra (black walnut)	common on limestone soils, especially deep loam, loess and fertile alluvial soils;	nuts ripen and drop Sept.-Oct.; good crops are irregular (perhaps twice in 5 years);
Prunus serontina (black cherry)	podzolic and grey-brown podzolic soils;	fruit ripen between Aug.-Sept.; good crops every 3-4 years;
Quercus muhlenbergii (chinkapin oak)	most often found on limestone outcrops in dissected terrain;	acorns ripen Sept.-Oct.; acorns are eaten by many species;
Quercus falcata (southern red oak)	uplands, on dry sandy, or clay soils on upper slopes;	acorns ripen Sept.-Oct.;
Quercus lyrata (overcup oak)	lower, poorly drained parts of first bottoms and terraces; poorly drained backwater swamps;	acorns ripen Sept.-Oct.;

Species	Habitat	Life history
Quercus shumardii (Shumard oak)	well-drained soils of alluvial terraces, colluvial sites, and bluffs adjacent to streams;	acorns ripen Sept.-Oct.; good crop every 2-3 years; rated high for wildlife food;
Quercus stellata (post oak)	common on gravelly or sandy soils of low organic content in upland areas;	acorns fall Sept.-Nov.;
II.Southern Floodplain Forest		
Nyssa aquatia (tupelo)	low, wet flats or sloughs on floodplains of alluvial streams;	no data;
Quercus spp. (various oaks)	see above:	see above;
Taxodium distichum (bald cypress)	restricted to very wet soils	no data;
Acer rubrem var. *drummondii* (red maple)	most commn where soils are extremely wet or dry; common in swampy areas;	no data;
Carya aquatica (water hickory)	well-drained, moist, alluvium soil, sites undergo spring flood and summer dessication;	nuts mature Sept.-Oct.;
Carya illinoensis (pecan)	bottom alluvial soils not subjected to prolonged overflow;	nuts fall Sept.-Dec.; yearly yield is stable; nuts eaten by crows, black birds, squirrels;

Species	Habitat	Life History
Celtis laevigata (sugar berry)	common on clay soils of broad flats or shallow sloughs within floodplains;	fruits ripen Sept.-Oct.;
Liquidambar stryaiiflora (sweetgum)	grows best on rich, moist alluvial clay and loam soils;	no data;
Nyssa silvatica (black tupelo)	well-drained light soils of second bottoms;	no data;
Planatus occidentalis (American sycamore)	most frequently found along streams and bottomlands;	no data;
Populus deltoides (eastern cottonwood)	best growth on moist, well-drained soils, close to streambeds;	no data;
Populus heterophylla (swamp cottonwood)	on edges, but not in swamps;	no data;
Quercus falcata var. *pagodaefolia* (cherry oak)	widely distributed on best sites in first bottoms and on well-drained terraces and colluvial sites along large and small streams;	acorns fall Sept.-Oct.; consumed by grey squirrel, wild turkey, blue jays, woodduck, red-bellied woodpecker, red-headed woodpecker, white-breasted nuthatch, common grockle, racoon, white-tailed deer, eastern fox squirrel;
Quercus lyrata (overcup oak)	see above;	see above;
Quercus michauxii (swamp chstnut oak)	widely distributed on the best, well-drained loamy first bottom ridges;	acorns ripen Sept.-Oct.; good crop every 3-5 years;

Species	Habitat	Life History
Quercus nigra (water oak)	found on a variety of bottomland soils at borderline sites between flats and ridges;	acorns mature Aug.-Oct.; squirrels and insects eat acorns;
Quercus shumardii (Shumard oak)	see above;	see above;
Salix nigra (black willow)	most common on river margins on lower, wetter sites;	seeds disseminated by wind;
Ulmus americanus (American elm)	common on wet, flat bottoms, but found on nearly all soil groups;	seeds eaten by mice, squirrels, opposum, ruffed grouse, bob-white, and Hungarian partridge;
Ampelopsis arborea (pepper vine)	swampy woods;	flowers June to August;
Berchemia scandens (supple-jack)	low woods;	flowers in May;
Campsis radicams (trumpet-creeper)	low woods, thickets;	flowers July to September;
Foresteira acuminata (swamp-privet)	wet river banks, swamps, ponds;	flowers late March to early May;
Fraxinus caroliniana (water ash)	bottomlands;	flowers in May;
Fraxinus profunda (pumpkin ash)	bottomlands;	flowers April to May;

Species	Habitat	Life History
Gleditisea aquatica (water locust)	river swamps;	flowers May to June;
Ilex decidua (possum-haw)	low woods, thickets, bottoms;	flowers April to May;
Persea borbonia (red bay)	woods, wooded swamps;	flowers May to July;
Planera aquatica (water elm)	swamps;	flowers in April;
Vitis spp. (grape)	woods, thickets;	flowers May to October;

III. Non-arboreal plants (data from Wharton and Barbour 1973)

Arundinaii gigantia (cane)	riverbanks, floodplains, valley slopes;	no data;
Smilax bona-nox (bristly greenbriar)	open disturbed woodland; more frequent in calcareous areas;	no data;
Smilax glauca (sweetbriar)	old thickets and clearings on leached or eroded ground;	no data;
Smilax hispida (hispid briar)	second growth woods and thickets;	no data;

Species	Habitat	Life History
Smilax rotundiflora (greenbriar)	clearings and second-growth thickets;	no data;
Salix humilis (upland willow)	dry ground and lowland clearings and moist areas;	no data;
Salix interior (sandbar willow)	bars in streams, in other alluvia and pond margins;	no data;
Salix sericea (silky willow)	banks of small streams in open wooded areas;	no data;
Salix tristis (dwarf upland willow)	lowland woods and clearings;	no data;
Polygonaceae (smartweed family)	swamps and lowland thickets;	no data;
Calycocarpum lyoni (cupseed)	treetops in rich floodplains;	no data;
Cocculus carolinus (carolina snailseed)	moist woods and thickets on limestone cliffs near streams;	no data;
Minispermum canadense (moonseed)	moist thickets and woodland borders;	no data; poisenous berries;
Asimina triloba (pawpaw)	variety of wooded and open habitats;	no data;
Hydrangea arborenscens (wild hydrangea)	moist wooded cliffs and ravine slopes;	no data;

Species	Habitat	Life History
Itea virginica (	stream edges in swampy woods;	no data;
Philadelphus hirsutus (mock-orange)	cliffs and woodland borders;	no data;
Ribes cynosbati (pricly gooseberry)	rocky wooded slopes, especially above creeks;	no data;
Ribes missouriense (Missouri gooseberry)	rocky wooded creek banks and in woodland borders;	no data;
Amelanchier arborea (serviceberry)	variety of wooded and open areas;	no data;
Armia arbutiflora (red chokecherry)	swamps;	no data;
Crataegus crus-gulli (cockspur thorn)	no data;	no data;
Physocarpus opulefolius (ninibark)	cliffs and rocky creek bottoms in areas of limestone outcrops;	no data;
Prunus americana (wild plum)	widespread;	no data;
Pyrus angustifolia (wild crab)	widespread in western Kentcky;	no data;

Species	Habitat	Life History
Rosa carolina (Carolina rose)	edge of woods, open woods;	no data;
Rosa palustra (swamp rose)	wet ground; baks of sluggish streams;	no data;
Rosa setigera (climbing rose)	clearings;	no data;
Rubus occidentalis (black raspberry)	areas with moist soil;	no data;
Rubus enslenii (southern dewberry)	edge of woods;	no data;
Rubus flagellaris (northern dewberry)	edge of woods;	no data;
Rubus allegheniensis (highbush blackberry)	mid-sucessional species;	no data;
Ceras candensis (redbud)	understory in oak woods;	no data;
Gleditisia aquatica (water locust)	swamps;	no data;
Rhus aromatica (fragrant sumac)	limestone cliffs and thin soil above limestone cliffs;	no data;
Rhus copallena (winged sumac)	noncalcareous soils on poorly drained flats and eroded hillsides;	no data;

Species	Habitat	Life History
Rhus glabra (smooth sumac)	clearings;	no data;
Aesculus glabra (Ohio buckeye)	second growth woods and thickets on dry slopes;	no data;
Rhammus caroliniana (Carolina buckthorn)	open woods;	no data;
Ampelopsis arborea (pepper-vine)	wet alluvium;	no data;
Ampelopsis cordata (heart-leaf ampelopsis)	wooded valleys and floodplain thickets;	no data;
Parthenocissus quinquefolia (Virginia creeper)	thickets and woods;	no data;
Vitis aestivalis (summer grape)	thickets and open woods;	no data;
Vitis cinerea (grayback grape)	moist, alluvial soil;	no data;
Vitis labrusca (fox grape)	thickets and clearings in moist ground;	no data;
Vitis palmata (catbird grape)	swamps and wet thickets;	no data;
Vitis vulpina (frost grape)	variety of habitats;	no data;

Species	Habitat	Life History
Hypericum densifloram (bushy St. John's wort)	no data;	no data;
Hypercum frondosum (golden St. John's wort)	limestone cliffs;	no data;
Hypericum spathulatum (shrubby St. John's wort)	woodland borders;	no data;
Decodon verticillatus (water-willow)	standing water in cypress swamps;	no data;
Dirca palustris (leatherwood)	no data;	branches useable for baskets;
Cornus amomum (silky dogwood)	stream banks and in swamps;	no data;
Cornus drummondi (rough-leaf dogwood)	dry conditions, especially on calcareous soil;	no data;
Cornus foemina (stiff dogwood)	stream banks and wet flats;	no data;
Cornus obliqua (pale dogwood)	swamps, stream banks and dry hills;	no data;
Cornus racemosa (gray dogwood)	dry conditions or stream banks;	no data;
Lyonia ligustrina (male-berry)	swampy woods; swampy stream banks;	no data;

Species	Habitat	Life History
Vaccinium arboreum (farkleberry)	open oak woods on non-calcareous	(berries are inedible)
Bumelia lycioides (buckthorn bumelia)	infrequent;	no data;
Styrox americana (snowball)	swampy woods;	no data;
Forestiera acuminata (swamp privet)	riverbanks and swampy forest;	no data;
Forestieria ligustrina (upland forestieria)	dry rocky ground;	no data;
Bignonia capreolata (cross-vine)	calcareous soil on river banks, cliffs and ravines;	no data;
Campsis radicans (trumpet-vine)	forest edge;	no data;
Cephalanthus occidentalis (buttonbush)	swamps, pond borders, margins of sluggish streams;	no data;
Sambucus canadensis (elderberry)	alluvial bottoms;	no data;
Viburnum radum (possum-haw)	swamps and margins of sluggish streams;	no data;
Viburnum prunifolium (black-haw)	wooded slopes and woodland borders;	no data;

Species	Habitat	Life History
Viburnum recognitum (arrow-wood)	wooded stream banks;	no data;

Appendix B. Habitats and availability of animal species in the study area.

I. Mammals (data from Barbour and Davis 1974; Alllen 1972; Altshelter 1931; Bowyer 1981; Franklin et al. 1975; Hobbs et al. 1982; Murie 1951; Haines 1970; McHugh 1958; Roe 1970).

Species	Habitat	Availability
Didelphis virginiana (Virginai opposum)	forest edge along woodland streams and ponds;	do not hibernate, but may den up in very cold weather; solitary;
Sorex longirostris (southeastern shrew)	swampy lowland weed fields, moist woods and honesuckle patches;	no data;
Blauna brevicauda (short-tailed shrew)	moist forest brushland:	populations vary from year to year; available all year;
Cryptotis parva (least shrew)	grasslands;	occasionally a nest may be occupied by 6 or more adults; available all year;
Scalopus aquaticus (eastern mole)	sandy soils of floodplains and stream banks;	one adult per nest; active all year;
Sylvagus floridanus (eastern cottontail)	a wide variety of habitats; most common in upland thickets;	available all year; home range 0.4 - 4 ha.
Sylvilagus aquaticus (swamp rabbit)	lowland swamps and wooded floodplains;	available all year;
Tamias striatus (eastern chipmunk)	woodlands and varied terrain;	hibernate in winter (Nov.-March); home range 0.15 ha.

Species	Habitat	Availability
Marmota monax (groundhog)	forest edge;	hibernate in winter (Nov.-Feb.); solitary;
Sciurus carolinensis (gray squirrel)	oak-hickory forest;	active all year; home range 0.5 ha.; migration may accompnay poor mast year;
Sciurus niger (box squirrel)	open country with oak, hickory, and wlanut trees;	home range c. 2.0 ha.; solitary; active all year;
Glaucomys volans (southern flying squirrel)	oak-hickory forest;	active all year; live in groups in winter; solitary in summer;
Castor canadensis (beaver)	small streams	active all year; small family groups;
Oryzomys palustris (marsh rice rat)	lowland marshes;	active throughout the year; solitary;
Reithrodontomys humulis (eastern harvest mouse)	fields of tall, dense weeds;	solitary in summer; nest in groups in winter; active all year;
Peromyscus maniculatus bairdii (prairie deer mouse)	fields of weeds or grass;	active all year; solitary but ranges overlap;
Peromyscus maniculatus nubiterrae (cloudland deer mouse)	dense forests;	active all year; solitary;
Peromyscus leucopus (white-footed mouse)	almost everywhere	active all year;

Species	Habitat	Availability
Peromyscus gossypinus (cotton mouse)	wooded streambanks, swampy woods, brushland;	active all year;
Ochrotomys nuttalli (golden mouse)	desne understory of woodlands;	sociable with up to 6 adults per nest; active all year;
Sigmodon hispidus (hispid cotton rat)	weedy patches	solitary; home range of 0.5 ha.; active all year;
Neotoma floridana (pack rat)	caves, cliffs, rocky outcrops;	active all year; solitary;
Microtus ochrogaster (prairie vole)	fescue prairies; cattail swamps;	solitary with very small territories (80 m^2); active all year;
Microtus pinetorum (pine vole)	from grassland to woodland;	solitary with very small ranges; active all year;
Ondatra zebethicus (muskrat)	along slow-moving lowland streams;	active all year; family units in dens;
Zapus hudsonius (meadow jumping mouse)	grassland marshes; lakeside weeds and open, weedy, wet woods;	solitary nests; large range (c. 10 ha.); hibernate Nov.-April;
Canis latrans (coyote)	open brushlands; woodland borders;	family groups in dens; active all year;
Vulpe vulpes (red fox)	open areas;	family groups in dens; active all year;

Species	Habitat	Availability
Urocyon cinereoargenteus (gray fox)	heavily wooded bottomlands;	family groups in dens; active all year;
Ursus americanus (black bear)	widely varied habitats;	solitary or small family groups; winter hibernation (De.-March);
Procyon lotor (racoon)	hardwood stands along streams;	active all year; solitary or in small family groups;
Mustela frenata (long-tailed weasel)	forest edges and streambanks;	solitary or small family groups in dens; active all year;
Mustela vison (mink)	various habitats near permanent water;	active all year; solitary or in family groups in dens;
Mephitis mephitis (striped skunk)	woodland edge; rocky areas;	active all year; solitary or family groups in dens;
Lontra canadensis (river otter)	swamps, bayous, and sluggish streams;	small family groups; active all year;
Lynx rufus (bobcat)	woodlands and brushy hollows;	active all year; solitary or in small family groups;
Odocoileus virginianus (white-tailed deer)	second growth woodland and forest edge;	active all year; solitary to small groups; few yard; small, sedentary territory (c. 1.6 km diameter);
Cervus e. canadensis (elk)	secondary growth; canebreaks in river valleys;	non-migratory; solitary bulls; cow herds of 20-30 individuals;
Bison bison bison (bison)	non-forested areas; grasslands; secondary growth;	perhaps available all year; probably in small herds;

II. Amphibians (data from Snyder 1972)

Species	Habitat	Availability
Siren intermedia (lesser siren)	sluggish backwaters and ponds;	active all year; solitary;
Cryptobranchus alleganiensis (hellbender)	deep, swift streams;	hibernate in coldest period; solitary;
Nectaras maculosus (mudpuppy)	ponds;	active all year; solitary;
Ambystoma texamum (small-mouthed salamander)	wooded, open, lowland and upland areas;	hibernate in coldest period (Dec.-Jan.); solitary;
Ambystoma talpoideum (mole salamander)	terrestrial, but occurs near ponds;	active all year; solitary;
Ambystoma spacum (marbled salamander)	wooded hillsides and stream banks;	hibernate in coldest period (Dec.-Jan.); solitary but nests may occur close together;
Ambystoma maculatum (spotted salamander)	woodlands;	active all year; solitary but group in large numbers to mate;
Ambystoma tigrinum (tiger salamander)	wooded areas;	active all year; solitary;
Notophthalmus viridescens (newt)	ponds	hibernate in coldest period (Dec.-Jan.); solitary except for breeding season;

Species	Habitat	Availability
Desmognathus fuscus (dusky salamander)	margins of spring-fed streams;	hibernate in coldest months (Dec.-Jan.); solitary;
Plethodon dorsalis (zigzag salamander)	wooded areas;	hibernate in coldest period (Dec.-Jan.); congregate in large numbers in spring;
Plethodon glutinosus (slimy salamander)	woodlands;	hibernate during cool spring; solitary;
Pseudstriton ruber (red salamander)	springs and spring-fed branches and adjacent areas;	hibernate during coldest period (Dec.-Jan.); solitary;
Eurycea lucifuga (cave salamander)	limestone caves and outcroppings;	hibernate during coldest period (Dec.-Jan.); cluster in large numbers;
Eurycea longicauda (long-tailed salamander)	along edges of clear, flowing streams and in wooded areas;	hibernate during coldest period (Dec.-Jan.); solitary;
Eurycea bislineata (two-lined salamander)	close to springs, streams, or seeps in wooded areas;	hibernate during coldest period (Dec.-Jan.); solitary;
Gastrophygne carolinensis (eastern narrow-mouthed toad)	open and semi-open area;	hibernate in coldest period (Dec.-Jan.); periodically congregate near ponds;
Scaphiopus holbrooki (eastern spadefoot)	burrow in loose soil;	hibernates in coldest period (Dec.-Jan); congregates to breed in summer;
Bufo woodhousei (fowler's toad)	wooded, open, wet and dry areas;	hibernates in coldest period (Dec.-Jan.); congrgates for breeding season (late April);

Species	Habitat	Availability
Bufo americanus (American toad)	wooded, open, wet, and dry areas;	hibernate in coldest period (Dec.-Jan.); congregate for breeding (Mar.-April);
Hyla vusicolor (gray treefrog)	trees; ponds to breed;	hibernate in coldest period (Dec.-Jan);
Hyla crucifer (spring peeper)	wooded areas;	hibernate in coldest period (Dec.-Jan.);
Pseudacris triseriata (northern chorus frog)	edges of small ponds;	hibernate in coldest period (Dec.-Jan.); congregate in large numbers in spring, otherwise are solitary;
Acris crepitans (northern cricket frog)	edges of ponds, puddles, and streams;	hibernate in coldest period (Dec.-Jan.);
Rana pipiens (leopard frog)	wide variety of aquatic and semi-aquatic habitats;	hibernate during coldest period(Dec.-Jan.);
Rana palustris (pickerel frog)	dense, stream-side vegetation;	hibernate in coldest period (Dec.-Jan.);
Rana clamitans (green frog)	along streams flowing into Cumberland River;	hibernate in coldest period (Dec.-Jan.);
Rana catesbeiana (bull frog)	wide habitat, especially during rainy season; near permanent water;	hibernate in coldest period (Dec.-Jan.):

III. Reptiles (data from Snyder 1972)

Species	Habitat	Availability
Chelgdra serpentina (snapping turtle)	bottom dwellers in ponds;	no data;
Kinosternon subrubrum (mud turtle)	mud bottoms of ponds; wanders overland during rainy periods;	no data;
Macrochelys temminchki (alligator snapping turtle)	bottom dwellers of ponds and lakes; (largest freshwater turtle in the world);	no data;
Sternothaerus odoratus (stinkpot turtle)	ponds and backwaters;	no data;
Terrapene carolina (box turtle)	almost all terestrial habitats and near shallow ponds;	hibernates in coldest period (Dec.-Jan.);
Chrysemys picta (painted turtle)	quiet, shallow waters;	no data;
Chrysemys scripta (pond slider)	quiet waters;	no data;
Chrysemys concinna (river cooter)	sluggish waters;	no data;
Graptemys pseudogeographica (false map turtle)	lake dweller;	bask in groups on logs;

Species	Habitat	Availability
Graptemys geographica (map turtle)	large, quiet rivers and lakes;	no data;
Trionyx maticus (smooth softshell turtle)	lakes with loose mud or sandy bottoms;	no data;
Trionyx spiniferas (spiney softshell turtle)	lakes with loose mud or sandy bottoms;	no data;
Sceloporous undulatus (eastern fence lizard)	dry, open, wooded areas;	no data;
Cnemidophorus sexlineatus (six-lined racerunner)	exposed, loose soiled areas;	no data;
Lygosoma laterale (ground skink)	widespread in woodlands;	no data;
Eumaces fasciatus (five-lined skink)	moist areas in or near sinks;	no data;
Eumeces laticeps (broad-headed skink)	wooded areas;	no data;
Natrix erythrogaster (plain-bellied water snake)	ponds, sloughs;	hibernates in winter;
Natrix rhombifera (diamond-backed water snake)	sloughs, warm, sluggish backwaters of lakes;	no data;

Species	Habitat	Availability
Natrix sipedon (common water snake)	all types of aquatic habitats;	no data;
Storeria dekayi (brown snake)	moist sites, although not necessarily near standing water;	no data;
Storeria occipitomaculata (red-bellied snake)	moist, wooded areas;	no data;
Thamnophis sauritus (eastern ribbon snake)	stream margins and edges of lakes and ponds;	no data;
Thamnophis sirtalis (common garter snake)	everywhere except dense, mature woodlands;	active Mar.-Oct.;
Virginia valeriae (smooth earth snake)	variety of habitats;	no data;
Heterodon platyrhinos (eastern hognose snake)	areas of sandy or loose soil;	no data;
Diadophis punctatus (ringneck snake)	debris-laden wooded hillsides;	hibernate in winter;
Carphophis amoenus (worm snake)	wooded areas with moist soils;	no data;
Coluber constrictor (racer)	variety of habitats, especially open woodlands and grassy areas;	no data;
Opheodrys aestivus (rough green snake)	brushy situations near water;	no data;

Species	Habitat	Availability
Elaphae obsoleta (rat snake)	variety of habitats, usually near woods or brush;	no data;
Pituophis melanoleucus (pine snake)	areas of dry, loose soil around pines;	no data;
Lampropeltis getulus (common kingsnake)	bottomlands	no data;
Lampropeltis triangulum (milk snake)	moist situations in all vegetation;	no data;
Cemophora coccinea (scarlet snake)	widespread;	no data;
Tantilla coronata (crowned snake)	drier situations;	no data;
Agkistroden contortrix (copperhead)	wooded and brushy areas;	no data;
Agkistroden piscivorus (cottonmouth)	near water;	no data;
Sistrurus miliarius (pigmy rattlesnake)	most common in Tennessee River drainage, in southern part of the area;	no data;
Crotalus horridus (timber rattlesnake)	brushy and wooded areas;	no data;

IV. Fish (data from Clay 1962)

Species	Habitat	Availibility
Ichthyomyzon unicuspis (silver lamprey)	large streams;	no data;
Lampetra aepyptera (Ohio brook lamprey)	Ohio Valley;	no data;
Scaphirhynchus platorynchas (shovelnose sturgeon)	formerly abundant in Cumberland River;	no data;
Acinpenser fulvescens (lake sturgeon)	Ohio River;	uncommon;
Scaphirhynchus albus (pallid sturgeon)	Ohio River;	rare;
Polgodon spathula (paddlefish)	larger, sluggish streams of the Mississippi Valley;	formerly abundant; may have spawned locally;
Amica calva (bowfin)	sluggish streams;	common;
Lepisosteus osseus (longnose gar)	quiet, clear water of larger streams;	spawns in May;
Lepisosteus platostomus (shortnose gar)	tolerant of turbidity;	no data;

Species	Habitat	Availability
Lepisosteus oculatus (spotted gar)	clear water with rooted vegetation;	no data;
Lepisosteus spatula (alligator gar)	Mississippi and Ohio valleys;	no data;
Alosa chrysochloris (skipjack herring)	large rivers only;	andromonous
Alosa ohiensis (Ohio shad)	Ohio River;	no data;
Dorosoma cepedianum (gizzard shad)	turbid water;	no data;
Dorosoma petenense (threadfin shad)	tributaries of Ohio and Mississippi rivers;	subject to winter kill;
Umbra limi (central mudminnow)	soft-bottomed, sluggish pools;	no data;
Esox americanus (grass pickerel)	weed beds along margins of low-gradient streams; occasionally in overflow fields;	no data;
Esox masquinongy (Ohio muskellunge)	lower Tennessee drainage; formerly also in lower Cumberland drainage;	no data;
Hiodon alosoides (goldeye)	prefers rivers;	thrives in lakes but requires streams to spawn;
Hiodon tergisus (mooneye)	lakes and larger streams;	no data;

Species	Habitat	Availability
Cycleptus elongatus (blue sucker)	deeper waters of Cumberland and Tennessee rivers;	no data;
Ictiobus cyprinellus (bigmouth buffalo)	larger rivers;	may stray into flood backwaters;
Ictiobus bubalus (smallmouth buffalo)	clear, midstream of larger rivers;	no data;
Ictiobus niger (black buffalo)	large rivers; tolerant of some turbidity;	occasionally strays into flood backwaters;
Carpiodes cyprinus (quillback)	large and small streams;	spawns in overflow pools in spring;
Carpiodes carpio (river carpsucker)	large streams with clear water;	spawns in quiet water in April-May;
Carpiodes velifer (highfin carpsucker)	occurs in both deep and intermediate water;	no data;
Maxostoma breviceps (shorthead redhorse)	all major streams, expecially those with clear water, moderate current and sand or gravel bottom;	no data;
Maxostoma carinatum (river redhorse)	lower Tennessee and Cumberland rivers;	no data;
Maxostoma anisurum (silver redhorse)	deep pools with little silt accumulation;	no data;
Maxostoma duquesnei (black redhorse)	non-turbid or non-silted bottoms;	no data;

Species	Habitat	Availability
Maxostoma erythrurum (golden redhorse)	all medium-sized creeks to large rivers;	winters in large streams; spawns in creeks and smaller rivers in April;
Minytrema melanops (spotted sucker)	streams with clear, sluggish water and moderately firm bottom; lakes and streams; prefers small to large streams;	no data;
Hypentelium nigricans (hog sucker)	streams of moderate to high gradiaent, with numerous riffles;	summers in creeks; spawns in riffles in spring;
Catostomus commersoni (white sucker)	lakes and streams of all sizes;	breeds in spring, usually in upstream areas;
Semotilus atromaculatus (creek chub)	prefers small to moderate streams of a riffle-and-pond character;	no data;
Hybopsis micropogon (river chub)	rivers and creeks; prefers streams with riffles and flowing pools and bottoms of sand, gravel, and boulders with little or no flocculent material;	no data;
Hybopsis storeriana (silver chub)	river channels; avoids creeks; especially on floors of deep pools;	no data;
Notropis cornutus (common shiner)	permanent stremas of all sizes;	no data;
Notropis ardens (rosefin shiner)	streams thorughout Tennessee River drainage; clear water and silt-free bottom;	no data;

Species	Habitat	Availability
Notropis umbratilis (redfin shiner)	clear water with a silt-free bottom;	no data;
Notropis atherinoides (emerald shiner)	lakes and river channels;	occurs in schools;
Pimephales notatus (bluntnose minnow)	small, semi-permanent creeks and shallower portions of large streams;	
Pimephales promelas (fathead minnow)	quiet waters of small creeks and ponds;	no data;
Pimephales vigilax (bullhead minnow)	sluggish pools of larger streams, their backwaters and sloughs;	spawns each spring to late summer;
Campostoma anomalum (stoneroller)	almost every stream;	breeds during summer in riffles; retires to deeper pools in winter;
Ictalurus punctatus (channel catfish)	larger creeks and rivers;	may follow rising floodwaters away from main channel;
Ictalurus furcatus (blue catfish)	lower Tennessee River;	similar to channel catfish;
Ictalurus melas (black bullhead)	quiet waters of ponds, lakes and streams; tolerant of silted water;	no data;
Ictalurus natalis (yellow bullhead)	clear waters of ponds, shallow portion of lakes, low-gradient streams;	no data;
Ictalurus nebulosus (brown bullhead)	lakes, larger ponds, larger streams;	no data;

Species	Habitat	Availability
Pylodictis olivaris (flathead catfish)	large rivers; deep sluggish pools are preferred;	no data;
Notorus flavus (stonecat)	stoney riffles of moderate gradient in larger creeks and rivers; sensitive to siltation;	no data;
Anguilla rostrata (American eel)	deep pools with muddy bottoms;	no data;
Lota lota (burbot)	cold, fresh water;	no data;
Fundulus notatus (blackstripe topminnow)	quiet waters of pools;	no data;
Fundulus catenatus (northern studfish)	quiet pools of upland tributaries of Cumberland and Tennessee rivers;	no data;
Gambusia affinis (mosquitofish)	quiet waters and small ponds;	no data;
Aphredoderus sayanus (priate perch)	sluggish, weedy water;	no data;
Labidesthes sicculus (brook silverside)	lakes and large, quiet streams;	no data;
Roccus chrysops (white bass)	large streams;	spawns in spring when it runs upstream to riffles;
Micropterus dolomieui (smallmouthed bass)	primarily in flowing water; most abundant in streams with many riffles;	spawning occurs in tributaries of larger streams;

Species	Habitat	Availability
Micropterus punctulatus (Kentucky bass)	streams of moderate current and large pools;	spawns upstream in shallow waters;
Microptereus salmoides (largemouth bass)	lakes, oxbows, sluggish streams;	spawns in shallow areas near shores;
Lepomis macrochirus (bluegill)	ponded or sluggish water;	no data;
Lepomis cyanellus (green sunfish)	creek pools, ponds; less abundant in large rivers;	no data;
Lepomis megalotis (longear sunfish)	non-turbid environments;	no data;
Lepomis microlophus (redear sunfish)	large bodies of quiet water;	no data;
Lepomis punctatus miniatus (spotted sunfish)	no data;	no data;
Lepomis symmetrieus (bantam sunfish)	no data;	no data;
Lepomis humilis (orangespotted sunfish)	tolerant of siltation;	no data;
Amploplites rupestris (rock bass)	streams and lakes, especially where bedrock and boulders form bed; prefers pools to riffles;	no data;

Species	Habitat	Availability
Chaenobryttes gulosus (warmouth)	ponded or sluggish water; prefers clear water;	no data;
Pomaxis annularis (white crappie)	quiet waters of lakes and large ponds; and sluggish pools of medium to large streams;	no data;
Pomaxis migromaculatus (black crappis)	large ponds and medium to large streams;	no data;
Stizostedion vitreum vitreum (walleye)	lakes and large streams in clear, deep water;	highly migratory; spawns in spring in streams;
Stizostedion candense (sauger)	lakes and large to medium streams; tolerant of turbidity in low-gradient streams;	spawns in early spring in shallow streams;
Percina caprodes (logperch)	riffles of moderate to large streams;	no data;
Percina maculata (blackslide darter)	clear streams of moderate size with riffles of moderate gradient and bottoms of sand and gravel; fond of both pools and riffles;	no data;
Etheostoma caeruleum (rainbow darter)	clear riffles of moderate size with bottoms of sand and boulders;	no data;
Etheostoma blennioides (greenside darter)	riffles	no data;

Species	Habitat	Availability
Aplodinotus greenniens (freshwater drum)	large streams and lakes, especially areas with silty bottom;	available all year; spawn in shallow backwaters in spring;

V. Waterfowl

- the area is in the migration route of mallards, pintails, baldplates, gadwells and shovellers; some mallards may winter in the area;

- diving ducks which migrate through include lesser scaups, ring-necked ducks, and cahvasbacks; some of each winter in the area;

- Canada geese winter in the area;

- blue and lesser snow geese migrate through the area; stopping areas may vary from year to year;

VI. Wild Turkey (Melaegris gallapavo silverstris)

- habitat includes open hardwoods having abundant mast-bearing trees nest to abundant water;

- prefer to roost in treest in standing water or trees surrounded by canebrakes;

- available all year; numbers may vary with mast production; occurred in large flocks;

- pre-Columbian population in Kentucky estimated to have been 398,640 or 10 per square mile.

Appendix C. Chert types identified in this study (from Gatus 1979).

Type	Description
Continental Deposits	Usually found as desilicified pebbles, cobbles and boulders which exhibit a patina indicative of water transport. Almost all are brownish-orange on the exterior. Freshly fractured surfaces exhibit a porous texture, with colours ranging from white to light yellowish-brown to grey. In many instances the colours and fossils resemble those of the St. Louis, Warsaw and Fort Payne cherts.
Clayton/McNairy	These units are classified together locally. The chert occurs as small pebbles and may have been of little importance to prehistoric knappers.
Tuscaloosa	A redeposited chert without water-induced patination. Most field specimens are cobble or boulder size and are well rounded. Old surfaces range in colour from off-white to light reddish-brown to light medium brown. Fresh fractures reveal coarse interiors that are usually white. Mineral inclusions are far more common than fossils.
Kinkaid	Occurs in nodular and lenticular form. Colour of fresh fractures is medium to dark blue grey and brownish-grey near the cortex. This chert is semi-vitreous and highly fossiliferous with crinoid stems making up c. 50 per cent of the observed fossil content.
Degonia	This chert is usually bedded and weathers to angular fragments. The outer surface is usually white or light yellowish-white. Fresh fractures reveal a bluish-white, transluscent material and, less frequently, a blue green colour. Cortical flakes may have a light brown hue. Small angular, cubic

Type	Description
	cavities pervade all samples. Macrofossils were not observed in any of the samples.
Clore	Light brown on weathered surfaces and has a yellowish-brown to orangish-brown cortical area up to 5 cm thick. Fresh fractures reveal a translucent brownish-grey, semivitreous surface. Cortical flakes appear mottled due to differential weathering. No macrofossils were observed.
Menard	Varies from black to dark grey to light grey and occurs as irregular nodules and bedded nodules. Old fractures are brownish-blue, while fresh ones are light grey to blue grey and semivitreous. Neither minerals nor macrofossils were observed.
Vienna	Cortical area, which is up to 5 cm thick, is very fossiliferous, containing mostly crinoid stems. Both the cortical area and the internal fracture planes reveal a relatively moderate to high iron content. Much of the chert is coarse, but some is relatively fine-grained, giving it a waxy lustre. The coarser material is brownish-grey; the fine-grained portion is brownish-blue.
Renault	Field specimens occur as irregular nodules or lenses. Exterior surfaces are light grey. Fresh fractures are mottled light greyish-brown. This chert is translucent in areas of lighter colour. Crinoid stems and mineral inclusions are common.
Ste. Genevieve/Fredonia	Collected specimens come from only one locale, the Cox site (LCAP site 55). Chert extracted from exposed rock occurred as nodules, lenses and beds and ahd a white to grey cortex. Internal colour variations range from medium brown to brownish-blue and grey blue. Light blue

Type	Description
	inclusions, observed most commonly near large crystal formations, tended to turn white in cortical areas. Samples were both fine-grained and medium-grained.
Glen Dean	Chert from this unit is rare. It occurs in blocky fragments which are white, yellowish-brown and dark brown in colour.
upper St. Louis	Most available samples are nodular or angular chunks. All specimens occurred in residuum. Colours range from a medium blue to light brown to olive to light grey and medium grey. Bluer examples develop light to medium brown cortical areas which, when completely desilicified, turn grey and finally white. The grey and olive chert develop grey to white cortices. Fine grained, semivitreous blue samples contain few macrofossils or mineral inclusions as does the medium grained olive material. The brown and grey varieties tend to contain more fossils. Blue and brown varieties tend to be translucent. The grey and olive chert, which is generally medium to coarse grained, tend towards opacity. Old fractures frequently red due to a high iron content.
lower St. Louis/Salem	These geological formations have been mapped together in the study area. The cherts occur in a number of varieties. one is a semivitreous deep blue grey to black grey with light blue mottling. Another variety tends to be deep to medium brown and contains light and dark inclusions which commonly form discontinuous laminae. The texture is earthy. In most respects this is similar to the Dover chert of Tennessee. Other varieties are speckled or semivitreous.
Warsaw	This chert is more common to the areas near the rivers. Most collected samples were characterized by the presence of large numbers of fossils. Blue-grey is the most common colour, although greys and

Type	Description
	and browns have also been observed. Several examples revealed concentric ring designs. Lustre varies from earthy to semi-vitreous and grain ranges from very fine to coarse.
Fort Payne	Field specimens range from light and medium grey to tan and light pink and to charcoal black. The light to medium grey chert bears few fossil or mineral inclusions. Some laminations resembling tree rings were noted. Specimens range from fine to medium grained in texture.
Camden/Jeffersonville	Field observations indicated that chert from these units occur as pebbles, cobbles and boulders. The cortex has the texture of sandpaper and is very porous and permable. It weathers light grey to orangish-brown. Large fossils, expecially brachiopods, are common. Freshly fractured surfaces range in colour from white to yellowish-white to brownish-white to tan.
Caseyville/Lusk	Chert from this unit occurs only as sparse angular fragments of pebble size which are cemented into a conglomerate.

Appendix D. Items per class in each assemblage.

Class Assembalge	cores	angular fragments	bipolar by-products	cortical flakes	secondary flakes	microblades	bifacial thinning flakes	heavy retouched objects	retouched/ utilized flakes	gravers
Morrisroe A	9	163	8	49	1293	-	108	1	14	2
Morrisroe B	9	98	8	73	979	-	16	-	2	1
Morrisroe C	10	83	12	68	611	-	46	-	3	-
Morrisroe D	13	195	7	179	3 703	-	485	1	7	1
Morrisroe E	9	1 342	8	336	9 232	-	1 182	-	41	3
Morrisroe F	20	444	15	356	30 989	-	1 286	-	63	4
Morrisroe G	17	457	2	375	11 381	-	1 097	-	51	3
Morrisroe H	28	281	2	135	3 461	-	504	-	65	-
Morrisroe I	14	113	2	81	1 596	-	295	-	6	2
Morrisroe J	61	286	26	156	996	-	141	-	22	1
Trail site	57	722	4	342	18 980	12	3 016	1	521	15
15Tr50	32	405	-	18	2 821	40	244	-	120	-
15Tr53	6	102	-	5	369	3	9	-	47	-

Class Assemblage	perforators	notches	steeply retouched flakes	bifaces	hafted bifaces	drills	reworked hafted bifaces	atlatl weight	mortar	pestle
Morrisroe A	-	9	1	2	2	1	-	-	-	-
Morrisroe B	-	7	1	1	4	-	-	-	-	-
Morrisroe C	-	4	1	8	1	1	-	-	-	-
Morrisroe D	-	12	3	18	4	2	-	-	-	-
Morrisroe E	-	34	8	51	6	-	-	-	-	-
Morrisroe F	1	37	7	73	13	5	-	-	-	-
Morrisroe G	2	32	9	82	18	9	-	1	3	1
Morrisroe H	-	12	3	48	10	2	-	-	1	2
Morrisroe I	-	11	3	37	8	1	-	-	-	1
Morrisroe J	-	22	6	54	8	-	1	-	-	-
Trail site	-	51	15	100	36	13	7	-	-	-
15Tr50	-	7	-	26	11	2	-	-	-	-
15Tr53	-	3	-	6	1	1	-	-	-	-

Class Assemblage	pitted cobbles	battered cobbles	ground cannel coal	ferrogeneous concretions	miscellaneous groundstone
Morrisroe A	-	-	-	-	-
Morrisroe B	-	-	-	-	-
Morrisroe C	-	-	-	-	-
Morrisroe D	-	-	-	-	-
Morrisroe E	2	-	-	-	-
Morrisroe F	1	6	-	-	-
Morrisroe G	-	7	-	1	-
Morrisroe H	16	-	1	-	-
Morrisroe I	2	14	-	-	1
Morrisroe J	1	14	-	-	2
Trail site	1	3	-	-	2
15Tr50	-	9	-	-	-
15Tr53	-	-	-	-	-

Assemblage \ Class	cores	angular fragments	bipolar by-products	cortical flakes	secondary flakes	microblades	bifacial thinning flakes	heavy retouched objects	retouched/ utilized flakes	gravers
15Tr56	1	26	-	-	209	-	3	-	38	-
40Sw74	122	278	-	60	1 361	5	4	-	520	2

Class	perforators	notches	steeply retouched flakes	bifaces	hafted bifaces	drills	reworked hafted bifaces	atlatl weights	mortars	pestles
Assemblage										
15Tr56	-	1	-	5	3	-	-	-	-	-
40Sw74	2	49	3	144	32	-	3	-	-	-

Class	pitted cobble	battered cobble	ground cannel coal	ferrogeneous concretion	miscellaneous groundstone
Assemblage					
15Tr56	-	-	-	-	-
40Sw74	-	8	-	1	-

Appendix E. Items in each assemblage, transformed by centering.

Type Assemblage	cores	angular fragments	bipolar by-products	cortical flakes	secondary flakes	microblades	bifacial thinning flakes	heavy retouched flakes
Morrisroe A	-18.2	-410.0	1.7	-99.9	-4565.7	-4.0	-454.4	0.7
Morrisroe B	-18.2	-475.0	1.7	-75.9	-4879.7	-4.0	-546.4	-0.3
Morrisroe C	-17.2	-490.0	5.7	-80.9	-5347.7	-4.0	-516.4	-0.3
Morrisroe D	-14.2	-378.0	0.7	30.1	-2155.7	-4.0	-77.0	0.7
Morrisroe E	-18.2	769.0	1.7	187.1	3373.3	-4.0	619.6	-0.3
Morrisroe F	-7.2	-12.9	8.7	207.1	25130.3	-4.0	723.6	-0.3
Morrisroe G	-10.2	-116.0	-4.3	226.1	5522.3	-4.0	534.6	0.7
Morrisroe H	0.8	-292.0	-4.3	-13.9	-2397.7	-4.0	-58.4	-0.3
Morrisroe I	-13.2	-460.0	-4.3	-67.9	-4262.7	-4.0	-267.4	-0.3
Morrisroe J	33.8	-287.0	19.7	7.1	-4862.7	-4.0	-421.4	-0.3
Trail site	29.8	149.0	-2.3	193.1	13121.3	8.0	2453.6	0.7
15Tr50	4.8	-168.0	-6.3	-130.9	-3037.7	36.0	-318.4	-0.3

Type Assemblage	retouched/ utilized flakes	gravers	perforators	notches	steeply retouched flakes	bifaces	hafted bifaces	drills
Morrisroe A	-87.3	-0.3	-0.3	-10.4	-3.0	-41.7	-8.5	-1.5
Morrisroe B	-99.3	-1.3	-0.3	-12.4	-3.0	-42.7	-6.5	-2.5
Morrisroe C	-98.3	-2.3	-0.3	-15.4	-3.0	-35.7	-9.5	-1.5
Morrisroe D	-94.3	-1.3	-0.3	-7.4	-1.0	-25.7	-6.5	-0.5
Morrisroe E	-60.3	0.7	-0.3	14.6	4.0	7.3	-4.5	-2.5
Morrisroe F	-38.3	1.7	0.7	17.6	3.0	29.3	2.5	2.5
Morrisroe G	-59.3	0.7	1.7	12.6	5.0	38.3	7.5	6.5
Morrisroe H	-39.3	-2.3	-0.3	-7.4	-1.0	4.3	-0.5	-0.5
Morrisroe I	-95.3	-0.3	-0.3	-8.4	-1.0	-6.7	-2.5	-1.5
Morrisroe J	-19.33	-1.3	-0.3	2.6	3.0	10.3	-2.5	-2.5
Trail site	419.7	12.7	-0.3	31.6	11.0	56.3	25.5	10.5
15Tr50	18.7	-2.3	-0.3	-12.4	-4.0	-17.7	0.5	-0.5

Type Assemblage	reworked hafted bifaces	atlatl weights	mortars	pestles	pitted cobbles	battered cobbles	ground cannel coal
Morrisroe A	-0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
Morrisroe B	-0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
Morrisroe C	-0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
Morrisroe D	-0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
Morrisroe E	-0.7	-0.1	-0.3	-0.3	0.5	-3.4	-0.1
Morrisroe F	-0.7	-0.1	-0.3	-0.3	-0.5	2.6	-0.1
Morrisroe G	-0.7	-0.1	2.7	0.7	-1.5	3.6	-0.1
Morrisroe H	-0.7	-0.1	0.7	1.7	14.5	-3.4	0.9
Morrisroe I	-0.7	-0.1	-0.3	0.7	0.5	10.6	-0.1
Morrisroe J	0.3	0.9	-0.3	-0.3	-0.5	10.6	-0.1
Trail site	6.3	-0.1	-0.3	-0.3	-0.5	-0.4	-0.1
15Tr50	0.7	-0.1	-0.3	-0.3	-1.5	5.6	-0.1

Type Assemblage	ferrogeneous concretion	miscellaneous groundstone
Morrisroe A	-0.1	-0.4
Morrisroe B	-0.1	-0.4
Morrisroe C	-0.1	-0.4
Morrisroe D	-0.1	-0.4
Morrisroe E	-0.1	0.6
Morrisroe F	-0.1	-0.4
Morrisroe G	0.9	-0.4
Morrisroe H	-0.1	-0.4
Morrisroe I	-0.1	0.6
Morrisroe J	-0.1	1.6
Trail site	-0.1	1.6
15Tr50	-0.1	-0.4

Type Assemblage	retouched/ utilized flakes	gravers	perforators	notches	steeply retouched flakes	bifaces	hafted bifaces	drills
15Tr53	-54.3	-2.3	-0.3	-16.4	-4.0	-37.7	-9.5	-1.5
15Tr56	-63.3	-2.3	-0.3	-18.4	-4.0	-38.7	-7.5	-2.5
40Sw74	418.67	-0.3	1.7	29.6	-1.0	-11.7	21.5	-2.5

Type \ Assemblage	15Tr53	15Tr56	40Sw74
heavy retouched flakes	-0.3	-0.3	-0.3
bifacial thinning flakes	-553.4	-559.4	-558.4
microblades	-1.0	-4.0	1.0
secondary flakes	-5489.1	-5649.1	-4494.7
cortical flakes	-143.9	-148.9	-88.9
bipolar by-products	-6.3	-6.3	-6.3
angular fragments	-471.0	-547.0	-295.0
cores	-21.2	-26.2	94.8

Type Assemblage	reworked hafted bifaces	atlatl weights	mortars	pestles	pitted cobbles	battered cobbles	ground cannel coal
15Tr53	0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
15Tr56	0.7	-0.1	-0.3	-0.3	-1.5	-3.4	-0.1
40Sw74	2.3	-0.1	-0.3	-0.3	-1.5	4.6	-0.1

Type Assemblage	ferrogeneous concretion	miscellaneous groundstone
15Tr53	-0.1	-0.4
15Tr56	-0.1	-0.4
40Sw74	0.9	-0.4

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