PALEODEMOGRAPHIC MODELING IN THE LOWER MISSISSIPPI RIVER VALLEY

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Doctor of Philosophy

BY

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

PALEODEMOGRAPHIC MODELING IN THE LOWER MISSISSIPPI RIVER VALLEY

presented by Jeffrey S. Alvey,

a candidate for the degree of doctor of philosophy,

and hereby certify that, in their opinion, it is worthy of acceptance.

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DEDICATION

This dissertation is dedicated to Dr. Janet Rafferty for teaching me the meaning of dedication and for helping me to always see the bigger picture.

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This dissertation represents the conclusion of my 14-year academic career. Countless individuals have contributed to this journey and I thank them all. My formative undergraduate years at Mississippi State University were spent under the mentorship of a number of dedicated professors including Janet Rafferty, Evan Peacock, Homes Hogue, Jimmy Hardin, Joe Seger, and Paul Jacobs. All of these individuals played critically important roles in my development as an archaeologist. During my time at the University of Missouri I had the great luck to study with a group of individuals whose work I had long admired. I thank my dissertation committee, Michael O'Brien, Karthik Panchanathan, Lee Lyman, and Michael Glascock, for their encouragement and guidance in navigating this long and stressful process.

Special thanks are also due to the many archaeologists whose diligent efforts to combine radiocarbon dates into state or regional databases made the research presented here possible. Those who deserve special thanks include David Abbott, John Connaway, Lela Donat, Heather Gibb, Robert Kelly, Michael Meinkoth, Erick Robinson, John Samuelsen, Paige Silcox, Douglas Sims, and Kevin Smith.

Finally, I thank my parents, Charles and Louise Alvey, for their love and unfailing support and for setting me on this path so many years ago. I know you would be proud.

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ABSTRACT

The three studies presented below address the relationships that exist between prehistoric population dynamics, settlement organization, climate, and subsistence in the central and lower Mississippi River valley and adjacent uplands, as well as how sampling strategies in archaeology affect the quality of data upon which we model these kinds of relationships. Evidence is provided that demonstrates that long-held commonsensical assumptions about the relationship between maize agriculture and population growth during the Woodland and Mississippi periods are unfounded. Results demonstrate that maize agriculture played little to no role in the region's period of major demographic expansion, which occurred ca. AD 650. The investigation of two episodes of population decline during the Late Archaic and late prehistoric periods reveal that changes in settlement organization associated with the movements of groups from upland to lowland environments, or vice-versa, represent major contributing factors to these episodes. The final study presents findings on the relationship between shovel-testing strategies and the accuracy and usefulness of the models of archaeological occupations that result from the information collected during shovel testing. These results demonstrate that some common approaches to shovel testing lead to faulty models that fail to accurately represent important occupational variables, thus compromising our ability to make valid significance determinations.

Chapter 1

Introduction

The following chapters provide archaeological studies of three distinct but interrelated topics. Chapters 1 and 2 focus on modeling paleodemographic change during the period from the Late Archaic (4000–1000 BC) to the time of first European contact (mid-16th century) in the central and lower Mississippi River valley and adjacent uplands. Relationships between population dynamics, settlement organization, climate, and subsistence are explored to better understand the interplay of these variables and how they contributed to the cultural evolution of prehistoric societies of the region. Paleodemographic modeling is accomplished through the use of summed probability distributions (SPDs), which use the frequency distributions of radiocarbon dates through space and time as proxies for demographic change. Chapters 1 and 2 provide a discussion of the role that sampling plays in the construction of SPDs, as well as its role in the ultimate success of SPDs as proxies of demographic change; however, the topic of sampling in archaeology receives further treatment in Chapter 3 where standard methods of shovel testing are assessed in terms of their success in accurately modeling the occupations present at 44 archaeological sites in Mississippi. Archaeologists working in the eastern United States routinely employ shovel testing as a method for site discovery and delineation in areas of dense ground cover, and as a means of collecting information on the kinds and numbers of artifacts and features present at a site. This sampling strategy is employed in the context of Section 106 compliance, as well as in academic research. This chapter presents findings on the relationship between shovel-testing strategies and the accuracy and usefulness of the models of archaeological occupations that result from the information collected during shovel testing. These results demonstrate that some common approaches to shovel testing lead to faulty models that fail to accurately represent important occupational variables, thus compromising our ability to make valid significance determinations.

Chapter 2

Exploring the Relationship between Maize Agriculture and Population Growth in the Central and Lower Mississippi River

Introduction

The relationship between prehistoric humans and maize (*Zea mays*) in the Eastern Woodlands of North America has received much attention and has often played a central role in explanations of increasing cultural complexity and demographic change seen in the region during the period of AD 700–1300 (Blitz 1993; Greenlee 1998; Griffin 1967; Hart 1999; Morse and Morse 1983; Munson 1988; Peebles and Kus 1977; Schurr and Schoeninger 1995; Smith 1990, 1992; Steponaitis 1986). Some research (Bender et al. 1981; Hart 1999; Lynott et al. 1986), however, has cast doubt on long-held commonsensical assumptions about the role of maize agriculture in the cultural and demographic shifts seen in the Eastern Woodlands during the Woodland and Mississippi periods. This research demonstrated that the intensification of maize agriculture did not occur in the region until after AD 1000, despite its presence in the region as early as AD 200. Despite this demonstration, questions about the relationship between population growth and maize agriculture persist as researchers debate whether to cast the intensification of maize agriculture between AD 1000–1200 as a driver of population growth or as a response to population growth within an environment of increasing demographic stress.

Within the debates on Mississippian culture the role of population dynamics has often been invoked as a central causal factor, especially as it relates to evidence of increasing cultural complexity among subsistence/settlement strategies and political organization (e.g., Fowler 1974; House 1990; Kelly 1990; Morse and Morse 1990; Phillips et al. 1951; Smith 1990); however, empirically derived regional-scale data are rarely cited in support of this position. This is due in large part to the absence of comprehensive regional-scale analyses designed to identify regional demographic trends. The lack of comprehensive regional-scale analyses is an important omission considering that changes in population structure and size, often attributed to the intensification of maize agriculture, are frequently cited as defining characteristics in the emergence and spread of Mississippian culture.

The current study aims to fill this gap using summed probability distributions (SPDs) as proxies for demographic and subsistence change among the prehistoric populations of the central and lower Mississippi River valley and adjacent uplands. The SPDs presented here were generated from 2,420 radiocarbon dates amassed from this region. Comparisons of SPD curves produced from all radiocarbon dates to curves produced solely from radiocarbon dates of maize specimens reveals the timing of population growth relative to maize intensification in the region and demonstrates that assumptions about the positive relationship between maize agriculture and population are unfounded.

Paleodemography

Population size and density have often been treated as important variables in studies of human genetic and cultural evolution and given primacy in models of prehistoric settlement-subsistence pattern change (Binford 1968; Boserup 1965; Cowgill 1975; Flannery 1969; Johnson and Earle 2000). Two common topics of anthropological studies into the effects of paleodemographic change on cultural evolution include: 1) the relationship between changes in population size and/or density and changes in cultural complexity (e.g., Carneiro 1967, 1970; Henrich 2004; Powell et al. 2009; Premo and Kuhn 2010; Richerson et al. 2009; Shennan 2001; Vaesen et al. 2016), and 2) the relationship between the adoption or intensification of agriculture and population growth (e.g., Bronson 1977; Cohen 1977; Gignoux et al. 2011; Morgan 2015; O'Brien 1987; Shennan et al. 2013).

Malthus' (1798) insights first drew scientists' attention to the relationship between population and resources by emphasizing the strain that growing populations placed upon the available means of subsistence. Since that time, much work has been conducted investigating this relationship and how it might account for the origins and spread of agriculture (see Cohen 1977; MacNeish 1992; Rindos 1984). Despite the importance attributed to population growth as a factor in the adoption of agricultural practices, the processes involved in any particular case were undoubtedly complex and directed by local environmental, technological, demographic, and social conditions. As Richerson et al. (2001:388) note, "the processes involved in such a complex phenomenon as the origin of agriculture are many and densely entangled." The adoption of maize agriculture in the Eastern Woodlands undoubtedly represents such a complex history involving changes in variables such as climate, demography, the rate of genetic adaptation of maize, and ceramic, lithic, and storage technology. The yield of any domesticate is ultimately determined by the combination of all genetic, environmental, and cultural factors that affected the plant while adapting to its symbiosis with humans, thus its success is strongly linked to this history (Rindos 1984). Having recognized the complex nature of agricultural origins, most modern researchers avoid simplistic explanations centered on demographic determinism. The retreat from a Malthusian emphasis on the role of population pressure has shifted population growth from inevitable prime mover of subsistence diversification and/or intensification to one of a number of interacting variables. Based on the resulting need to better account for changes in these interacting variables, the importance of modeling the independent trajectories of climatic, environmental, demographic, and technological variables relative to one another becomes evident.

Methods for estimating population dynamics represent a necessary requirement of any study into the link between demographic change and cultural evolution. Archaeological data including numbers of sites and estimates of site size and occupational intensity and measures of the use and discard of artifacts have traditionally been used as proxies to represent change in population size and density, and when available, may be supplemented with data from historic or ethnographic sources (Anderson 1996; Gallivan 2002; Galloway 1994; Kolb 1985; Miller 2018; Milner 1986). Additionally, basin-scale studies conducted in the lower Mississippi River valley (LMV) by Kidder (2006, 2010, Kidder et al. 2008) have provided settlement models for the Archaic-Woodland period transition derived from the region's archaeological and geological records. These studies have shown the potential of chronological models derived from radiocarbon dates to help link important cultural, environmental, and climatic events.

In recent years the "dates as data" approach first advocated by Rick (1987) has shown increasing promise as a method for monitoring paleodemographic change by exploiting the large collection of radiocarbon dates that archaeologists have compiled over the past seven decades (e.g., Attenbrow and Hiscock 2015; Bevan et al. 2017; Blackwell and Buck 2003; Boulanger and Lyman 2014; Buchanan et al. 2008; Chaput and Gajewski 2016; Collard et al. 2010; Downey et al. 2014; Housley et al. 1997; Oh et al. 2017; Peros et al. 2010; Riede 2009; Robinson et al. 2019; Selden and Pertulla 2013; Shennan and Edinborough 2007; Timpson et al. 2014). This method has benefitted from the widespread availability of radiocarbon data sets made possible by their placement in easily shared digital databases. One of the major contributions of the many site-level investigations that have occurred in the study area over the past 70 years is the extensive collection of radiocarbon dates that has been amassed through the cumulative efforts of researchers. Although these dates were usually obtained to provide absolute chronological frameworks for individual archaeological sites, methods are available to synthesize these data into regional demographic models. Summed probability distributions (SPDs, hereafter) of calibrated ^{14}C dates provide a demographic proxy for tracking prehistoric population dynamics, which are defined here as the timing, scale and direction of prehistoric population fluctuations. The construction of SPDs for different regions allows for the seamless comparison of demographic trends among regions, providing an alternative to artifact-based approaches where classification inconsistencies impede regional comparisons. Models of population dynamics constructed at a variety of scales can be compared to identify points of divergence in the population history of different regions, and comparisons can be made to important settlement, subsistence, or climatic events to better understand the timing of such events relative to changes in population size as inferred from SPDs. I exploit this approach to estimate the history of human demography in this paper.

Study Area

With the goal of investigating the demographic changes associated with the appearance and spread of maize agriculture, an emphasis on the lower and central portions of the Mississippi River valley provide a logical geographical focus as the earliest manifestations of Mississippian culture have been attributed to this region (Phillips et al. 1951; Morse and Morse 1983; Smith 1990). The need to focus on the Mississippi River valley and to incorporate regions where large collections of radiocarbon dates are available led to the study area being defined as shown in Figure 2.1. Delineation of the study area was further determined by a desire to examine regional trends in population dynamics at different geographic scales, and to do so using SPDs, which led to the splitting of this area into smaller eco-regions (Figure 2.2). The choice to construct and present SPDs by eco-region was related to the recognition of the important roles played by soils, vegetation, and landform in the organization of settlement as demonstrated by previous research in the region (e.g., Peacock 1997; Smith 1978, 1992). Paleoenvironmental changes will potentially result in changes in carrying capacity and net primary productivity, including production of maize, and such changes may vary across eco-regions. The eco-regional SPDs presented below thus represent first tests of the possibility that those eco-regions may have experienced different demographic histories, and also different histories of maize adoption and use, because primary

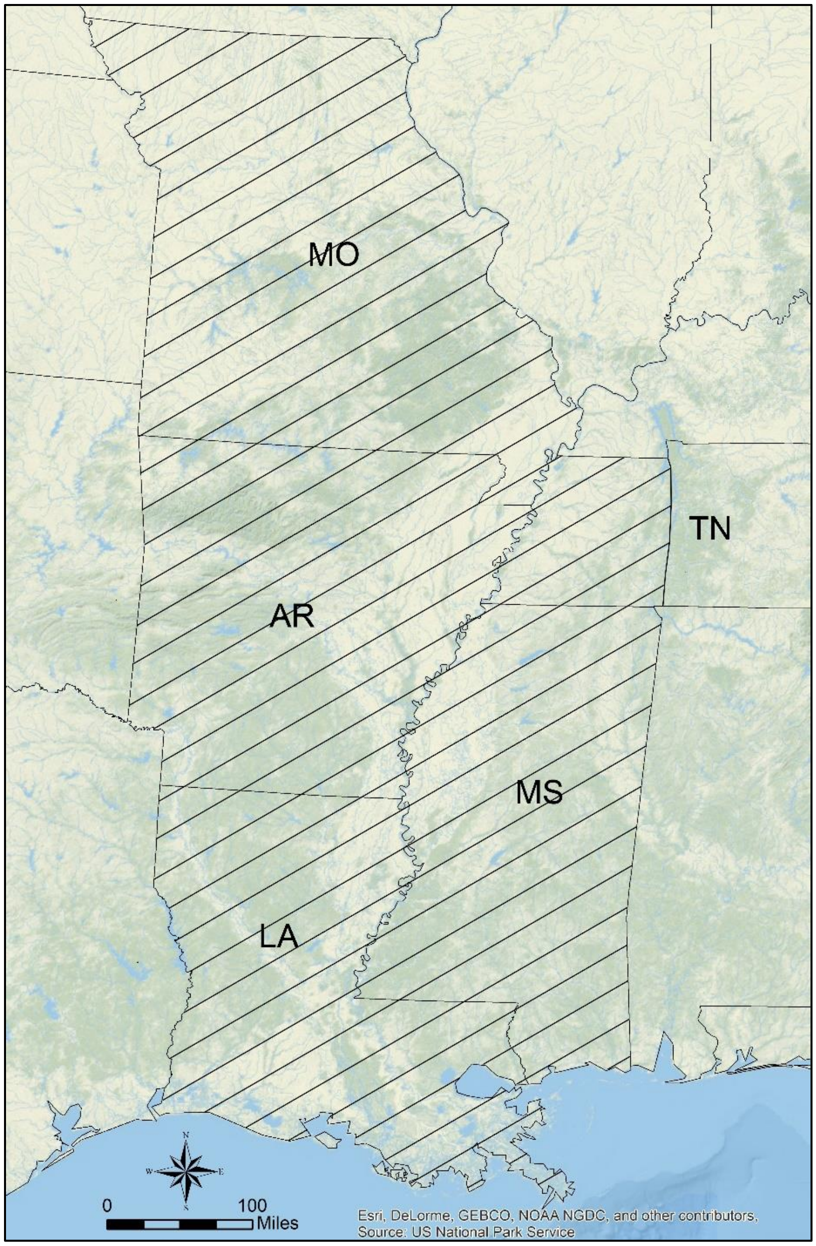

Figure 2.1. Map showing the study region (cross-hatched).

productivity would vary chronologically and spatially as a result of variability in geology, soils, topography, groundwater, etc. among the different eco-regions. The shift from upland to riverine environments also seems to be an especially important settlement-pattern shift during the Woodland-Mississippi transition and thus the ability to draw comparisons between SPDs for different topographic regions (i.e., Mississippi River alluvial basin versus adjacent uplands) further contributed to the attractiveness of the use of eco-regions as defined in Figure 2.2.

The eco-regions shown in Figure 2.2 are based largely on previously defined physiographic regions within these five states. Shapefile data for physiographic regions obtained from the U.S. Geological Survey (USGS) and state environmental agencies were used to establish the boundaries of these regions. Modifications were made to the boundaries of some traditional physiographic regions to accommodate the current study. For example, the region defined as “MS/TN Highlands” comprises several smaller physiographic regions, such as the North Central Hills, Loess Hills, Black Prairie, and Jackson Prairie. These regions were combined into the MS/TN Highlands strictly because of the relatively small numbers of dates that exist for each of these respective regions. By combining the smaller regions into the MS/TN Highlands, the issue of poorly representative samples from each of these regions was mitigated.

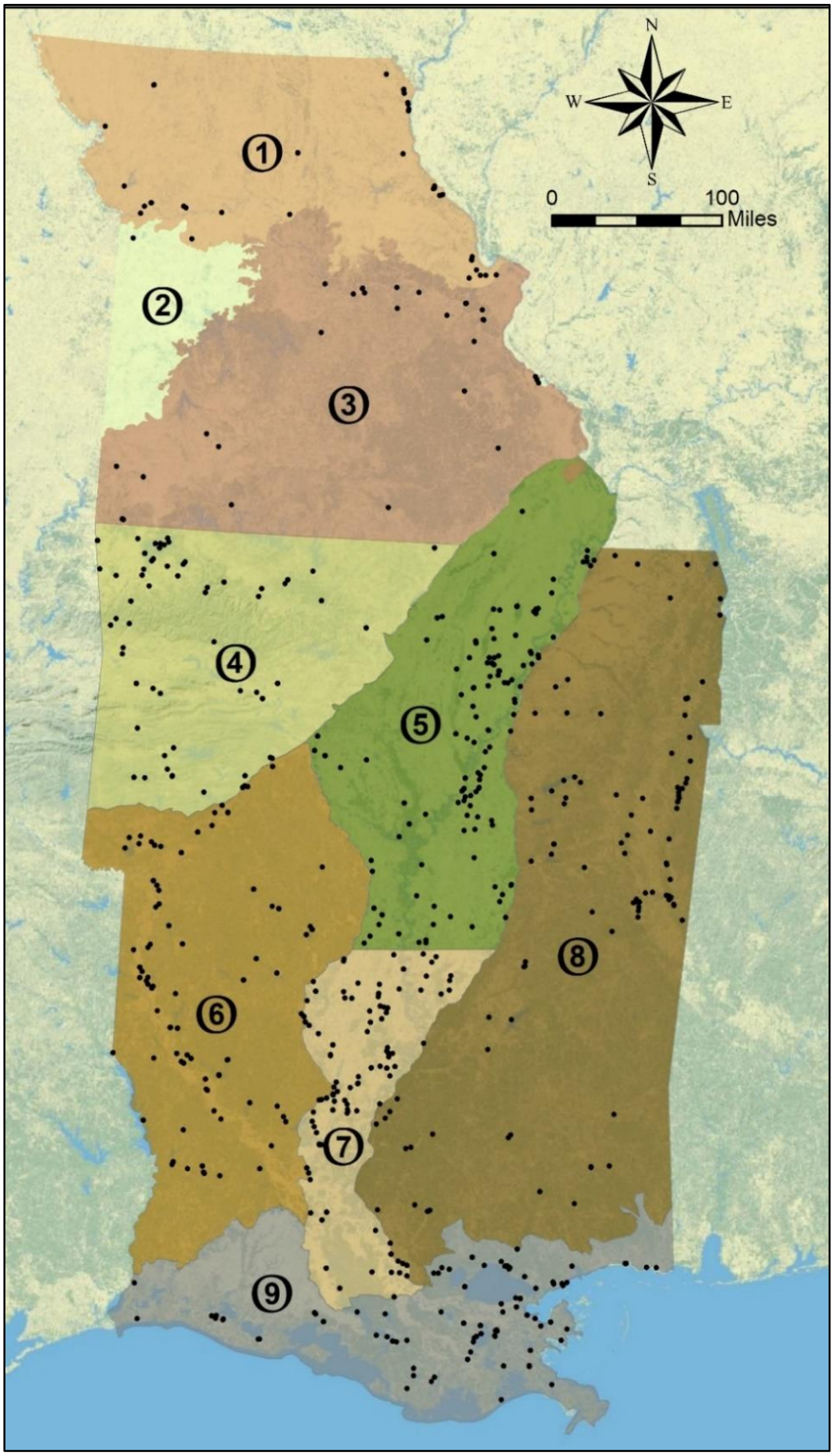

Figure 2.2. Map showing the eco-zones defined for the study area and the locations of archaeological sites (black dots) from which radiocarbon dates were used. 1 – Central Dissected Hills, 2 – Osage Plains, 3 – MO Ozark Highlands, 4 – AR Ozark Highlands, 5 – Upper LMV Alluvial Plain, 6 – South Central Plains, 7 – Lower LMV Alluvial Plain, 8 – MS/TN Highlands, 9 - Coastal Zone.

Materials and Methods

Summed Probability Distributions

Since its inception in the late 1940s, radiocarbon dating has been the principal instrument for the establishment of interval-scale chronology of prehistoric settlement in the Americas. Hundreds of radiocarbon assays are available for the study area and were amassed to create a comprehensive database that could be used in a dates-as-data approach to the development of regional population histories. The dates-as-data method was first proposed by Rick (1987:58), who assumed that "date records are not true random samples, but with sufficient numbers of dates from fairly large regions, numerous sites and investigators, the general trends of prehistoric occupation should be evident." The use of SPDs as proxies of human demographics relies on three principal assumptions: 1) the frequency of radiocarbon dates correlates directly and strongly with human population size, 2) all dated materials were deposited through human activity, rather than natural processes, and 3) the choice of dated material has been sufficiently randomized to mitigate the effects of sampling bias. SPD curves used in the current study were created for each dataset using CalPal Advanced (Weninger and Jöris 2008), based on radiocarbon dates calibrated using the IntCal13 calibration curve (Reimer et al. 2013). All calibrated date ranges are presented in years BC/AD since the chronological assignment of the Woodland and Mississippi periods has historically employed this system.

Interpretive and Analytical Challenges

As use of SPDs has increased, so too have discussions of the method's weaknesses, which have been outlined in several studies (e.g., Surovell and Brantingham 2007; Surovell et al. 2009; Thorndycraft and Benito 2006; Williams 2012) with subsequent responses regarding how these weaknesses may be overcome (Boulanger and Lyman 2014; Crema et al. 2016; Shennan et al. 2013; Timpson et al. 2014, 2015).

In addition to problems that result from issues such as sample size or taphonomic bias, as discussed below, some researchers have pointed to the possibility that SPDs of radiocarbon dates may be more a measure of energy consumption than population change (Freeman et al. 2018). Freeman et al.'s (2018) research tests the assumption that there is a proportional relationship between population size and the frequency of radiocarbon dates produced by prehistoric people. Their findings confirm that variables such as the rate of energy consumption can affect SPD curves and that this kind of change may be unrelated to changes in population size. However, because of the correlation between a society's population size and its energy consumption, the authors conclude that SPDs provide useful proxies of population dynamics, but that efforts to correct for variables such as energy consumption would improve our ability to draw inferences about demographic change from SPDs and represents an important area of future research. It should be noted that the potential effect of not correcting for energy consumption is most problematic for studies attempting to estimate changes in absolute population levels or growth rates rather than those aimed at identifying variables such as the timing or direction of population changes.

While some radiocarbon determinations can be incorrect as a result of laboratory error, it is expected that this effect on the validity of the method will be minimal when large sample sizes are employed. A more important problem relates to the representativeness of the sample of dates used in any given study and how variables such as sample size and taphonomic bias can diminish the representativeness of samples. Timpson et al. (2015) highlight an important general point about sampling, that while no sample provides a perfect representation of the population of interest, the use of larger, more inclusive datasets will help mitigate much, but perhaps never all, of the effect of sampling error.

As Shennan and Edinborough (2007:1340) note, "…the probability of having a sample to date from a given period should bear roughly the same relation to the number of sites occupied for all periods." It seems almost universally true, however, that archaeologists tend to express strong preferences for certain regions and/or periods. This is certainly true in the study area where a considerable proportion of research has focused on Mississippi-period mound sites in the Mississippi River alluvial basin, while other regions, periods, or site types have received less attention. It should be noted, however, that research undertaken in the context of cultural resource management in the U.S. since the 1970s has to some extent ameliorated the effect of over-sampling of Mississippian mound sites due to the greater diversity of site types that have been investigated, as the choice of site selection is determined to a large extent by the location of some archaeological site relative to some proposed development. Investigations related to Section 106 compliance have resulted in a more representative treatment of the archaeological record, which has insured the recovery of radiocarbon samples that better represent the full population of archaeological materials suitable for radiocarbon determinations.

Based on the effects of regional-scale selection biases by archaeologists working in the study area, one would suspect relatively large numbers of radiocarbon dates from the Mississippi period to be as much a product of this bias as an indicator of increased prehistoric populations during this period. Importantly, however, we must consider the positive correlation between the interest paid by archaeologists to certain regions or periods and the intensity of settlement associated with those places and times. Increasing numbers of settlements and more intensive occupations of certain locales during prehistory resulted in the development of substantial archaeological deposits with high archaeological visibility. This visibility is associated not only with the construction of prominent earthworks, but also derives from increases in site size and artifact density that have resulted in preferential treatment of certain sites by archaeologists. The richness and visibility of the material record at these locations has led to the preferential study of these sites over sites representing more ephemeral occupations that left a more meager material record. Additionally, as has been routinely discovered by many a disappointed researcher, the recovery of material for radiocarbon assays from Mississippian mound sites does not insure that the dated material was deposited during the Mississippian occupation, as the sites chosen for the construction of Mississippian mounds often represent a long and complex occupational history. A regional-scale sampling bias should thus not be expected to obscure the timing or direction of population fluctuations in the study area but should at worst serve to amplify the relative intensity of settlement during certain periods. The significance of this effect is determined only by the nature of the research questions being asked.

In addition to the problem of regional-scale sampling bias, Williams (2012) discusses additional sources of bias that result from intra-site sampling and taphonomic loss. The choice of materials from a site for assaying is often driven by the need to chronologically frame a stratigraphic sequence and those materials are thus unlikely to constitute a representative sample of occupation events at a site. The possibility of multiple interdependent dates from the same site must also be considered. In such instances, multiple dates obtained from a single stratum or feature may overrepresent one period of time relative to other strata or periods. Such an effect appears negligible for the collection of dates used here considering that for the 558 sites used in this study, the average number of dates per site is only 4.2. Among the state databases for which provenience information is consistently provided for dates, such as Arkansas, no evidence was found that suggests that numerous instances of multiple dates were obtained from the same context. This should not be surprising since the costs of radiocarbon dates, and the limited funds that tend to be available to researchers, ensure the efficient choice of specimens for radiocarbon dating, and discourages researchers from obtaining numerous dates from the same context.

Taphonomic loss contributes an additional bias where the likelihood of preservation of organic materials suitable for radiocarbon determinations decreases as the age of samples increases. Differential taphonomic loss should also be expected among differing environmental regions where varying climatic and geological attributes result in some depositional environments being more conducive to the preservation of organic remains than others. The potential effects of these conditions must always be considered when comparing results among different periods or regions or when dealing with especially ancient settlements where the preservation of organic materials is rare. However, as Attenbrow and Hiscock (2015:33) state, “the issue is not merely the existence of such processes, but the variation in their effect over time.” In response to this issue, some researchers (e.g., Surovell and Brantingham 2007; Surovell et al. 2009) have attempted to correct for such taphonomic bias by developing preservation/decay curves from non-cultural datasets to help account for the effects of taphonomic loss; however, while the logic of these kinds of corrections is clear, considerable regional variability in geomorphic/taphonomic processes suggests that correction curves calibrated to local conditions must be employed before the value of such measures can be realized. At present, no such curves have been developed for the study area. This represents an important area for future research, and future comparisons of curves corrected for taphonomic bias to those presented here should prove enlightening. It seems unlikely, however, that with the current study’s focus on the ca. 2600-year period from the beginning of the Woodland to the end of the Mississippi period that the preservation of dateable remains would vary enough across this period to significantly affect the estimates of population dynamics provided below.

Lastly, researchers have noted that fluctuations within the calibration curves used by calibration software can affect the shapes of SPD curves (Steele 2010; Williams 2012). However, it has been demonstrated that this effect is not present when employing the CalPal software due to the way that Bayesian priors are applied to the posterior data frequency (Buchanan et al. 2011; Boulanger and Lyman 2014; Schmidt et al. 2012; Weninger et al. 2011).

Chronometric Data

Comprehensive databases of radiocarbon dates for Arkansas, Louisiana, Mississippi, Missouri, and Tennessee are available as either published lists in state journals or as public digital databases maintained by state agencies. A comprehensive database of radiocarbon dates from Arkansas is maintained by the Arkansas Archeological Survey and is available through the Automated Management of Archeological Site Data (AMASDA) with information on acquisition available at http://archeology.uark.edu/forms-records/amasda/. Radiocarbon dates from Louisiana are available online in a searchable database maintained by the Louisiana Division of Archaeology (https://www.crt.state.la.us/dataprojects/archaeology/C14/index.asp). At present, no online database of radiocarbon dates from Mississippi is available. A chronometric database for Mississippi was published by Sims and Connaway (2000) in the state journal, and these data are available from the Mississippi Department of Archives and History as a Microsoft Excel file; however, no systematic effort has been made to keep the database up-to-date. The dates used here from Mississippi represent those listed in Sims and Connaway (2000) and additional dates acquired by the author through a review of literature published after 2000. Similarly, no online database exists for radiocarbon dates from Tennessee, but a list was published by Smith (2002). No effort was made by the author to collect dates from Tennessee published after 2002. Dates from Missouri were obtained from an online database that has been created by

Michael Meinkoth of the Missouri Department of Transportation; however, the database is not open access, and users must register and be granted access.

In addition to the creation of SPD curves for modeling prehistoric population dynamics in the study area, an SPD was also produced from the dates of maize samples to monitor the geographic spread of maize and the timing of its arrival in the study area for comparison with the demographic models. The Ancient Maize Map (http://en.ancientmaize.com/) represents an online repository for information on the geographic spread of maize from its original homeland in western Mexico (Blake et al. 2017). Among the information available on the website, a database of radiocarbon dates is provided that represents a compilation of direct dates from maize samples obtained from throughout the Americas. At present, the Ancient Maize Map database provides 343 dates from Central and South America and 317 from North America; however, none of the North American dates are from the study area. Monitoring the geographic spread of maize and the timing of its arrival in the study region for comparison with demographic models was accomplished by combining the dates provided by the Ancient Maize Map database with dates from the study areas that were obtained from maize samples. Sixteen radiocarbon dates of maize specimens are available from the Ancient Maize Map database for adjacent regions in Kentucky (n=2) and Illinois (n=14). Due to the availability of these dates, and their proximity to the study area, they were included in this study; however, two dates from the Holding site (11MS118) in Illinois were excluded. Recent research has demonstrated that these specimens, previously thought to be the oldest specimens of maize from the Mississippi River valley, were incorrectly identified as maize (Simon 2017). Nine dates from sites in Illinois compiled by Simon (2014) were also used in the current study.

Sample Size

Data collected for the current study included 2,465 radiocarbon dates from 558 archaeological sites within the study area; 45 of these dates from marine or freshwater shell samples were removed due to the likelihood that these would be affected by a reservoir effect (De Atley 1980; Peacock and Feathers 2009). The demographic analysis presented below is thus based on 2,420 samples. Reliance on the spatial and temporal density of radiocarbon dates as proxies of demographic change makes consideration of the role of sample size in affecting such measures important. Considering the 7000-year period represented in the current study, the sample of 2,420 dates provides a temporal density that equates to a single date every 2.89 years. Table 1.1 provides information on the spatial density of dates by eco-region with the regions listed in order from highest to lowest densities. It is expected that there is a positive correlation between the density of dates from a region and the representativeness of the SPD constructed from those dates as a model of regional population dynamics.

Table 2.1. Information on the spatial density of radiocarbon dates by eco-region.

Eco-region	**Size of area (sq. km)**	**No. of dates**	**Spatial density of dates (per sq. km)**
Lower LMV Alluvial Plain	30,080	412	0.0137
Upper LMV Alluvial Plain	68,091	537	0.0079
Coastal Zone	49,239	294	0.0060
South Central Plains	81,923	297	0.0036
MS/TN Highlands	129,959	447	0.0034
AR Ozark Highlands	64,782	182	0.0028
Central Dissected Hills	61,534	142	0.0023
MO Ozark Highlands	94,036	109	0.0012
Totals	**579,644**	**2420**	**Avg. density: 0.0051**

In order to evaluate the potential effects of sample size on the data a random resampling of dates from one of the study's eco-regions, the Lower LMV Alluvial Plain, was undertaken. Results are presented in Figure 2.3 with SPD curves derived from increasingly smaller samples listed from bottom to top. This eco-region was chosen for resampling due to its position as the region with the highest density of dates, which when resampled with increasingly smaller samples, provided the greatest span across which changes in sample sizes could be compared. This assessment demonstrates that reductions in the current sample size appears to have minimal effect on the SPD curve at even the lowest sampling level of 10% of the original sample. The timing and direction of demographic fluctuations remain largely intact throughout, though changes in their relative magnitude vary somewhat. This suggests that while additional dates from the region would certainly increase the SPD curve's representativeness of regional population dynamics, its current distribution based on a sample of 412 dates would be only minimally affected. When considering the 41 dates that comprise the 10% sample from the Lower LMV Alluvial Plain, this represents a spatial density of dates similar to that from the MO Ozark Highlands whose spatial density is lowest among the regions considered here. These results suggest that confidence in the demographic models provided below should be high, as sample size appears to be sufficient among the various regions for identifying at least the timing and direction of demographic fluctuations even at a spatial density of around 0.0012 dates per square kilometer.

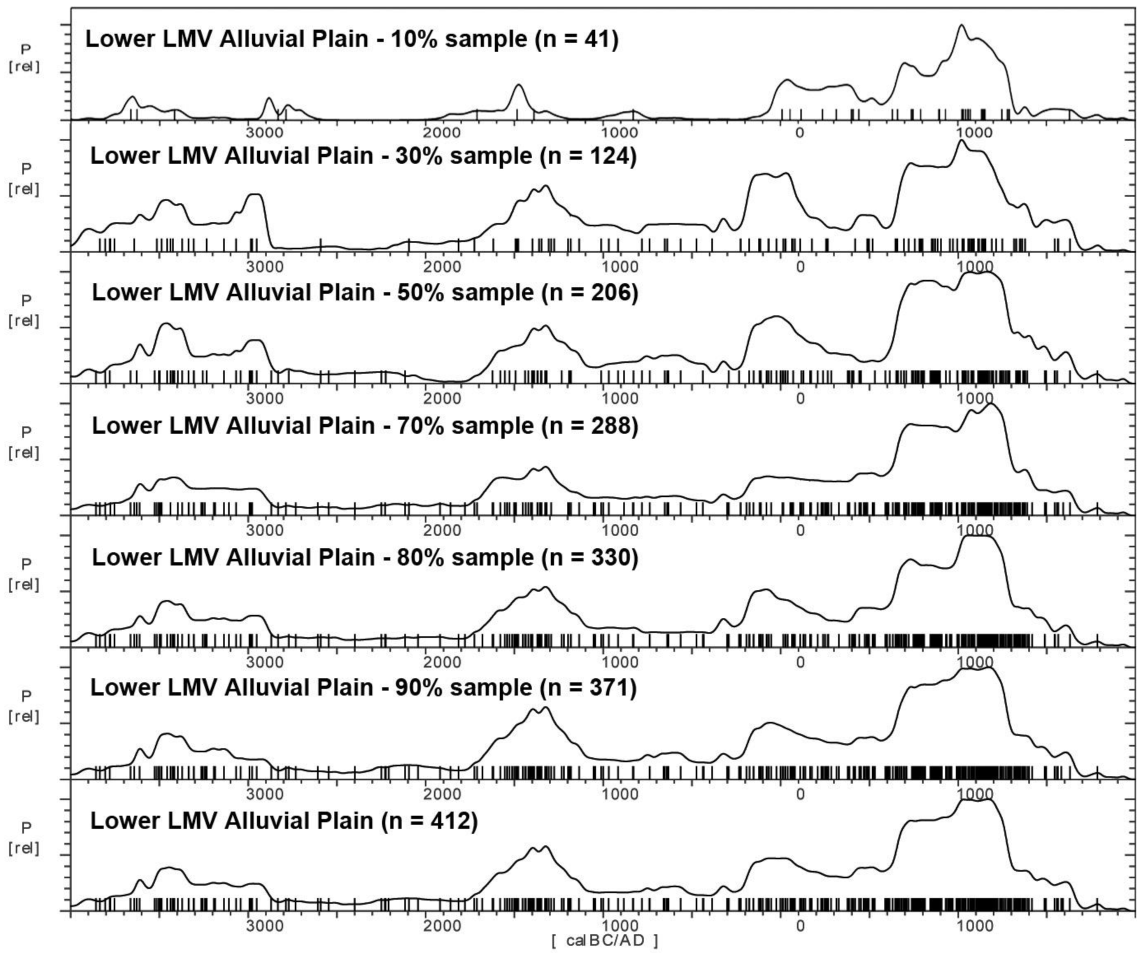

Figure 2.3. Summed probability distributions demonstrating the effects of changes in sample size on the Lower LMV Alluvial Plain sample.

Results

It is important that the results of this study, and other similar studies that rely upon SPDs as paleodemographic proxies, be presented as provisional and falsifiable models to be tested when larger samples are available or through other methods. The models presented below are built on data that are currently available.

Population Dynamics in the Study Area

The SPD curve (black) presented in Figure 2.4 provides a model of population dynamics for the study area that documents changes during the past 6000 years, while the yellow curve represents the SPD generated on 70 radiocarbon dates of maize specimens from 47 archaeological sites in the study area, as well as Kentucky and Illinois. Although the current study is focused on assessing the degree of association of demographic changes with the adoption of maize cultivation during the Woodland-Mississippi period, SPDs generated here also represent the preceding 3500 years. This choice was made because population structure at any point in time is to a large extent determined by the structure that preceded it in time. Thus, cropping the view of population dynamics to exclude the period before 1000 BC would obscure the demographic stage that was being set prior to the dramatic changes that begin in some regions during the early centuries of the Woodland period.

The model in Figure 2.4 suggests that beginning around 400 BC the trend of relatively minimal population growth that had characterized the preceding 3600 years came to an end. After 400 BC a period of sustained population growth continued in the study area for a millennium. The end of this period is characterized by the most pronounced increase in population growth that the region experienced. Just after AD 600 a dramatic increase in regional population levels appears to have occurred. This increase took place over a relatively short period of time as its peak was reached by ca. AD 700. At this time, population growth appears to have stalled, maintaining at this level for a period of 400 years until ca. AD 1000, when another, though less dramatic, increase is

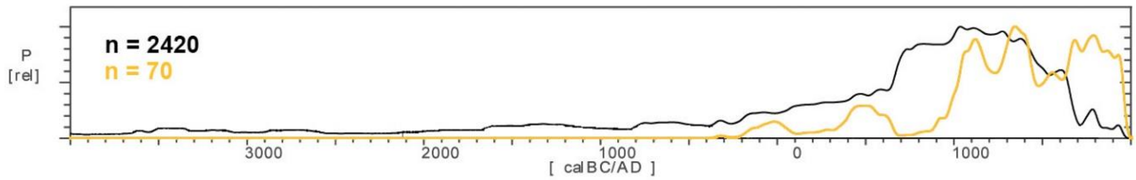

Figure 2.4. Summed probability distribution curve (yellow) generated on 70 radiocarbon dates of maize specimens from 47 archaeological sites in the study area, as well as Kentucky and Illinois, overlaid on the curve (black) generated on 2,420 radiocarbon dates from 558 archaeological sites in the study area representing the past 6,000 years.

seen. This AD 1000 spike in population appears to represent the peak of population growth in the study area. However, this period of peak population was short lived, and its end at ca. AD 1100 marks the beginning of a 300-year period of slow decline until ca. AD 1400, though this period would be punctuated by short periods of population rebound. At ca. AD 1400 this downward trend entered a period of accelerated decline that lasted until the period of first contact with Europeans in the mid-16th century.

Because of the usefulness of demographic models that capture variation in population dynamics on smaller geographic scales, SPDs were constructed for a variety of sub-regions of the larger study area (Figure 2.5). As described above, these sub-regions are defined largely through reference to traditionally established physiographic regions that exist within the larger study area. The resulting eco-regional models reveal considerable variation in the timing of important events in the region's demographic history; however, they do consistently show a dramatic increase in populations at around AD 650, with some exceptions such as the MS/TN Highlands, which experienced a period of dramatic growth much earlier than any other region. Conversely, the post AD 1000 decline seen in the general model appears less consistent in the eco-regional models as the timing and duration of the decline varies considerably from eco-region to eco-region.

Modeling the Spread of Maize

To model the spread of maize from Mexico into the study area, SPD curves were generated on 277 radiocarbon dates of maize specimens collected from throughout this region. This region was split into five areas as shown in Figure 2.6, which allows comparison of geographically variable frequency distributions in dated maize specimens through time. The curves presented in Figure 2.6 show a rapid increase in the frequency of maize in all regions outside of Mexico at AD 1000, with a largely simultaneous decrease in the frequency of maize from Mexico during the same period; however, the evidence additionally suggests the cultivation of maize in all four of these regions was well established by AD 200–300.

When comparing the cumulative SPD curve generated from the maize samples to the curve generated from all radiocarbon dates a number of interesting trends are apparent (Figure 2.4). The first appearance of maize generally follows the increase in population levels that began around 400 BC; however, the parallel growth trends in the two curves diverge suddenly near AD 600. As population levels are entering their period of most dramatic growth, the SPD curve for maize specimens begins a steep decline followed by a period of low frequency until the dramatic increase that occurs near AD 1000. After reaching its frequency peak from AD 1000–1100 the maize curve remains relatively high for several more centuries, though this period is marked by episodic downturns.

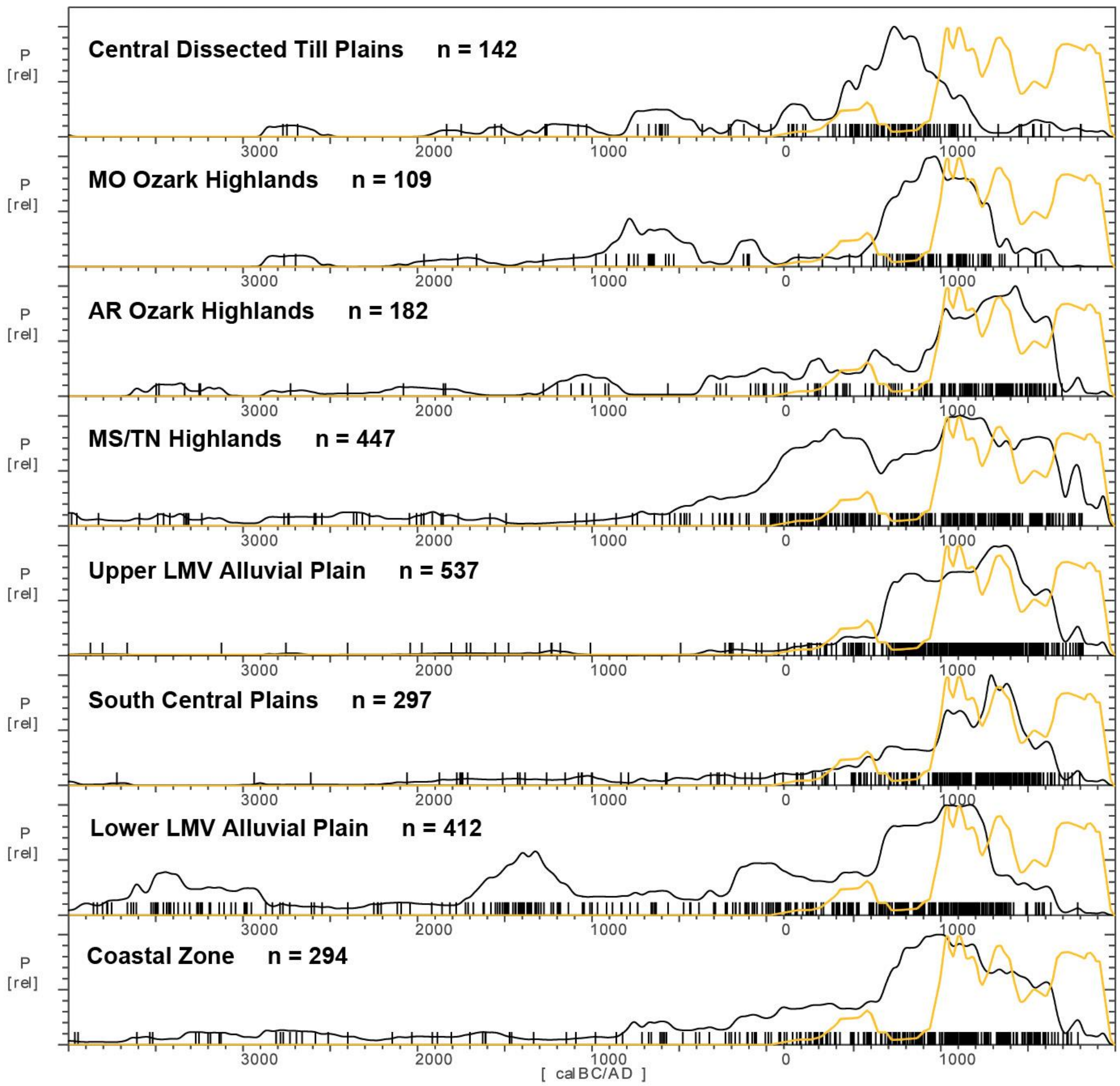

Figure 2.5. SPD curve (yellow) generated on 70 radiocarbon dates of maize specimens from 47 archaeological sites in the study area, as well as Kentucky and Illinois, overlaid on SPD curves generated by eco-region for the past 6,000 years.

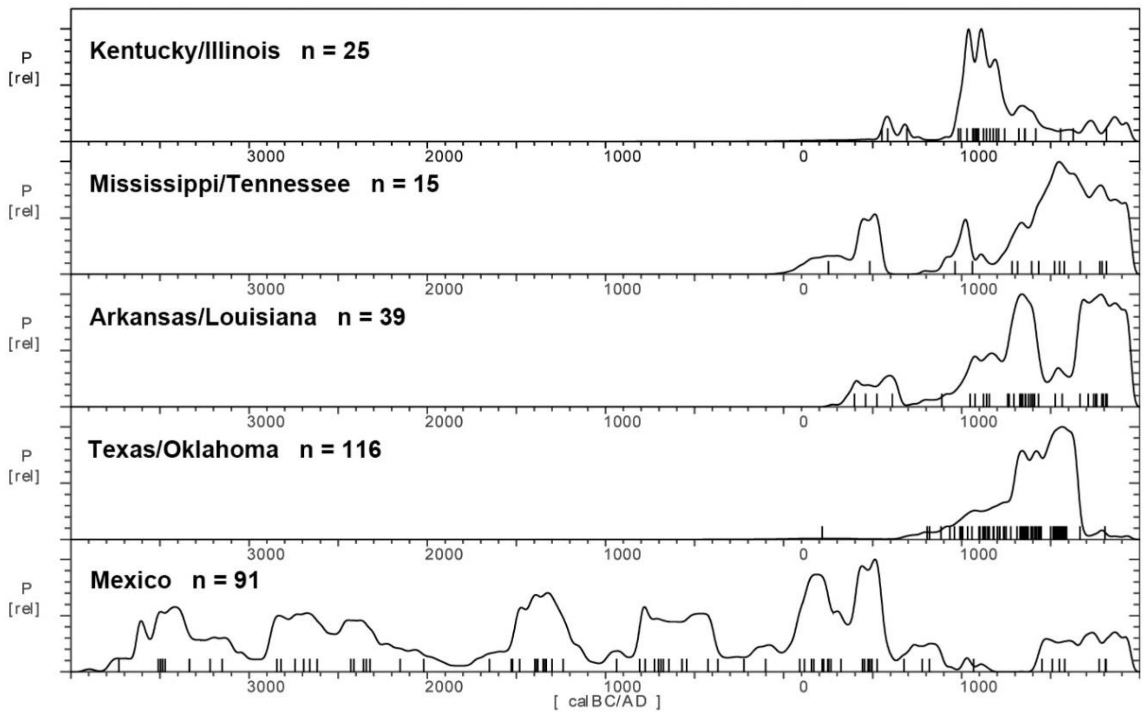

Figure 2.6. Summed probability distribution curves generated on radiocarbon dates of maize specimens subdivided by geographic regions spanning the region between the study area and Mexico.

Discussion

The models of population dynamics presented above provide little evidence to support the idea that ca. AD 1000 represents the watershed moment for demographic expansion in the study area or that this area's most dramatic period of population growth was driven by the intensification of maize agriculture. While AD 1000 does appear to represent the time of peak population, the evidence demonstrates that the major demographic expansion began about 350–400 years earlier and was followed by a ca. 300-year period when populations plateaued before entering a period of relatively modest population increase until reaching the AD 1000 peak. At AD 650 the most dramatic increase in population that the study area witnesses occurred after a ca. 1000-year period of continual though modest growth that stretched across much of the Woodland period. The beginning of the Woodland demographic shift at ca. 400 BC also marks the end of a millennia-long trend of minimal population growth and aligns well with previous research (Kidder 2006; Rafferty 1994; Thomas and Sanger 2010) that identifies important shifts in subsistence/settlement patterns that characterized the period of the Late Archaic to Early Woodland transition.

While the evidence does not support the intensification of maize agriculture as a driver of population growth, it does demonstrate that the onset of maize intensification after AD 1000 corresponds to the beginning of demographic decline (Figure 2.4). The demographic trends provided by the eco-regional models (Figure 2.5) demonstrate that while each region eventually experienced a final dramatic decline in prehistoric populations, there is considerable variability in the timing of these events, with some beginning as early as the Late Woodland period and others as late as AD 1650. Importantly, the evidence suggests that the precipitous decline in population in most regions pre-dates the arrival of Europeans by 100–700 years. This suggests that while the effects of European disease and colonization may have ultimately prevented populations from rebounding, the cause of their original decline must be sought elsewhere. Some have pointed to climate change and its effect on maize agriculture as the major driver of population decline during the Mississippi period (e.g., Bird et al. 2017; Milner et al. 2013). However, variability in the timing of population decline shown in Figure 2.5 reveals the need for climatic proxies from the region with high spatial and chronological resolution before these regional trends can be tied to climatic events such as decadal droughts or decreasing annual temperatures that would have negatively affected societies reliant on maize agriculture. Instances of significant population decline have been identified previously in the eastern United States for the late Mississippi period (e.g., Cobb and Butler 2002; Morse and Morse 1983; Walthall 1980; Williams 1990), but the problem of classification inconsistencies in ceramic typologies and phase construction have hindered the detection and comparison of regional demographic trends (but see Krus and Cobb 2018). The data presented here demonstrate the advantage of SPDs in the modeling of population dynamics and this approach should prove useful in other regions for identifying the timing of population decline seen throughout the Midwest and Southeast during the period of AD 1300–1500.

The Role of Plant Cultivation in Demographic Change

The SPDs based on maize specimens demonstrate that while maize was present in the study area it contributed little to the AD 650–700 expansion, as its frequency in the archaeological record was low at this time. In addition to not appearing as a driver of demographic expansion it also seems maize did not contribute to sustaining population levels, as the period of peak maize coincides largely with the beginning of a dramatic decline in regional population. This correspondence aligns with previous evidence that the emergence of more complex societies in the region during AD 750–1000 does not appear closely tied to the intensification of maize agriculture, as stable isotope analyses suggest that maize did not become an important dietary staple until after AD 1000 and as late as AD 1200 in some parts of the Mississippian culture area (Lynott et al. 1986; Rogers 2011; VanDerwarker 2017). These results suggest that the population growth documented here should be viewed as a variable independent of any relationship to maize agriculture. The results also demonstrate that while post AD 1000 populations were declining throughout most of the study area, the frequency of maize remained at relatively high levels for the next 800 years except for a decline around AD 1500–1600. This lends support to the idea that a post AD 1000 settlement-subsistence pattern characterized by an increasing reliance on maize agriculture may have faced increasing instability in the face of climatic change associated with the Little Ice Age from 720–140 years BP (AD 1280–1860) (Perry and Hsu 2000), thus aligning with Rindos' (1984:172) characterization of agriculture as "globally persistent but locally unstable."

The SPD curves derived from maize specimens are built on a relatively small sample. This, of course, has consequences for the representativeness of these models, but even more assuredly we must acknowledge the extremely low likelihood that the earliest specimens of maize to enter the study area, or adjacent regions, are represented among these samples. Consider the relatively small amount of the Woodland archaeological record that has been sampled in the region and the likelihood that methodological strategies for the recovery of floral remains at sites dating to these periods were often inadequate (e.g., little to no flotation of sediments). From this perspective, the fact that these numbers of dated maize specimens are available for this period likely means that maize cultivation was relatively well established in the region by this time. If this assessment is correct, then we should expect that maize was indeed present in the study area prior to AD 200, especially when considering that recent microbotanical research has identified maize phytoliths in New York state as early as 300 BC, and in Michigan between 400–350 BC (Hart et al. 2012; Raviele 2010).

Regardless of the timing of maize's introduction into the study area, the data clearly support the position that we should look elsewhere for the driver(s) of major demographic expansion that occurred around AD 650. It is well established that between 4,000 and 2,000 years ago, the inhabitants of the Eastern Woodlands began to cultivate indigenous cultigens including squash (*Cucurbita pepo*), sunflower (*Helianthus annuus*), sumpweed (*Iva annua*), goosefoot (*Chenopodium berlandieri*), maygrass (*Phalaris caroliniana*), erect knotweed (*Polygonum erectum*), and little barley (*Hordeum pusillum*), which are referred to as the Eastern Agricultural Complex (EAC) (Fritz 1990, 1997, 2008; Smith 1987, 1992, 2011; Smith and Cowan 1987; Smith and Yarnell 2009). For the Mississippi River valley, and adjacent upland areas, Fritz (2008:330) describes a scenario of increasing reliance on indigenous cultigens during the Middle Woodland period based on the archaeological recovery of "impressive quantities of these seed crops, sometimes in storage contexts." Fritz (2008:333-334) further notes that:

> Unmistakable signs of increased food production are manifested by Late Woodland [Baytown] plant remains from northwest Mississippi, eastern Arkansas, and southeast Missouri, but most of the crops produced during this time were members of the Eastern Agricultural Complex [EAC] rather than corn. It remains unclear when native seed production became economically important and how the timing varied spatially.

The evidence presented here for major demographic expansion during the Middle and Late Woodland periods, and the potentially important role in this expansion for EAC cultigens and improvements in storage technology, suggests the need for future site investigations with substantial flotation programs and the construction of frequency models derived from SPDs of radiocarbon-dated specimens of EAC cultigens. Through the development of SPDs for EAC cultigens, and the comparison of these to demographic models such as the ones presented here, we should be able to fill in some of the blanks identified by Fritz (2008) related to the timing and intensity of native seed production.

Data Considerations

As discussed above, the ways in which we collect and present data on radiocarbon assays is critically important to insuring the increasing usefulness of SPDs as proxies for demographic change. Similar arguments have been made by others as part of a larger appeal for improvements in how archaeologists report data related to materials submitted for radiocarbon assay and the work by Nolan (2012) and Thompson and Krus (2018) provide useful guidelines in this regard. Additionally, the discussion below highlights issues encountered during this research that are particularly relevant to researchers working within the Southeast and Midwest.

Database Development. The possibility of conducting the kind of research presented here is due in large part to the availability of large and comprehensive databases of radiocarbon dates. The efforts required to produce and maintain the state-wide databases of radiocarbon dates used here are significant and the individuals and agencies that have undertaken these efforts are to be commended. In the United States, the state historic preservation offices (SHPO) are well suited to undertake such syntheses, and those SHPOs that have not yet done so should follow the lead of states such as

Arkansas and Louisiana, where comprehensive online databases are maintained and readily available to researchers. Most of the radiocarbon dates produced in the U.S. are acquired by researchers working in the context of cultural resources management. Though some of these dates end up in widely circulated publications, many remain hidden within the infamous gray literature. As the central clearinghouse for archaeological data within states, the SHPO is well situated to aggregate these data and maintain these kinds of databases. SHPOs should work to develop and maintain such databases and researchers should work to ensure that the radiocarbon dates they produce end up in such places.

Sample Selection. An awareness of the role that sampling bias plays in affecting the representativeness of demographic models derived from SPDs is critically important if we are to improve the usefulness of this method. Researchers are often faced with limited financial resources to support radiocarbon dating of specimens within their respective studies. This fact undoubtedly contributes to the biased selection of specimens from contexts that will most efficiently allow the researcher to frame some chronological sequence of interest, as well as the choice of which contexts to sample through excavation. However, a strategy that involves a broader and more random selection of materials for radiocarbon assay would not only lead to the creation of data sets more suitable for the kind of analysis presented here but would ultimately lead to stronger occupational models for archaeological sites, as the broader sampling of contexts would capture materials from occupations that preceded or followed the occupation of primary interest. Identifying occupational continuity or discontinuity is critically important in studies of cultural evolution and the ability to do so is strongly tied to our ability to account for the complete occupational history of a site. Because of these needs, archaeologists would ideally submit randomly chosen samples of materials from excavated contexts that had also been randomly chosen. As mentioned, project finances often constrain these choices, and force more limited sampling, but opportunities along these lines are often possible and researchers should pursue them in future studies and funding agencies should support such efforts.

In selecting samples for radiocarbon assay, researchers should also consider the possible interdependence of dates with other dates from the same project and should report such issues to the laboratory analyzing the samples. Laboratories may even consider adding the question "why was this particular sample submitted for radiocarbon assay?" to the submission form.

Species Identification. If the species of plant or animal had been identified for all 2,420 specimens from which the radiocarbon dates used here were derived, it would be possible to model frequency distributions of these species through space and time, as was done for maize. Distinguishing between maize specimens and other charred plant material is often easily accomplished macroscopically. This has led to the common designation of maize radiocarbon samples as such, whereas most other plant material submitted for radiocarbon dating from the region is identified only generically with terms such as "charred plant material" or "nutshell." Bone specimens are only rarely identified as anything other than "bone" or "animal bone." Whenever possible, the species of plant or animal be identified by researchers prior to the submission of materials for radiocarbon dating so that this designation may be noted within the laboratory results. Further, specimens that can be identified to species should be preferred for radiocarbon assay over unidentifiable specimens, as the choice of taxonomically identified specimens increases the utility of the resulting dates. Doing so will add an important dimension to what can be accomplished in the future by the kind of research presented here. Bevan et al.'s (2017) study into the relationship between population dynamics and food production in the middle and later Holocene of Britain and Ireland provides an excellent example of how SPDs can be used to monitor changes in the relative importance of certain food sources, and how these can be related to fluctuations in population growth. The database used by Bevan et al. (2017) with its high density of radiocarbon dates for the region, and the high proportion of well-identified floral and faunal material, represents a model for archaeologists to emulate around the world.

Conclusions

This study provides the initial application of SPD analysis for the central and lower Mississippi River valley and adjacent uplands and represents a first step in the development of models of population dynamics based on the density of radiocarbon dates. Comparison of SPDs derived from all radiocarbon dates from the region with the curves derived solely from maize specimens demonstrates that maize agriculture played little to no role in the region's period of major demographic expansion around AD 650. When considering this evidence along with previous research into the region's settlement-subsistence patterns, it seems likely that subsistence diversification and intensification (Morgan 2015; Morrison 1994) in conjunction with changes in ceramic, storage, and lithic technology, especially the adoption of the bow and arrow around AD 600 (Blitz 1988; Muller 1986; Nassaney and Pyle 1999; Shott 1993), lead to dramatic increases in the carrying capacity of the environment that accelerated a growth trend that had been on a gradual ascent for the past 1000 years. Studies have documented that sedentariness often results in population increase (see Rafferty 1985) as decreased mobility results in closer spacing between child births (Lee 1972, 1979). In the MS/TN Highlands eco-region discussed here, it has been demonstrated that groups had become sedentary by at least 400 BC (Rafferty 1994), which aligns well with the growth trend seen in both the eco-regional and regional demographic models. This supports the advent of sedentariness as an important factor in the trend of continual population growth that began in the region around ca. 400 BC, although the causes of sedentariness in the study area remains an open question.

Maize was present in the region during this important period of demographic change, and its cultivation was clearly part of the subsistence strategy employed during this time, though its relative importance among the suite of plant resources being exploited likely varied throughout the region. This fact clearly indicates that more research into the role of maize during the Woodland period is needed if we are to understand why it ultimately out-competed other domesticates. In short, it appears that any explanations of the Mississippian cultural phenomenon would greatly benefit from increased research into Woodland-period archaeology.

In addition to the insights provided about the relationship between population dynamics and maize agriculture, the results presented here offer an absolute chronological framework for the study area that establishes a demographic baseline to which other key settlement, subsistence, or climatic events can be compared and their relationships studied. The limits of this study, both geographical and inferential, are defined largely by the current availability of large regional databases of radiocarbon dates. Since only a portion of the Mississippian culture area was studied here, there is still much to be learned through comparisons with other areas of the Midwest and Southeast. I encourage researchers to begin amassing databases for these other regions so that these data are available for future comparative studies.

As discussed above, by identifying the species of material from which radiocarbon dates are determined, comparisons can be made between the frequency distributions of these materials and the demographic models provided here to clarify the relationship between population dynamics and the spatiotemporal distributions of some material of interest. Future research should pursue the further development of such comparisons through other methods (e.g., thermoluminescence dating of shell-tempered pottery from the region) that allow for the monitoring of changes in the frequency distributions of materials through space and time. Further development of this approach should lead to a better understanding of how the constellation of traits associated with Mississippian culture were spatiotemporally distributed, which should provide a stronger basis for subsequent questions of how or why they came to be distributed as such. The roles played by the four variables of demographic change (in-migration, out-migration, birth rate, and death rate) must ultimately be considered in explaining the models of population dynamics presented here, but the question of how these contributed to the episodes of population growth and decline identified here will be left to future studies.

Chapter 3

Assessing Episodes of Prehistoric Regional Population Decline in the Lower Mississippi River Valley and Adjacent Uplands

Introduction

Human societies have, in part, been shaped by various forces that influence mobility and settlement of populations. Abandonment is one possible response (Cameron and Tomka 1993). Abandonment events can occur at different scales, which have important consequences for the societies who experienced them and for archaeologists attempting to identify and explain them. Evidence for dramatic increases in abandonment events across large regions suggests larger environmental and/or social processes that must be accounted for in efforts to explain settlement pattern change.

In this paper, two previously identified episodes of regional population decline in the lower Mississippi River valley and adjacent uplands are investigated. Kidder's (2006) research has addressed the first of these episodes near the end of the Late Archaic period (1000–500 BC) when an abrupt gap in settlement of the Tensas Basin in the lower Mississippi Valley appears to coincide with climatic and environmental changes associated with increased rainfall and flooding. This work identified the complex relationship among climate, environment, and human settlement patterns that characterize the region's Late Archaic to Woodland transition and revealed how the study of such relationships benefit from large, high-resolution datasets that allow for analyses at different temporal and spatial scales.

The second episode of population decline addressed here has been termed the "Vacant Quarter" by Williams (1990:173) and is associated with evidence of widespread abandonments near the end of the late prehistoric period, just prior to first contact with Europeans (ca. AD 1300–1500). While Williams (1990, 2001) identified the phenomenon as being centered on the mouth of the Ohio River, he acknowledged that similar events had been identified within other areas of the Midwest and Southeast (e.g., Badger and Clayton 1985; McNutt and Weaver 1985; Morse and Morse 1983; Walthall 1980).

While previous research has provided evidence for these abandonment events, the scope of these episodes, how they varied regionally, and whether they are best characterized in terms of settlement reorganization or increasing mortality is less clear. The current study aims to clarify these issues using demographic models derived from the summed probability distributions (SPDs) of radiocarbon dates amassed for a portion of the Mississippi River valley and adjacent uplands. In addition to providing a general demographic model for the study area at large, groups of SPDs were separated by eco-region to compare how population dynamics changed through time at both the regional and eco-regional scale (Figure 3.1). These comparisons provide strong evidence for episodes of regional population decline during the period of 1000–500 BC and AD 1300–1500, which appear to represent population shifts between upland and lowland environments driven by climatic change. The possibility of regional population decline as the result of settlement organization is tested through the association of radiocarbon dates with elevation data for the sites from which they were recovered to assess how population declines may correlate with shifts from upland to lowland areas or vice-versa.

Paleodemography in the Mississippi River Valley

Demographic Change during the Late Archaic

Archaeological research in the Mississippi River valley has demonstrated stark contrasts in settlement-subsistence patterns between Late Archaic times and the preceding periods and also the need to account for regional variation in climatic, environmental, and settlement-subsistence patterns (Anderson 2001; Brown and Vierra 1983; Butler 2009; Gibson and Carr 2004; Kidder 2006; O'Brien and Wood 1998; Sassaman and Anderson 2004; Stafford et al. 2000). Central to discussions of changing settlement patterns in the Midwest and Midsouth during the Middle and Late Archaic periods are the climatic and environmental changes attributed to the Holocene climate optimum (Perry and Hsu 2000; Sandweiss et al. 1999). The warm, dry conditions of the period likely pushed some populations out of desiccated upland environments into wetter lowland areas, thus focusing settlement and subsistence activities in a narrower environmental niche and increasing population densities (Anderson 2001; Knox 1983; Schuldenrein 1996; Webb et al. 1993; Wright 1992). While this general characterization is common among archaeological accounts of the period, it is also commonly acknowledged that regional variation in these changing conditions, as well as human responses to those conditions, should be expected. Documenting regional variation in settlement in the lower Mississippi Valley represents an important component of any study that aims to assess population decline as a response to changing climatic and environmental conditions, as such episodes may represent the movements of people from one environmental zone to another rather than population decline in the sense of mortality rates outpacing birth rates, although the two are not mutually exclusive.

Kidder's (2006) research identified the Late Archaic to Early Woodland transition in the lower Mississippi Valley as a time of significant climatic, environmental, and cultural changes defined largely by the occurrence of massive floods in the region. This shift away from the xeric conditions of preceding periods represents the initiation of a new climatic regime that is implicated by Kidder as a significant disruptor of human settlement in the lower Mississippi Valley. Episodes of site abandonment identified in the Tensas River basin are presented as evidence of human responses to deteriorating lowland conditions. These conditions are further implicated in the demise of the Poverty Point culture through the disruption of long-distance trade and exchange along the Mississippi River valley and its effect on the social and economic processes that define the culture.

The Vacant Quarter Hypothesis

Since Williams' original formulation of the Vacant Quarter hypothesis, much work has been done to outline the spatial and temporal dimensions of the phenomenon and to assess possible explanations (Badger and Clayton 1985; Cobb and Butler 2002; Krus and Cobb 2018; McNutt and Weaver 1985; Meeks and Anderson 2013; Milner and Chaplin 2010; Morse 1990; Morse and Morse 1983; Muller 2009; O'Brien and Wood 1998; Price and Price 1990; Smith 1986; Walthall 1980; Williams 2001). However, as Krus and Cobb (2018:303) note, "At this time, it is difficult to delineate the timing and tempo of the unfolding of the Vacant Quarter with precision or certainty." Previous research has identified the period of ca. AD 1300–1500 as a time during which episodes of site abandonment are seen across the Midwest and Southeast, although these episodes are generally characterized as cases of population decline rather than complete abandonment. Discussions of these episodes have tended to focus on the abandonment of major Mississippian mound centers where the phenomenon appears to have occurred earliest at more northerly sites such as Cahokia, Kincaid, and Angel, but later spread down the Mississippi Valley and throughout the Southeast. Efforts to investigate this phenomenon have to a large extent relied on the presence or absence of ceramic marker types associated with post-AD 1300 occupations, with their low frequency in certain areas seen as evidence for population decline. However, the low frequency of marker types associated with this period may simply result from inconsistencies in pottery classification that result in Fiedel's (2001:101) "incongruous temporal definitions" that so often hamper large-scale regional studies of paleodemographic change. More recent research into the Vacant Quarter phenomenon (e.g., Cobb and Butler 2002; Krus and Cobb 2018; Meeks and Anderson 2013) has used radiocarbon dates to construct chronological models that serve as demographic proxies with the potential to reveal episodes of population decline. This work demonstrates the potential of such methods to assess the timing and scale of regional abandonment episodes and allows for cross-regional comparisons that otherwise are confounded by classification inconsistencies across regions. Attempts to explain this demographic phenomenon are often cast in terms of settlement reorganization, as evidenced in Williams' (1990:177) conclusion that "we seem to be looking at population rearrangement rather than real population decline." This position, however, is based largely on the lack of evidence for increases in mortuary remains during the period, rather than from actual measures of demographic decline or assessments of changing settlement patterns.

Materials and Methods

The models of population dynamics presented below are derived from the collection of radiocarbon dates that researchers have amassed for the region during the past several decades. Since its inception in the late 1940s, radiocarbon dating has become increasingly important in the construction of age models in prehistoric archaeology and remains the principal instrument for the establishment of an interval-scale chronology of prehistoric settlement in the Americas. Hundreds of radiocarbon assays from the study area were amassed to create a comprehensive database that could be used in a "dates-as-data" approach (Rick 1987) for the development of regional population histories. Alvey (2019) provides a detailed discussion of the renewed interest the method has received in recent years, as well as a discussion of the interpretive and analytical challenges presented by the method.

In short, summed probability distributions (SPDs) of calibrated ^{14}C dates provide a demographic proxy for tracking prehistoric population dynamics, defined here as the timing, scale and direction of prehistoric population fluctuations, that exploits the spatiotemporal precision of radiocarbon dates from archaeological contexts. This approach allows for the seamless comparison of demographic trends among sites or regions providing an alternative to artifact-based approaches where classification inconsistencies impede regional comparisons. Models of population dynamics constructed at a variety of scales can be compared to identify points of divergence in population histories, and comparisons can be made to important settlement, subsistence, or climatic events to better understand the timing of such events relative to changes in population size.

Chronometric Data

Comprehensive databases of radiocarbon dates for Arkansas, Louisiana, and Mississippi are available as either published lists in state journals or as public digital databases maintained by state agencies. A comprehensive database of radiocarbon dates from Arkansas is maintained by the Arkansas Archeological Survey and is available through the Automated Management of Archeological Site Data (AMASDA), with information on acquisition available at http://archeology.uark.edu/forms-records/amasda/. Radiocarbon dates from Louisiana are available online in a searchable database maintained by the Louisiana Division of Archaeology (https://www.crt.state.la.us/dataprojects/archaeology/C14/index.asp). At present, no online database of radiocarbon dates from Mississippi is available. The chronometric database for Mississippi was published by Sims and Connaway (2000) in the state journal and is available from the Mississippi Department of Archives and History as a Microsoft Excel file; however, no systematic effort has been made to keep the database up-to-date. Dates used here represent those listed in Sims and Connaway (2000) supplemented by dates acquired through a review of literature published after 2000.

Sample Size

The demographic models presented below were derived from a compilation of dates from published and public digital databases that resulted in 623 dates from Arkansas, 791 from Louisiana, and 538 from Mississippi, for a total of 1,952 dates. These dates originated from 527 archaeological sites (Arkansas: 158, Louisiana: 218, Mississippi: 151). An additional 45 radiocarbon dates of marine or freshwater-shell samples are available from these states but were not used due to the likelihood that they would be affected by a reservoir effect (De Atley 1980; Peacock and Feathers 2009).

Elevation Data

In order to monitor changes in the elevation of settlement locations through time, elevation values were assigned to each radiocarbon date based on its location of origin. The period of 4000 BC–AD 1700 was subdivided into 13 500-year duration bins both to provide sufficient chronological resolution and to ensure sufficient samples of dates per temporal bin. An average elevation was calculated for all dates that fell within each temporal bin (Table 2.1). Radiocarbon dates from Arkansas, Mississippi, and Louisiana were separated by state, and an elevation curve was constructed for each of the three groups of dates. The period preceding 3000 BC in Arkansas was excluded from consideration as only a small number of dates (<5) are available from this period.

Previous research (Brown 1985; Brown and Vierra 1983; Huang et al. 2003) has demonstrated a link between elevation shifts in settlement patterns and climate change where periods of low rainfall have driven populations into lowland riverine environments or, conversely, periods of higher rainfall have led to population expansion into upland environments as lowland environments receive more frequent flooding and as food resources in upland environments become more productive. Increased rainfall also leads to the development of seep springs in some upland environments, providing reliable sources of freshwater that likely would not exist during periods of low rainfall, thus making upland areas more habitable during those times (Rafferty and Peacock 2008).

Table 3.1. Summary table showing the average and range of elevation values associated with radiocarbon dates from Arkansas, Mississippi, and Louisiana for each 500-year period between 4000 BC–AD 1700.

	Arkansas			**Mississippi**			**Louisiana**		
C^{14} Age	**Elevation (m)**			**Elevation (m)**			**Elevation (m)**		
	Avg.	**Range**	**No. of dates**	**Avg.**	**Range**	**No. of dates**	**Avg.**	**Range**	**No. of dates**
4000–3500 BC	N/A	N/A	N/A	101	52–140	25	22	2–30	9
3499–3000 BC	N/A	N/A	N/A	89	46–130	27	20	2–40	11
2999–2500 BC	240	177–354	14	89	46–130	20	21	2–40	39
2499–2000 BC	177	85–299	11	69	35–130	16	18	2–82	31
1999–1500 BC	208	177–335	22	52	3–130	19	26	2–82	16
1499–1000 BC	85	21–256	18	28	3–70	15	29	2–82	56
999–500 BC	167	21–372	12	31	3–52	9	22	2–64	37
499 BC–AD 0	196	76–372	34	54	3–122	29	18	2–116	51
AD 1–500	180	20–372	29	63	3–122	74	18	2–55	95
AD 501–1000	102	29–488	145	50	3–131	103	21	2–85	202
AD 1001–1500	109	24–469	289	57	3–140	154	17	2–116	191
AD 1501–1700	116	34–488	85	60	3–122	51	16	2–55	53

Study Area

In addition to a focus on the lower Mississippi River valley, delineation of the study area was also determined by the desire to identify sub-regional variation in population dynamics that would reveal differences in demographic change between upland and lowland environments. This led to the establishment of eco-regions that allow for separate characterizations of demographic changes in the alluvial valley versus the surrounding uplands (Figure 3.1). The use of eco-regions also allows for comparisons between regions that are expected to have more or less internally homogenous ecology (topography, geology, soils, vegetation, etc.), but be more or less distinct from other eco-regions, such that human demographic responses may be independent of other regions. In short, variability in environmental conditions and primary productivity from different eco-regions suggests the potential for different abandonment (and reoccupation) histories.

The eco-regions shown in Figure 3.1 are largely based on previously defined physiographic regions within these three states. Modifications were made to the boundaries of some traditional physiographic regions to accommodate the current study. For example, the region defined as “MS Highlands” comprises several smaller physiographic regions, such as the North Central Hills, Loess Hills, Black Prairie, Jackson Prairie, and so on. These regions were combined into the MS Highlands because of the relatively small numbers of dates that exist for each of these respective regions. The issue of poorly representative samples from each region was mitigated by combining the smaller regions.

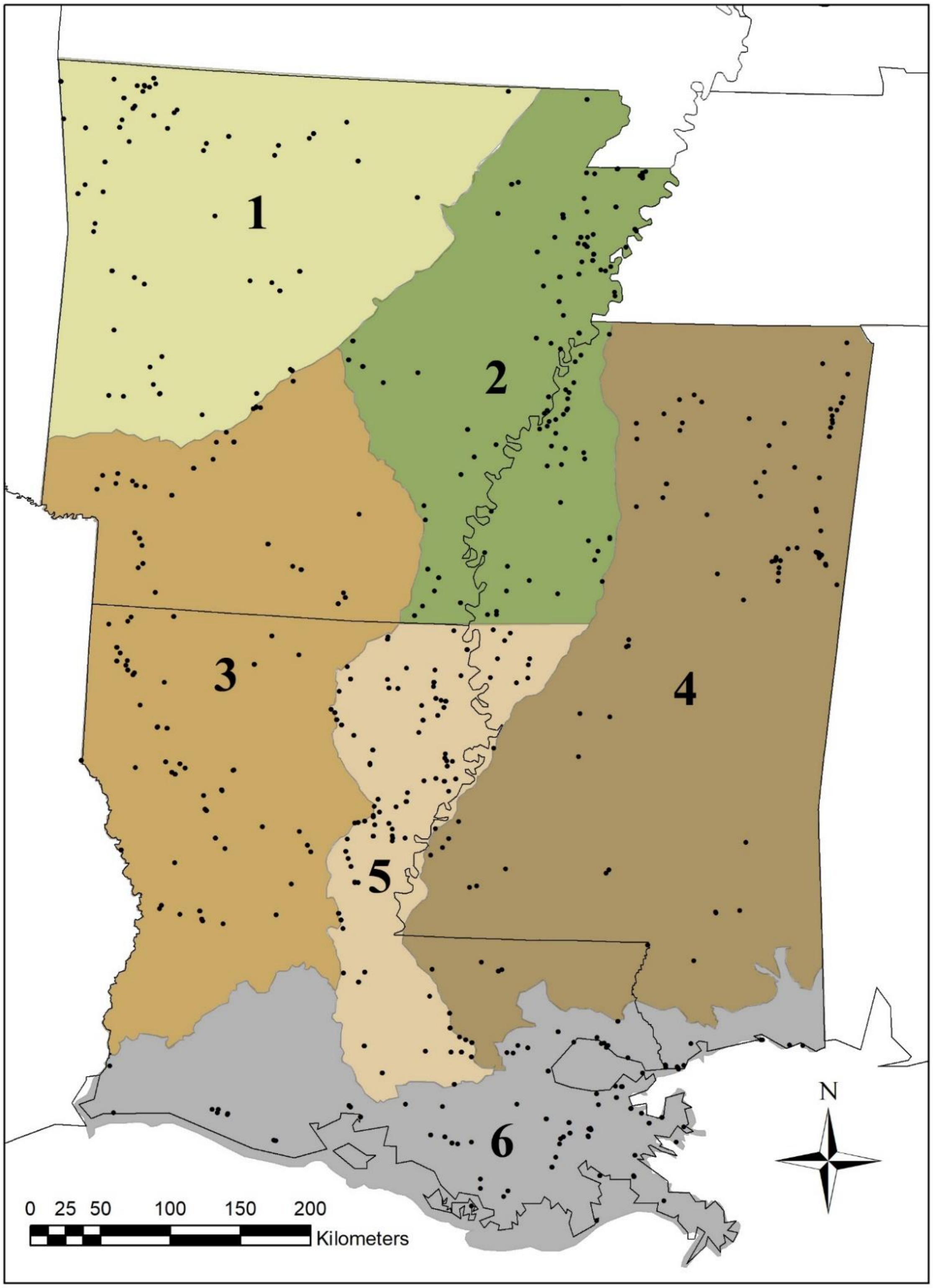

Figure 3.1. Map showing the eco-zones defined for the study area and the locations of archaeological sites (black dots) from which radiocarbon dates were used. 1 – AR Ozark Highlands, 2 – Upper LMV Alluvial Plain, 3 – South Central Plains, 4 – MS/TN Highlands, 5 – Lower LMV Alluvial Plain, 6 – Coastal Zone.

Results

Population Dynamics

Results shown in Figures 2.2 and 2.3 confirm that the periods of l000–500 BC and AD 1300–1500 were times of regional population decline in the lower Mississippi River valley and adjacent uplands. The SPDs display significant decreases in magnitude, implying fewer instances of the creation of archaeological materials suitable for C14 dating, which in turn is interpreted to reflect fewer people accumulating and depositing those materials. The eco-regional SPDs provided in Figure 3.3, however, demonstrate regional variation in the timing and duration of events. A gap in radiocarbon dates around 1000–500 BC, which is similar to what Kidder (2006) describes for the Tensas Basin of northeast Louisiana, is seen in three of the six eco-regions. These include the Arkansas Ozark Highlands (900–300 BC), Upper LMV Alluvial Plain (1100-300 BC), and South Central Plains (700-400 BC). The remaining eco-zones (MS Highlands, Lower LMV Alluvial Plain, and Coastal Zone) show no signs of population decline near the end of the Late Archaic based on the frequency of radiocarbon dates attributed to that period.

Similarly, while these results provide general support for a dramatic decline in regional populations during the post-AD 1300 period, considerable regional variability is also evident. The SPD generated for the region at large (Figure 3.2) shows a gradual decline in population beginning just after the region's population peak at AD 1000. Around AD 1300, however, this decline appears to have accelerated until AD 1500, when a slight rebound in populations appears to have begun. The eco-regional SPDs demonstrate that while all regions eventually experienced a dramatic decline in

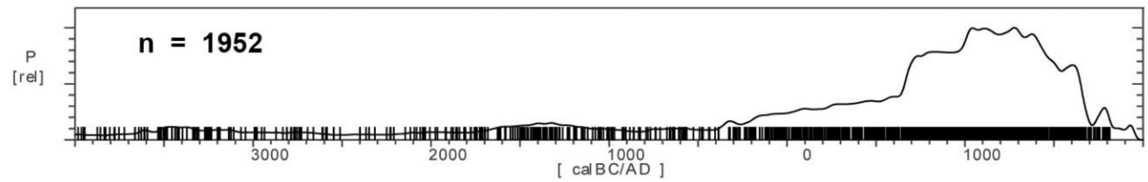

Figure 3.2. Summed probability distribution curve generated on 1,952 radiocarbon dates from 527 archaeological sites in the study area representing the past 6,000 years.

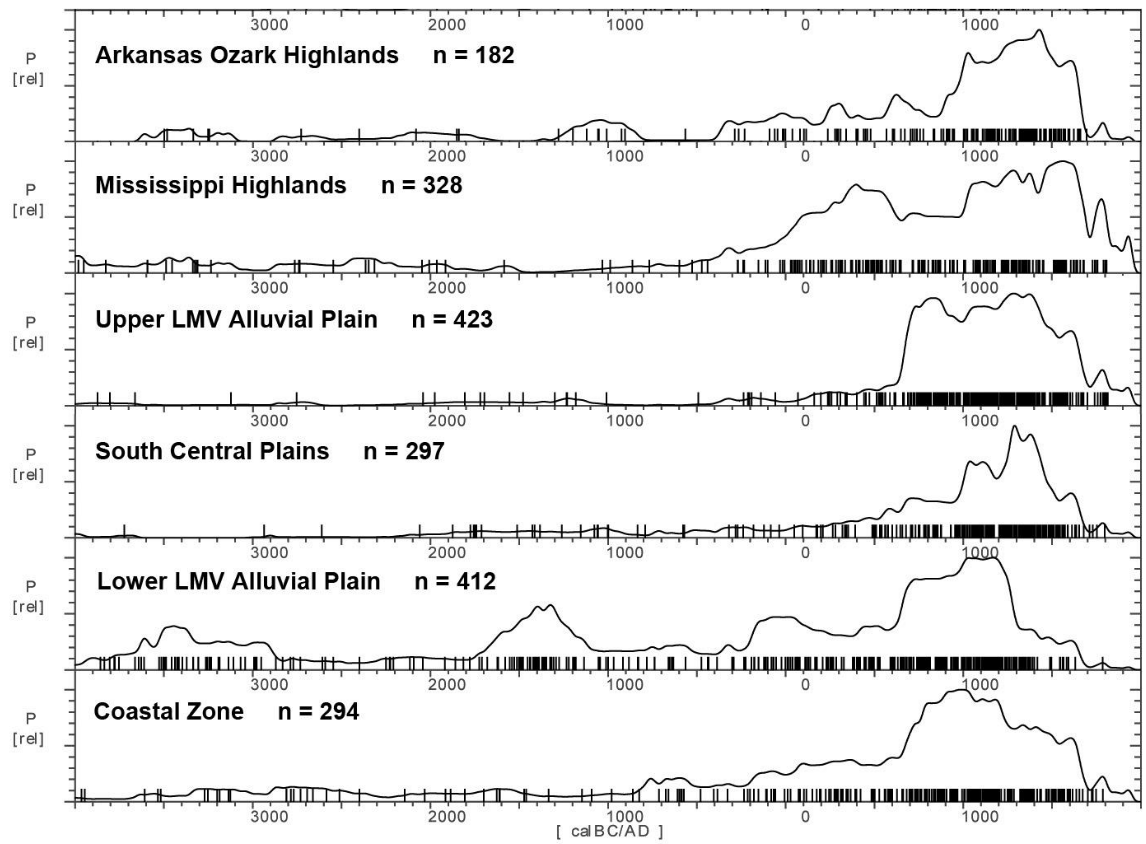

Figure 3.3. SPD curves generated by eco-region for the past 6,000 years.

populations, there was considerable variability in the timing of these events, with some regions showing little evidence of widespread abandonment. The eco-regions that show evidence of dramatic declines in population around the period of AD 1300–1400 are the Upper and Lower LMV Alluvial Plain regions and South Central Plains. The Coastal Zone shows a short-lived decline from AD 1200–1300, but after this time population decline was much more gradual, with an abrupt decline not occurring until AD 1600. The two remaining eco-regions, the Arkansas Ozark Highlands and the Mississippi Highlands, while showing some periods of short-lived decline, maintained relatively high populations throughout the period of AD 1000–1600.

Elevational Change in Settlement

Analysis of elevational change in settlement reveals several periods of settlement shifts among different elevational zones (Figure 3.4). Data from Arkansas and Mississippi reveal similar trends, where the occupation of more upland regions during the Middle Archaic period (6000–3000 BC) begins to shift to more lowland environments around 2500 BC. This trend continues in both regions until around 1000 BC. In both cases, however, the data demonstrate that the Late Archaic represents a period of increasing transition to lowland environments for this region. Most of the state of Louisiana lies at low elevations, thus little variation in settlement shifts among elevational zones is expected, although a slight increase in the elevation of settlements is seen in Louisiana at the end of the Late Archaic when populations are shifting to more lowland areas in Arkansas and Mississippi. Louisiana site locations from which radiocarbon dates are available range in elevation from 2–116 m AMSL; however, 662 of the 791 dates (84%) from Louisiana are from sites situated between only 2–30 m AMSL. For comparative purposes, elevations of sites from Arkansas range from 20–488 m AMSL while those from Mississippi range from 3–140 m AMSL. Elevational ranges for each of the three states are 17–823 m AMSL for Arkansas, 0–246 m AMSL for Mississippi, and 0–163 m AMSL for Louisiana.

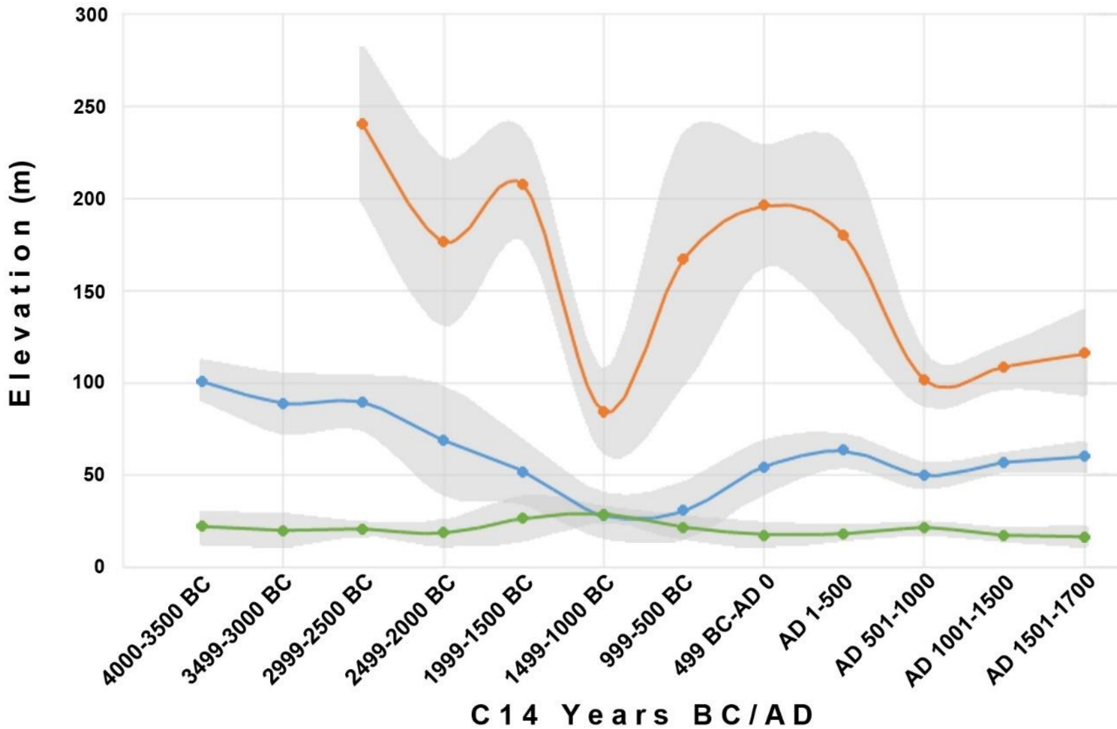

Figure 3.4. Curves showing elevational shifts in settlement through time. Elevation values represent the average elevation of radiocarbon dates based on the site locations in Arkansas (orange line), Mississippi (blue line), and Louisiana (green line) from which they were obtained, which was calculated for each period shown along the X-axis. Gray shaded areas represent the 95% confidence interval.

In Arkansas and Mississippi, the Woodland period (1000 BC–AD 1000) is characterized by a reversal of the lowland settlement trend of the preceding Late Archaic period; however, the average elevation of Woodland settlements would not reach the extremes seen during the Middle Archaic period in either Arkansas or Mississippi, suggesting a dispersed settlement pattern where groups exploited a variety of elevational zones but maintained a focus on lower elevational regions. The Woodland shift to more upland environments would be relatively short-lived, however, as a downslope trend beginning during the Middle Woodland continued in Arkansas and Mississippi until AD 1000. At that time, there was a slight and gradual upslope trend, which continued for 700 years. Little elevational change is seen in the Louisiana data, although a slight increase is again evident at the point at which populations in Arkansas and Mississippi were experiencing the AD 1000 shift towards lower elevations.

Discussion

Population Decline during the Late Archaic

Kidder's (2006) research in the Tensas Basin of northeast Louisiana, which is located within the Lower LMV Alluvial Basin eco-region discussed here, provided evidence for regional population decline at the end of the Late Archaic period. This period of demographic change was attributed to climatic and environmental changes associated with increased rainfall and flooding in the basin. While no evidence is provided by the current study that populations in the Lower LMV Alluvial Basin experienced widespread decline at the end of the Late Archaic, these conflicting results are likely a product of the differing scales of analysis represented by the two studies. Kidder's research area represents a relatively small area that could have experienced a period of abandonment while parts of the larger surrounding Lower LMV Alluvial Basin region did not. Based on the SPD curve for the Lower LMV Alluvial Basin, however, the conditions present in the portion of the Tensas Basin investigated by Kidder were not characteristic of the larger Lower LMV Alluvial Basin as population levels appear to have been relatively high within the region. Kidder (2006:221) acknowledges, however, that his study reveals only "abandonment of parts of the basin." Variance in the results of the two studies demonstrates the importance of "careful analysis of the relationship between changes in climate, environment, and culture at different temporal and spatial scales" that Kidder (2006:221) called for.

While the demographic models do not support widespread abandonment of the region at the end of the Late Archaic, the elevational shift from lowland to upland environments that began at the end of the Late Archaic does provide evidence for the abandonment of lower elevation environments. The shift to lowland environments that began around 5000–4500 BC ended abruptly around 1000 BC, at which time populations began to disperse back into upland environments (Figure 3.4). The elevation shifts in settlement shown in Figure 3.4 correspond well with fluctuations in solar output for the period of 6000–3000 years BP (4000–1000 BC) (Perry and Hsu 2000). The period of elevational decline in settlement from 6000–3000 years BP (4000–1000 BC) aligns with a period of increased solar output with ca. 3500 years BP (1500 BC) representing the period's highest peak (Perry and Hsu 2000: Figure 2). Following 3000 years BP (1000 BC), however, a trend of decreasing solar output would continue until a relatively short-lived increase from ca. 1500–1000 years BP (AD 500–1000). This evidence supports the position that incidences of regional population decline seen in some areas of the Mississippi River valley near the end of the Late Archaic represent settlement reorganization and that increasingly cooler and wetter conditions may be inferred as the cause of those movements. As discussed above, these conditions would have made lowland environments less hospitable while having the opposite effect on upland environments.

Population Decline during the Late Prehistoric (AD 1300–1500)

The evidence demonstrates that the concentration of populations in lowland environments that occurred throughout the Late Archaic period ended ca. 1000 BC. From this point until the end of the Middle Woodland period (ca. AD 500), a trend of expansion back into upland environments persisted. The subsequent shift from upland to lowland environments that characterized the period of AD 500–1000 reveals this as a time when conditions were pushing populations back to more lowland environments. The Late Woodland/Early Mississippi period trend towards more lowland environments was relatively short lived, however, as populations began to expand back into higher elevations.

While the evidence presented here reveals the period of AD 1000–1300 as a time of relatively stable, though slightly declining, population levels in the lower Mississippi Valley, evidence for the post-AD 1300 period reveals widespread episodes of regional population decline characterized by considerable spatial and temporal variation. Widespread collapse in native populations of eastern North America as the result of exposure to European disease is a well-established trademark of the post-AD 1540 period (Blakely and Detweiler-Blakely 1989; Ethridge and Hudson 2008; Larsen 1994; Milner 1980; Ramenofsky 2003). However, the occurrence of such widespread fluctuations in regional populations prior to this period suggests important changes that were the result of endemic conditions. While the role of endemic disease cannot be ruled out, the lack of evidence for such a scenario suggests other explanations. As discussed above, the eco-regions that appear to have experienced significant population decline during the period in question include the more lowland regions of the Upper and Lower LMV Alluvial

Plain and South Central Plains, while the upland regions (Arkansas Ozark Highlands and Mississippi Highlands) show little evidence for significant population decline. This scenario suggests that settlement pattern change tied to elevation shifts in settlement locations figures prominently in explanations of regional abandonment as populations shifted from lowland to upland regions.

Meeks and Anderson's (2013) research on water availability based on tree-ring reconstructions from the midcontinent identified ca. AD 1300–1500 as a time of increasing food stress that resulted from periods of extended drought, which the authors associated with population decline in the Mississippi, Ohio, Tennessee, and Cumberland River valleys. In the lower Mississippi Valley, however, the expansion into more upland areas during the post-AD 1000 period provides evidence that drought conditions did not prevail in the lower Mississippi Valley during the period associated with the Vacant Quarter phenomenon. While drought may not have characterized the period of AD 1300–1500 in the study area, the shift from upland to lowland environments during the Late Woodland period suggests that drier conditions may have persisted in the region during this time. The return of wetter conditions that is suggested by the elevational shift back to upland environments throughout the Mississippi period is further supported by research from the Mississippi Highlands eco-region, where a settlement pattern shift around AD 1200 is attributed to increasing precipitation during this period (Peacock and Gerber 2008; Rafferty 2002; Rafferty and Peacock 2008; Schmitz et al. 2003). The settlement history at Lyon's Bluff, a Mississippian mound and village site located in the Mississippi Highlands eco-region, also provides evidence that this region did not experience the kind of disruptions seen in many surrounding regions, as a continuous occupation occurred at the site from ca. AD 1200 until at least the mid- to late seventeenth century (Peacock and Hogue 2005). If the study area did experience wetter conditions after AD 1000, they likely made the cultivation of maize in the floodplain environments of lower elevation regions such as the lower Mississippi River alluvial basin an increasingly unreliable settlement-subsistence strategy, as major flooding episodes increased.

Research into the relationship between maize agriculture and population growth in the central and lower Mississippi Valley revealed that the period of peak maize production from ca. AD 1000–1300 was followed by a dramatic decline in maize production (Alvey 2019). Such a decline in production following a period of increasing reliance on maize agriculture supports the idea of an increasingly unstable subsistence strategy and aligns with Rindos' (1984:172) characterization of agriculture as "globally persistent but locally unstable." The decline of population levels in the Mississippi Valley during the AD 1300–1550 period supports a hypothesis featuring the instability of an agricultural system built on the reliance of a single domesticate of tropical origins caught in the deteriorating conditions of the Little Ice Age from 720–140 years BP (AD 1280–1860) (Perry and Hsu 2000).

Whether the effects of wetter conditions in floodplain environments or increasingly colder temperatures, or a combination of both, are to blame for the decreasing reliance on maize agriculture during the post-AD 1300 period, the evidence demonstrates that settlement reorganization where populations abandoned the lower floodplain regions for more upland environments plays a significant role in explanations of the Vacant Quarter phenomenon.

Conclusions

This study provides evidence that supports previous findings that the ends of the Late Archaic and Mississippi periods were times of climatic and environmental change that resulted in major demographic shifts among prehistoric groups. Although previously identified, the scope of these episodes, how they varied regionally, and whether they represented settlement reorganization or population decline in the sense of mortality rates outpacing birth rates was less clear. The current study has identified considerable regional variation in abandonment episodes during these periods in the lower Mississippi Valley and demonstrated that this variation corresponds to elevation shifts in settlement and the abandonment of lower or higher elevation landscapes, which may be inferred as responses to changing climatic and environmental conditions. The continual movement of groups into lower elevational environments throughout the Late Archaic period represents one of the more profound transformations in settlement reorganization seen during the region's prehistoric period. This shift likely represents a response to xeric conditions that pushed human groups into more productive and reliable lowland environments, although further paleo-environmental studies testing this hypothesis are needed.

Whereas the Early to Middle Woodland period would be characterized by populations shifting back into more upland environments, this trend would be relatively short lived, as another elevational decline in settlement locations would characterize the Late Woodland, suggesting a return to drier conditions. This decline, however, would be far shorter than the Late Archaic decline, and after AD 1000, prehistoric settlement would embark on a period of continual, though modest, expansion back into upland environments. The timing of this expansion in relation to the Vacant Quarter phenomenon does not support the idea that drought conditions were driving the episodes of regional abandonment in the lower Mississippi Valley after AD 1300 as identified in other regions by Meeks and Anderson (2013). The evidence for a shift from lowland to upland environments in the study area after AD 1000, and evidence for dramatic declines in both maize production and population levels after AD 1300, support a hypothesis that the climatic and environmental conditions that once supported the cultivation of maize in floodplain environments were deteriorating. Whether more frequent episodes of major flooding in lowland environments, or colder conditions brought on by the Little Ice Age, or some combination of these conditions, are to be implicated for the changes in subsistence and demography that characterize the post-AD 1300 period remains unclear.

Further research along a number of lines is critically important for further clarification of this issue. As has been often acknowledged, high-resolution climatic and environmental proxies for the lower Mississippi Valley are needed (Kidder 2006; Meeks and Anderson 2013; Peacock 2008), as are more substantive programs for the recovery of paleobotanical remains that employ more rigorous methods for the recovery and identification of both pollen and phytolith remains from food plants. As outlined previously (Alvey 2019), more systematic programs for the recovery and identification of plant remains intended for radiocarbon dating is critically important for constructing better models that reveal changes in the frequency distributions of different plant foods through time. However, any improvements in our ability to explain the kinds of regional-scale phenomena discussed here will be limited until archaeologists better recognize the importance of scale in archaeological phenomena (Lock and Molyneaux 2006), the need for multi-scalar analyses, and the methodological and theoretical demands of such approaches.

Chapter 4

The Problem of Undersampling for Models of Archaeological Occupations Derived from Shovel Testing and Its Consequences for Significance Determinations

Introduction

The generation of high quality research in cultural resource management (CRM) has demonstrated itself to be an enduring problem for the field and provides a constant challenge for its practitioners (King 2005; Peacock and Rafferty 2007; Willems and van den Dries 2007). The fluid environment of shifting archaeological values, and the continual generation of massive and variable quantities of data, contribute to the challenges faced by CRM archaeologists and have insured that the necessity of assigning significance to cultural resources will remain one of the field's more elusive challenges (Altschul 2005; Butler 1987; Dunnell 1982; Lynott 1980; McManamon 1990; Morton 2014; Raab and Klinger 1977, 1979; Sharrock and Grayson 1979; Tainter 1979). In addition to the challenges presented by significance determination, however, the pursuit of significance has promoted a broader appreciation for what is important in prehistory or history. As Goodyear et al. (1978:159) effectively summarized, this pursuit has contributed much to archaeology "by stimulating archaeologists to probe the resource base in new and explicit ways for all possible dimensions of significance."

As compliance-driven survey during the past 50 years has led to the discovery of tens of thousands of archaeological sites, followed by more intensive investigations of a subset of these sites during Phase II and III investigations, CRM research has revealed the tremendous variation in material culture present in the archaeological record, how this variation is distributed through space and time, and, though less successfully, the many "dimensions of significance" represented within this variation. In short, archaeology has to a great extent been unburdened by the overconfident fallacy that what one cannot recognize does not exist. The expansive prehistoric occupational variation revealed by CRM-driven investigations has found its way into regional settlement-subsistence models where it has provided important corrections to models biased by decades of investigation into large, artifact-rich sites with prominent earthworks that ultimately represent the loci of specialized activities that were part of a settlement pattern unique to a particular place and time (e.g., Bareis and Porter 1984; Jenkins and Krause 1986; O'Brien et al. 1982; Rafferty and Peacock 2008; Wood et al. 1986).

Within the three phases of cultural resources investigation, Phase I is generally characterized as the phase of site identification, whereas Phase II represents efforts to determine the significance of sites whose eligibility for the National Register of Historic Places (NRHP) could not be determined during Phase I investigations. However, these common phase designations provide misleading characterizations of how and when the determination of site significance most often occurs. Although Phase II is treated as the phase during which significance is determined, the reality is that most significance determinations are made during Phase I, when most of the dozens or even hundreds of archaeological sites that may be identified during a particular survey are written off as insignificant and thus ineligible for the NRHP and unworthy of further study. Only a relatively small fraction of the thousands of sites identified by archaeologists working in CRM each year reach Phase II testing, as most determinations are made based on site information gleaned during Phase I. Since the fate of our nation's cultural resources is being primarily determined by Phase I investigations, it is imperative that greater attention be paid to how we engage the archaeological record during this first phase, and whether the methods we employ at this stage enable us to successfully identify the dimensions of site significance that purportedly are used to advance sites into the subsequent phases of more intensive investigation.

In the hopes of improving the quality of Phase I investigations, the following study provides an assessment of methods commonly employed during Phase I by investigators working in the Eastern Woodlands. As a region predominately characterized by forest or pasture environments where ground surface visibility is low, it presents a particular challenge for archaeologists attempting to identify the presence of cultural resources. Much of the early literature on archaeological survey emphasized the role of "fieldwalking" (Banning 2002) because of its focus on regions characterized by high ground visibility such as the Middle East (Adams 1965; Adams and Nissen 1972), the American Southwest (Gumerman and Euler 1976; Plog et al. 1978), or within alluvial regions such as the Mississippi River Valley (Phillips et al. 1951; Phillips 1970), where annual agricultural plowing continually provided for exposed ground surfaces. Confronted with the task of identifying previously unrecorded archaeological sites within heavily vegetated regions, archaeologists in eastern North America have adapted sampling strategies devised for regions of high ground visibility to accommodate surveying in forest and pasture environments. Although methods such as fieldwalking, in addition to archival research, remote sensing, and predictive modeling, can be employed in the identification of archaeological site locations, shovel testing continues to serve as the principal method of site identification and investigation in Phase I cultural resources survey. Although the “site” concept is problematic (see Dunnell 1971, 1992), its ubiquity in archaeology, and especially its role as a management unit within CRM, the concept is used here where it is meant to refer to an archaeological locus that comprises one or more archaeological occupations. A definition of ”occupation” is provided below.

Archaeologists have long recognized the need for assessing the reliability of shovel testing as a method for site discovery and have examined how the variables of site size, artifact density, survey intensity and screening versus non-screening of shovel test (ST) fill affects the success of artifact recovery and site detection (Kintigh 1988; Krakker et al. 1983; Lightfoot 1986; Lynch 1980, 1981; McManamon 1984; Nance and Ball 1986, 1989; Peacock 1996; Plog et al. 1978; Schiffer et al. 1978; Shott 1985, 1989; Stone 1981). These kinds of studies provide important insights into the effectiveness of shovel testing, but more information is needed, as site discovery represents only one of several goals that must be accomplished to insure a successful Phase I survey, which do not conclude once all archaeological sites within an area of potential effect have been located.

Discovering a site and determining its location are the first steps of Phase I fieldwork, but this stage is immediately followed by more intensive site investigation once sites are discovered (Table 1). This is often accomplished by increasing shovel testing intensity through the reduction of shovel-test intervals. The goals of this second stage of Phase I fieldwork are to delineate site boundaries, recover an assemblage of artifacts that is sufficiently large to represent the characteristics of a site’s occupation(s) (e.g., function, duration, intensity, etc.), probe for evidence of sub-surface features, and assess the depositional integrity of the site. Unlike sampling strategies used to discover site locations, strategies used in the investigation of sites during Phase I survey have received considerably less critical attention. This represents an important omission, as the results of Phase I site investigation ultimately determine whether a site is preserved and subjected to further study or whether it will be destroyed. Of equal importance is the fact that for sites that have been found ineligible for inclusion on the NRHP after Phase I investigations, the results of these investigations likely represent all we will ever know about these sites.

Table 1. The purpose, methods, and technical goals for the two stages of shovel-test survey.

	Stage I	**Stage II**
Purpose	Site discovery	Site delineation/investigation
Methods	Shovel testing on a 30-m grid	Reduce shovel test interval and delineate site on cruciform or grid pattern
Technical goals	Identify sites through the detection of artifacts/features	Plot the extent of artifact distribution. Recover artifact assemblage sufficiently large to represent site’s occupational attributes. Probe for evidence of sub-surface features. Record soil profiles to assess site’s depositional integrity.

Sampling in Phase I Investigations

The purpose of archaeological fieldwork is “to discover the kinds and the frequency of target populations of data that exist within a given research area” (Mueller 1975:34). Central to this endeavor is the technique of sampling (Binford 1964; Plog 1976; Redman 1974; Vescelius 1960), which is generally defined as “a tool to aid the archaeologist in selecting units of investigation and in generalizing to larger entities” (Mueller 1975:ix). Whether explicitly acknowledged or not, sampling has long served as a central pillar of archaeological investigations, and the importance of developing a rigorous sampling design tailored to the needs of particular research questions is now widely recognized by archaeologists; however, assessments of how particular sampling designs may influence the patterns revealed from the sample data are lacking (but see Hole 1980; Plog 1976; Redman 1974).

Schiffer et al.'s (1978:2) definition of sampling as "the application of a set of techniques for varying the discovery probabilities of archaeological materials in order to estimate parameters of the regional archaeological record" emphasizes the central role probability theory has played in archaeological sampling. It is important to recognize that when discussing the goals of such methods in the context of archaeological survey, the emphasis is inevitably placed on techniques for estimating parameters that exist on a regional scale (e.g., number of sites within some area of interest); however, the principles of sampling are scale-free and are just as applicable at the scale of occupation or site. The development and assessment of sampling strategies in archaeology has relied heavily on simplistic probability models drawn from classical probability theory (e.g., Cochran 1963), which have focused on the unbiased estimation of simple parameters such as means and variances. Such measures alone, however, are often insufficient to answer many archaeological research questions or to assess the significance of archaeological resources in light of the National Register criteria for evaluation. It has long been recognized that probabilistic sampling techniques are inadequate for accomplishing a number of important goals in archaeological investigation, such as locating rare elements of the archaeological record, or those organized in clustered distributions, or revealing continuous spatial patterns in artifact distributions (O'Neil 1993; Redman 1987; Schiffer et al. 1978). When considering the requirements of site investigation during Phase I or II, one could argue that the accomplishment of these three goals are as critical as any to the process of significance determination, no matter what theoretical stance may be driving any particular significance assessment.

Locating Rare Elements

Archaeological values are evident in the kinds of research questions we ask and the frequency with which we ask them. Those questions that deal with the origins of some novel cultural behavior or event in a particular region tend to represent some of archaeology's most commonly asked questions. Consider the value we attribute to questions such as when ceramic technology, agriculture, or sedentariness first appeared in a region or when a region or continent was first populated. To answer such questions effectively, we must be able to identify rare elements of the archaeological record, given that the first appearance of some cultural feature is by definition a low-frequency phenomenon. Consideration of the efficacy of our sampling strategies for identifying such rare elements should thus be of primary concern.

Locating Clustered Distributions

Material culture in archaeological contexts is not randomly distributed but tends to cluster within areas where human behaviors were focused and sustained for extended periods. The potential of some sampling strategies to fail in locating such clusters of artifacts and features is an important problem. Considering that the explicit goal of Phase I survey is to identify the locations of archaeological sites and assess their internal structure (i.e., clustered distributions of artifacts and features), the importance of assessing methods used during Phase I to accomplish these tasks becomes evident.

Revealing Spatial Patterns

An essential component of any archaeological investigation includes characterizing the spatial distributions of cultural materials that comprise some archaeological locus. Archaeologists (Dunnell and Dancey 1983; Foley 1981a, 1981b; Thomas 1985) recognize that the archaeological record is continuous across geographic space, varying only in the density of its occurrence, and it is essentially the spatial pattern of cultural materials that determines the physical dimensions of archaeological sites. Identifying the spatial pattern of cultural materials is important for a number of reasons, including the need to identify the full spatial extent of the “population of interest,” as represented by the distribution of cultural materials under investigation. Additionally, there is the practical need of accurately defining an archaeological site’s boundary so that cultural resource managers can insure that future ground-disturbing activities avoid the location. Sampling strategies should therefore be assessed in terms of their success in revealing such patterns, or whether the act of sampling the record introduces discontinuities that distort our perception of the site’s spatial dimensions.

Sample Size and Measures of Richness

In addition to the importance attributed to identifying rare elements in the archaeological record, measures of artifact and feature richness are also of paramount importance in the context of significance determinations. In general, one could argue that there is no measure more closely associated with the determination of site significance than the richness of artifact and feature types identified during Phase I and II investigations. Consider the archaeological phenomenon commonly referred to as a "lithic scatter," which represents one of the most commonly disregarded elements of the archaeological record and is routinely assessed as ineligible for inclusion on the NRHP (Cain 2012). The disregard of such resources is strongly tied to the fact that such a phenomenon represents the lowest order of richness, as the designation implies the presence of only one type of artifact, lithic debitage. Conversely, sites from which dozens of different kinds of artifacts and features are identified are almost universally agreed upon as sites of great significance, and it is not uncommon to see such sites recommended as eligible for the NRHP during Phase I. A number of problems result from the use of richness in this manner, not the least of which is the failure to appreciate that differences in site characteristics, such as artifact type richness, often derive from the different roles that certain locales played within regional settlement patterns, and that the disregard of any aspect of those patterns prevents us from accurately modeling settlement organization (Alvey 2005; Cain 2012; Manning and Peacock 2008; Morton 2014; Peacock and Manning 2008; Peacock et al. 2008a, 2008b).

An additional problem, and one that is especially pertinent to the current study, is the degree to which artifact or feature richness varies as a function of sample size (Jones et al. 1983, Kintigh 1984, 1989; Rhode 1988). While much fault can be found in the ways that measures of richness are often employed in significance determinations, such measures are of great importance and utility. For these measures to be profitably used, however, we must consider whether the richness revealed within any particular assemblage reflects the reality of the occupation(s) or is simply a product of undersampling. Consider again the many designations of archaeological sites as lithic scatters that fill the state databases. How many of these characterizations are simply products of undersampling that have managed to capture only one artifact type because it represents the only type that occurs in high frequency? If sample size can affect such important determinants of significance, and if our determinations derive from samples of archaeological occupations, then understanding the effects of particular sampling strategies on measures of richness is of paramount importance.

Assessing the Construction of Occupational Models used in CRM

Producing answers to archaeological questions, especially those related to significance determinations, require measuring relevant variables of archaeological occupations such as their occupational function, intensity, and duration (both relative and absolute). Following Dunnell's (1971:151) definition, an occupation is treated here as a "spatial cluster of discrete objects which can reasonably be assumed to be the product of a single group of people at a particular locality deposited over a period of continuous residence comparable to other such units in the same study." An important point is that these units are based on historical connections between deposition events and not solely on spatial proximity (Dunnell 1992). However, factors such as preservation and sampling biases, and the fact that in most studies only a small portion of a site is excavated, make it improbable that the entire "cluster of discrete objects" associated with an occupation will be recovered. Thus, only a sample of the occupation contributes to the construction of occupational models. Despite this incompleteness, however, occupational models operate as central analytical units in archaeological studies as they serve to represent the spatial, temporal, and formal dimensions of some archaeological locus. As part of the Section 106 compliance process, Phase I cultural resource surveys employ various kinds of sampling strategies to identify and investigate cultural resources within an area of potential effect. These efforts are undertaken for the ultimate purpose of assessing the significance of those resources in light of the National Register of Historic Places criteria for evaluation. Although criteria A, B, C, and D may all be relevant to the evaluation of archaeological sites, it is criterion D that is most often cited when arguing for the eligibility of archaeological occupations or sites. Criterion D refers to sites "that have yielded or may be likely to yield, information important in history or prehistory." Unlike architectural resources, for example, much of what makes an archaeological site significant is buried within the soil and effectively hidden from the researcher. Only through the use of subsurface sampling methods can archaeologists working in regions of dense vegetation recover the information needed to determine whether a site is likely to yield information important to a region's history or prehistory.

Shovel testing is routinely employed in areas of dense ground vegetation as a method for site discovery and delineation, and as a means of collecting information on the kinds and numbers of artifacts and features present at a site; however, the details of how shovel testing is employed for these purposes varies from state to state. For example, state guidelines vary in their requirements for spacing between STs and transects, the horizontal and vertical dimensions of STs, or how shovel testing should vary for the purposes of site discovery versus site investigation/delineation. Shovel-testing strategies as developed in state guidelines are critically important in cultural resource management as they affect not only success in the discovery of previously uninvestigated resources, but ultimately determine our perceptions of sites and their attributes, and our resulting determinations of significance. Despite this importance, little research has focused on the processes involved in constructing occupational models during Phase I investigations or assessments of whether the resulting models effectively serve the purposes for which they were constructed.

The current study provides an assessment of standard practice in Mississippi for delineating and investigating sites during Phase I survey as set forth in the Mississippi SHPO's *Guidelines for Archaeological Investigations and Reports in Mississippi* (Sims 2001). This study assesses whether methods commonly employed during Phase I investigations are inadequate in the sense that they promote undersampling — a problem that could lead to faulty occupational models that poorly represent the occupation(s) under investigation. The Mississippi guidelines state that "When a positive shovel test is excavated, the testing interval should be reduced to 5 to 10 m with shovel testing continuing in a cruciform or grid pattern until two consecutive negative tests are encountered" (Sims 2001:13). Positive or negative shovel tests refer to those from which artifacts were or were not recovered, respectively.

Although this guideline allows for shovel testing on either a cruciform or grid pattern, consultants predominately adopt the cruciform pattern, as this strategy requires considerably less time than shovel testing on a grid pattern. This is an important point considering that consultants must operate within a competitive-bid environment, which rewards strategies that reduce costs and make organizations more competitive in the marketplace. Sampling strategies at the Phase I level should serve to accurately delineate a site's artifact distributions, assess for the presence of subsurface features, and lead to the recovery of an artifact assemblage that effectively represents the occupation(s) present at a site. Evaluating the success of various strategies for accomplishing these tasks is the ultimate goal of this paper.

Study Area

All of the sites included in this investigation are located in Mississippi within the state's central hill-belt regions (Figure 4.1), and all appear to represent non-mound habitation sites. The sites from Chickasaw (designated 22CSXXX), Franklin (designated 22FRXXX), Jefferson (designated 22JDXXX), and Smith counties (designated 22SMXXX) were recorded in 2018 during cultural resources survey on national forests in Mississippi conducted by researchers from the Cobb Institute of Archaeology, Mississippi State University, under contract with the U.S. Forest Service. All remaining sites were recorded during the 2014 and 2016 survey field schools sponsored by the Department of Anthropology and Middle Eastern Cultures, Mississippi State University, which were taught in the central and upper portions of the Big Black River valley.

The sites located in the national forests were chosen for use in the current study because of a recent shift in required field methods, where site delineation on a cruciform pattern has been abandoned and delineation on 5-m or 10-m grid is now required. This provided the opportunity to compare the results of site delineation on a 5-m or 10-m grid with the results that would have come from the use of a cruciform pattern. The sites from the Big Black River valley were investigated for the explicit purpose of employing multiple sampling strategies to assess the differences that resulted in the effects on

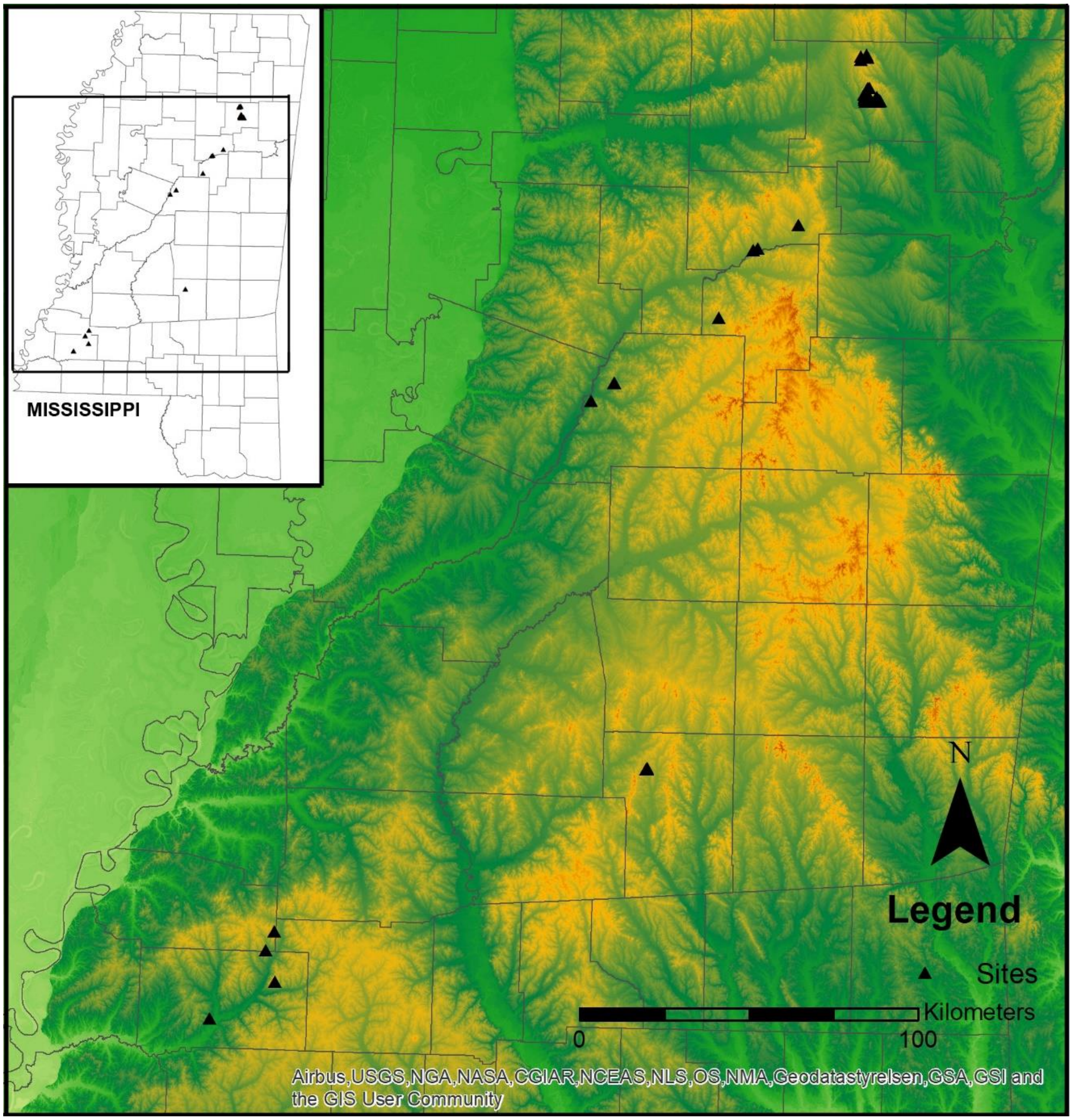

Figure 4.1. Map showing the locations of 44 study sites.

measures such as site size or artifact type richness and were investigated as they were encountered by the field schools.

The occupations represented among these 44 sites date predominately to the Woodland Period (500 BC–AD 1000), although a few sites contain occupations from the preceding and following periods. Settlement in the region during the Woodland Period is generally characterized by a dispersed settlement pattern where habitation sites occupied a variety of different elevational environments (Jackson et al. 2002; Johnson 1988; Peacock 1997; Rafferty 1994, 2002; Rafferty and Starr 1986). This is in contrast to the following Mississippi Period, when settlements became more nucleated in lower elevational environments, such as first terraces along the major stream or river bottoms. Sites associated with the Woodland Period often represent relatively small, short-duration occupations with relatively light artifact/feature density when compared to later Mississippian occupations. As a result of these attributes, sites such as these are at the greatest risk of being mischaracterized by undersampling and disregarded in the context of significance assessments.

Materials and Methods

Because of a desire for this study to inform on how shovel-testing strategies affect site delineation and investigation during Phase I survey, consideration is given only to the results of shovel testing, with no consideration given to the presence of surface-collected artifacts. As presented below, comparative analyses were conducted to monitor the effects of changes in ST parameters in three dimensions: 1) distance between STs; 2) size of STs; and 3) placement of STs (i.e., cruciform pattern vs. grid pattern) (Figure 4.2). In all instances, STs were excavated to the depth that clay subsoil was encountered, and all ST fill was screened through 1/4" wire-mesh hardware cloth for the recovery of artifacts. In most instances, STs were 30 cm in diameter, although this was varied in one of the sampling stages discussed below, where 50 x 50 cm shovel test pits (STPs) were employed. Transects that were established on either cruciform or grid patterns were

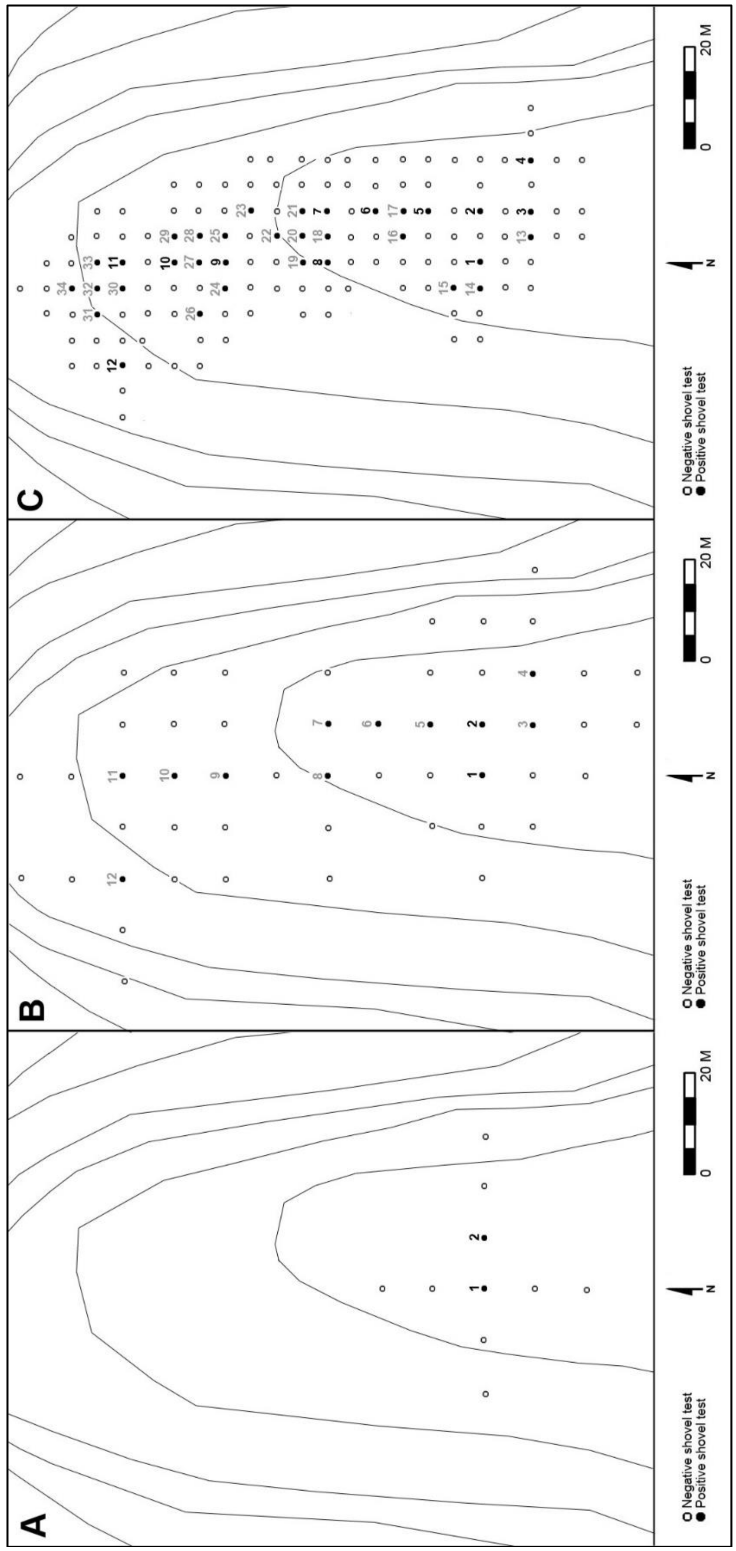

Figure 4.2. Contour maps showing the excavation of shovel tests on a 10-m cruciform (A), 10-m grid (B), and 5-m grid (C) at site 22SM1436 to illustrate how shovel test patterning differs between each strategy. Gray numbers represent positive shovel tests that resulted from a change in shovel test patterning from the previous stage.

oriented according to the cardinal directions or according to the orientation of the landform if it was not oriented along a north-south or east-west axis. Testing on a cruciform pattern involved using the original positive ST as the point from which all subsequent tests were established, whereas testing on a grid differed in that STs were dug in the cardinal directions or landform direction from all positive STs, rather than just the original positive ST. The extent of artifact distributions (site size) for both cruciform and grid patterns was determined by excavating STs along all transects until two consecutive negative tests were excavated in each direction or until the edge of a landform was reached, which is defined as any change in the slope of the ground surface that exceeded 15%.

Three studies were undertaken to assess how changes in sampling parameters affected the variables of site size, artifact count, artifact-type richness, occupational duration, and occupational function for 44 sites. The first analysis involved the study of 30 sites to assess how the delineation of sites on a cruciform (with 10-m spacing between STs) versus a 10-m grid pattern affected the site and occupational variables listed above. The second analysis involved the study of 10 sites where sampling was undertaken on cruciform, 10-m grid, and 5-m grid patterns. The third and final analysis involved the investigation of four sites where not only the pattern of shovel testing, but also the size of STs, varied during the three stages of sampling: 1) Stage I strategy employed the excavation of 30-cm diameter STs on a cruciform pattern with 10-m spacing between each test; 2) Stage II strategy employed shovel testing on a grid pattern with 10-m spacing between all STs and transects (as with Stage I, all STs were 30 cm in diameter); 3) like Stage II, Stage III employed shovel testing on a 10-m grid, however, STPs 50 x 50 cm in size were excavated instead of 30-cm-diameter STs. During Stage III, STPs were placed at the locations of all positive and negative STs established during Stage I and II. Thus, the excavation of STPs involved further excavating the area surrounding the 30-cm STs until a 50 x 50 cm area had been excavated. This also means that, in order to tabulate the numbers of artifacts recovered in the STPs during Stage III, artifact numbers recovered during Stage I and II must be included in this count.

Site Size

Estimates of site size were calculated by multiplying the distance between the northernmost and southernmost positive STs by the distance between the easternmost and westernmost positive STs.

Artifact Count

Artifact counts represent the total sum of artifacts recovered by shovel testing for each phase of sampling. This includes all materials determined to have been manufactured or modified by humans.

Artifact Type Richness

Analysis of artifact samples recovered during shovel testing was meant to identify differences in artifact-type richness, as these differences were used to determine whether the status of occupational function or duration at any given site varied along with changes in sampling parameters. Whereas archaeologists routinely employ numerous criteria for discriminating among different artifact types, the purpose of the analysis reported here was to classify artifacts in such a way that the resulting types would be useful in

Table 4.2. All artifact types defined within the assemblages recovered by shovel testing.

Ceramic	Hafted Bifaces	Lithic debitage	Misc. Stone Tools	Faunal	Floral
Plain claystone-tempered	Benton	Citronelle chert	Sandstone grinding stone	Animal bone	Charred wood
Plain fiber-tempered	Edwards stemmed	Ft. Payne chert	Sandstone pestle	Mussel shell	
Plain grog-tempered	Flint Creek	Kosciusko quartzite	Quartzite hammerstone		
Plain shell-tempered	Little Bear Creek	Catahoula quartzite			
Cord-marked sand-tempered	Madison	Tallahatta quartzite			
Incised claystone-tempered	Collins	Novaculite			
Incised sand-tempered		Quartz			
Fired clay		Sandstone			
		Siltstone			
		Fire-cracked rock			

assessing occupational duration and function for the 44 sites investigated. Table 4.2 provides a list of all 30 artifact types defined for the assemblages recovered from the 44 study sites.

The assessment of duration was accomplished by sorting artifacts according to their chronological usefulness. Applying this criterion could therefore result in instances where objects traditionally considered to be the same kind of artifact (e.g., hafted bifaces) were treated as different artifact types because they were diagnostic of different time periods. For example, a hypothetical artifact assemblage recovered during the first stage of site sampling might be attributed to the Middle Woodland Period based on the kinds of chronologically diagnostic artifacts that were recovered, but after additional phases of sampling, a projectile point dating to the Early Archaic Period might be recovered. In this instance, occupational duration was affected by the recognition of a new occupation as the result of the recovery of a new nonsequential artifact type that was diagnostic of a different period. Duration could also be affected, however, by the recovery of new, sequent artifact types. In these instances, the new artifact type(s) would not suggest the presence of multiple occupations but would expand the temporal duration of a single occupation.

Similarly, different artifact types could be identified according to the uses they served and thus the functional purpose they exhibit. Again, a traditional artifact type such as a hafted biface could be separated into distinct functional types such as spear point, knife, or scraper. It is also important to note the way lithic debitage was treated by this study in terms of its ability to inform on occupational function. While consideration was not given to debitage in terms of its classification within lithic reduction stages, which could inform on differences of occupational function, differences in exotic vs. local raw material was considered when recording the different "types" of lithic debitage that were present in any given assemblage, as the presence or absence of non-local raw materials informs on how that site functioned within regional exchange networks.

Results

Study 1 (10-m Cruciform vs. 10-m Grid)

Results demonstrate that important changes are seen among the measures of site size, artifact count, artifact type richness, and in the effects on occupational duration and function when comparing the differences between sampling on a 10-m cruciform or 10-m grid pattern (Figures 4.3 and 4.4; Table 4.3). With the shift from sampling on a cruciform to a grid, an increase in site size was seen among 24 of the 30 sites (80%), with increases ranging from 0–1200% and an average increase in size of 208% per site. An increase in artifact count was also seen among 26 of the 30 site assemblages (87%), with increases ranging from 0–500% and an average increase of 107% per assemblage. The

Table 4.3. Site data showing changes in site and occupational variables for cruciform and 10-m grid sampling strategies.

Sites	Site Size (sq. m)		Artifact Count		Richness		Was occupational duration affected?	Was occupational function affected?
	Cruciform	10-m grid	Cruciform	10-m grid	Cruciform	10-m grid		
22AT609	600	7800	14	84	3	5	Y	Y
22AT611	2000	2500	31	42	4	4	N	N
22AT618	1600	4500	13	34	3	4	N	N
22CS926	300	2100	12	32	5	7	Y	Y
22CS1006	100	100	7	7	2	2	N	N
22CS1008	100	100	2	3	1	1	N	N
22CS1009	500	3600	29	43	1	3	N	Y
22CS1010	400	4500	12	57	2	4	Y	Y
22CS1213	100	100	27	29	1	1	N	N
22CS1220	1200	1800	19	35	3	4	Y	N
22CS1221	600	900	14	17	4	4	N	N
22CS1229	300	2400	8	24	3	4	N	Y
22CS1234	1200	2000	5	5	1	1	N	N
22CS1235	600	1200	14	20	2	2	N	N
22CS1238	4900	6400	49	107	7	8	N	Y
22CS1241	600	1000	5	12	3	3	N	N
22CS1249	600	600	7	7	4	4	N	N
22CS1250	300	600	6	7	3	3	N	N
22CS1251	300	900	10	12	2	2	N	N
22CS1253	800	1750	29	69	3	4	N	Y
22CS1255	4200	4900	42	114	4	6	N	Y
22CS1257	100	100	6	6	2	2	N	N
22CS1258	200	1200	2	7	2	2	N	N
22CS1260	1500	3500	43	91	3	4	N	Y
22CS1262	1500	2400	15	45	2	3	Y	N
22CS1263	200	300	3	4	2	2	N	N
22CS1265	200	400	6	11	2	2	N	N
22CS1266	200	400	4	7	3	4	N	N
22CS1268	900	900	3	4	2	3	N	Y
22CS1270	5500	13000	33	78	7	13	Y	Y

data also demonstrate that the important measure of artifact type richness was increased in 15 of the 30 assemblages (50%), with increases ranging from 0–85% and an average increase of 29% per assemblage. Changes in the numbers of artifact types had important effects on the occupational duration and function attributed to the study sites. At least one of these variables was affected among 13 of the 30 sites (43%). This includes changes in occupational duration among six sites (20%) and changes in occupational function among 11 sites (37%).

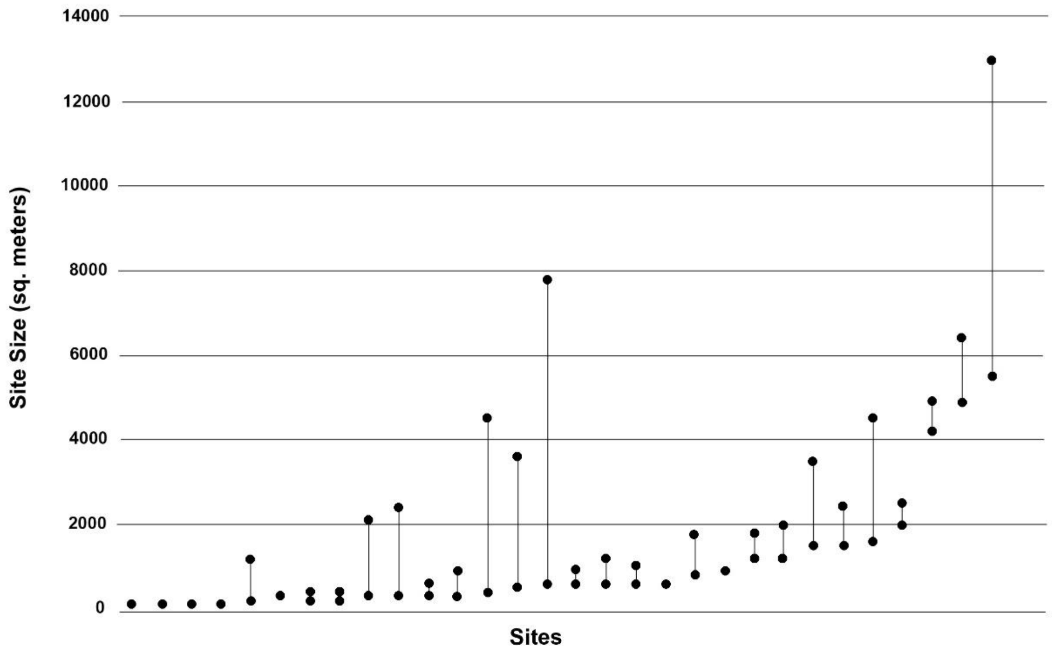

Figure 4.3. Graph of changes in site size when comparing shovel testing on a 10-m cruciform (lower black dot) and 10-m grid (upper black dot) among 30 sites from study 1. Sites represented by single dot experienced no change.

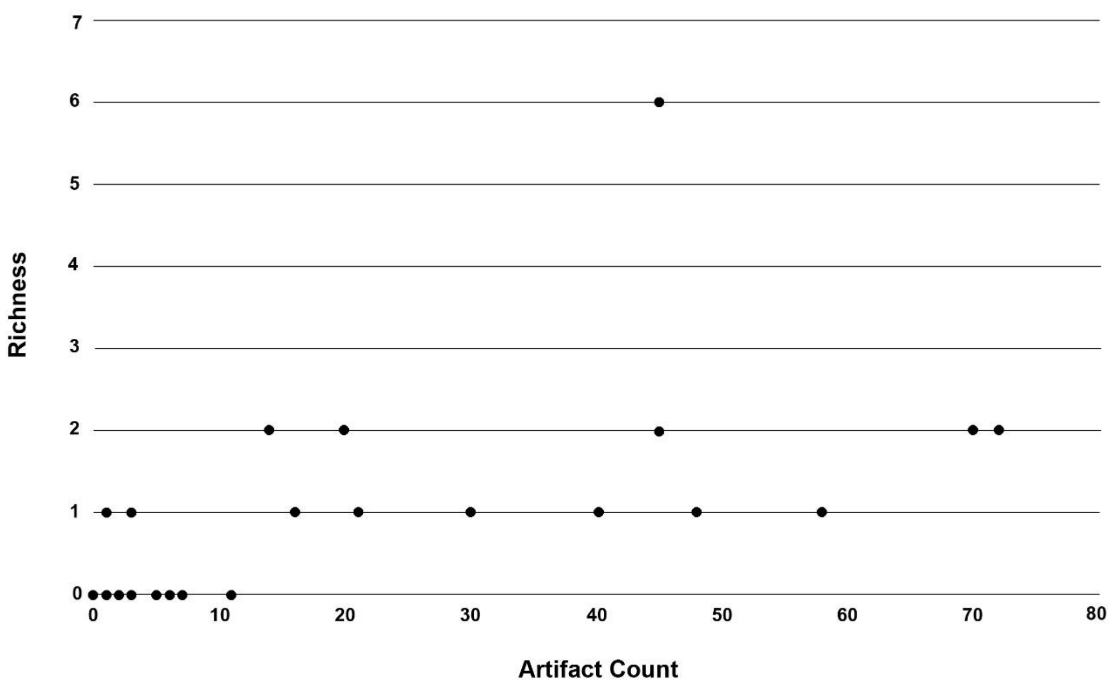

Figure 4.4. Graph of difference values in artifact count and artifact type richness when comparing shovel testing on a 10-m cruciform and 10-m grid among 30 sites from study 1.

Study 2 (10-m Cruciform vs. 10-m Grid vs. 5-m Grid)

The results of Study 2 provide even more dramatic evidence for how changes in sampling parameters can affect inferences of occupational or site attributes (Figures 4.5 and 4.6; Table 4.4). With the shift from sampling on a cruciform to a 10-m grid, an increase in site size was seen among five of the 10 sites (50%), with increases ranging from 0-400% and an average increase in size of 97% per site. Further increases are seen with the transition from a 10-m to a 5-m grid pattern, with increases in site size seen among 10 of the 10 sites (100%) ranging from 100–1167% and an average increase in size of 395% per site.

Table 4.4. Site data showing changes in site and occupational variables for cruciform, 10-m grid, and 5-m grid sampling strategies.

	Site Size (sq. m)			**Artifact Count**			**Richness**			**Was occupational duration affected?**		**Was occupational function affected?**	
Sites	**Cruci-form**	**10-m grid**	**5-m grid**	**Cruci-form**	**10-m grid**	**5-m grid**	**Cruci-form**	**10-m grid**	**5-m grid**	**10-m grid**	**5-m grid**	**10-m grid**	**5-m grid**
22CS919	100	500	4225	7	7	47	1	1	4	N	Y	N	Y
22CS1208	300	400	1375	4	7	22	4	4	6	N	Y	N	N
22CS1212	400	800	1950	11	12	27	2	2	2	N	N	N	N
22FR1505	100	100	300	6	6	66	1	1	3	N	N	N	Y
22FR1781	200	200	1000	8	10	31	1	1	3	N	Y	N	Y
22JE805	100	100	225	2	2	12	1	1	2	N	N	N	Y
22JE808	300	300	3800	22	22	90	2	2	6	N	Y	N	Y
22SM1436	100	3200	3600	13	15	132	1	1	6	N	Y	N	Y
22SM1439	100	400	800	9	15	68	1	3	6	Y	Y	Y	Y
22SM1440	100	100	800	5	5	27	2	2	2	N	N	N	N

Increases in artifact count when transitioning from a cruciform to 10-m grid pattern were also seen among five of the 10 sites (50%), with increases ranging from 0–75% and an average increase of 19% per site. Far more dramatic increases are seen when transitioning from a 10-m to 5-m grid, where increases are once again seen in all 10 assemblages (100%). These increases range from 125–1000% with an average increase of 450% per site. Unlike the results from Study 1, only slight changes were seen in the

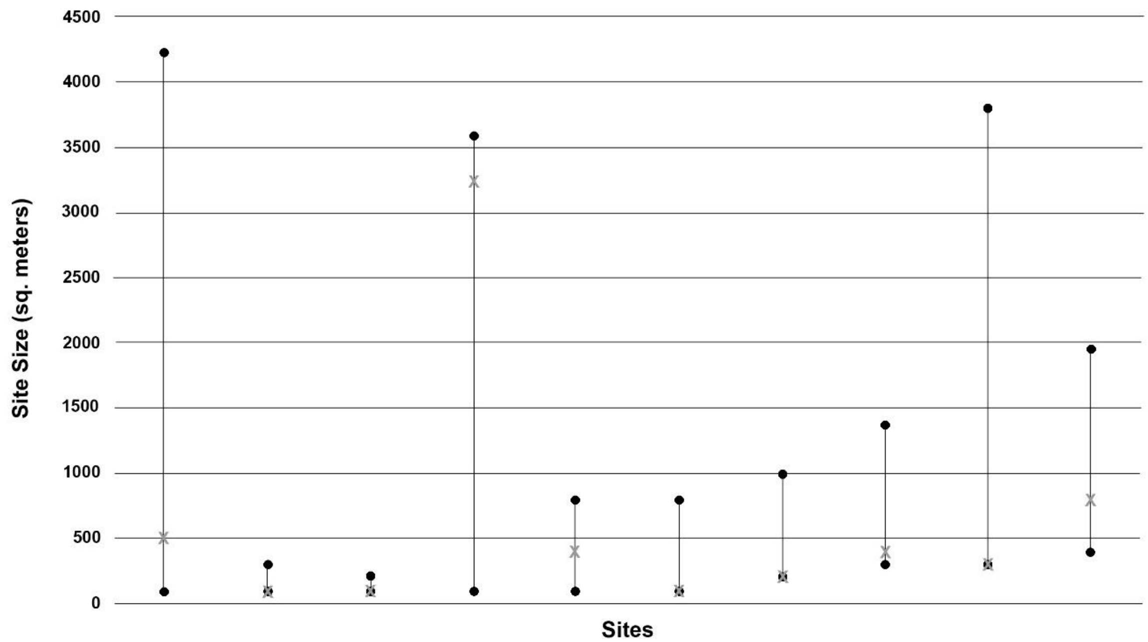

Figure 4.5. Graph of changes in site size when comparing shovel testing on a 10-m cruciform (lower black dot), 10-m grid (gray X), and 5-m grid (upper black dot) among 10 sites from study 2.

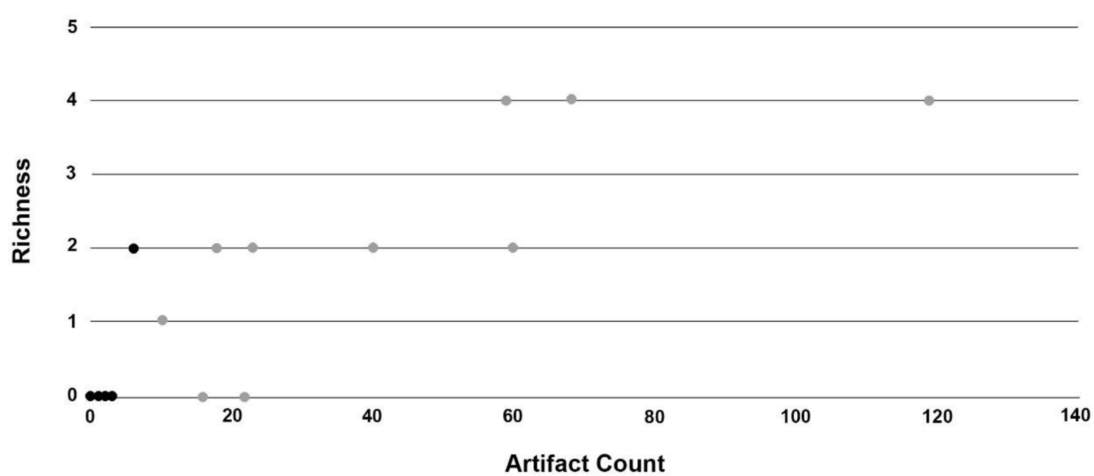

Figure 4.6. Graph of difference values in artifact count and artifact type richness when comparing shovel testing on a 10-m cruciform, 10-m grid, and 5-m grid among 10 sites from study 2. Black dots represent differences between 10-m cruciform and 10-m grid. Gray dots represent differences between 10-m cruciform and 5-m grid.

measure of artifact type richness when transitioning from the cruciform to 10-m grid pattern. Only one of the 10 assemblages (10%) showed evidence of increase as the artifact richness increased from one to three. As with site size and artifact count, however, the results from testing on a 5-m grid showed more dramatic increases in artifact type richness. Richness was increased in eight of the 10 assemblages (80%), with increases ranging from 0–400% and the count per assemblage increasing by 142% on average.

Changes in the numbers of artifact types also had important effects on the occupational duration and function attributed to the Study 2 sites. Results from testing on a 10-m grid show that changes to either occupational duration or function occurred in only one of the 10 assemblages (10%) during this stage. In this instance, both duration and function were affected. In the case of testing on a 5-m grid, however, far more dramatic effects are seen, with either duration or function being affected among eight of the 10 assemblages (80%). This includes changes of occupational duration among six sites (60%) and changes of occupational function among seven sites (70%).

Study 3 (10-m Cruciform STs vs. 10-m Grid STs vs. 10-m Grid STPs)

Study 3 was conducted similarly to the preceding two studies in that comparisons were drawn between shovel testing on a 10-m cruciform (Stage I) and a 10-m grid (Stage II) with 30-cm diameter STs being excavated during both stages. Study 3 differs, however, in that the final stage of sampling (Stage III) did not involve further modification of ST placement but instead involved the excavation of 50 x 50 cm STPs at the locations of all positive and negative tests excavated during Stage I and II.

The results of Study 3 conform to those of the previous two studies in demonstrating that dramatic increases in site size occur with increases in sampling (Figure 4.7 and 4.8; Table 4.5). From Stage I to Stage II, an increase in site size was seen among three of the four sites (75%), with increases ranging from 0–500% and an average increase in size of 225% per site. Increases in site size were also seen at three of the four sites with the transition to Stage III, with increases ranging from 0–600% and an average increase in size of 168% per site. Increases in artifact count when transitioning 13–585% and an average increase of 235% per site. Further increases are seen with the transition to Stage III, where increases are again seen at all four sites and range from 44–269% with an average increase of 183% per site. From Stage I to II, artifact type count increases are seen in two of the four assemblages (50%), with increases ranging from 0-100% with an average increase of 50% per site. from Stage I to II were seen among all four sites (100%), with increases ranging from Transitioning from Stage II to III, increases in artifact type count are seen in all four assemblages (100%), with increases ranging from 50–117% and an average increase of 80% per site. The results from Study 3 demonstrate that occupational duration and function were affected throughout the three stages of sampling.

Table 4.5. Site data showing changes in site and occupational variables for the three-stage sampling comparing 30-cm diameter shovel tests on a cruciform (Stage I) and 10-m grid (Stage II) with 50 x 50 cm shovel test pits on a 10-m grid (Stage III).

	Site Size (sq. m)			**Artifact Count**			**Richness**			**Was occupational duration affected?**		**Was occupational function affected?**	
Sites	**Stage I**	**Stage II**	**Stage III**	**Stage I**	**Stage II**	**Stage III**	**Stage I**	**Stage II**	**Stage III**	**Stage II**	**Stage III**	**Stage II**	**Stage III**
22WE511	600	2400	2400	23	56	197	3	6	11	Y	Y	Y	Y
22WE541	1200	2400	2800	8	24	64	3	3	5	N	N	N	Y
22CH522	300	1800	2800	7	48	177	3	6	13	Y	Y	Y	Y
Landrum 13	100	100	700	8	9	13	2	2	3	N	N	N	Y

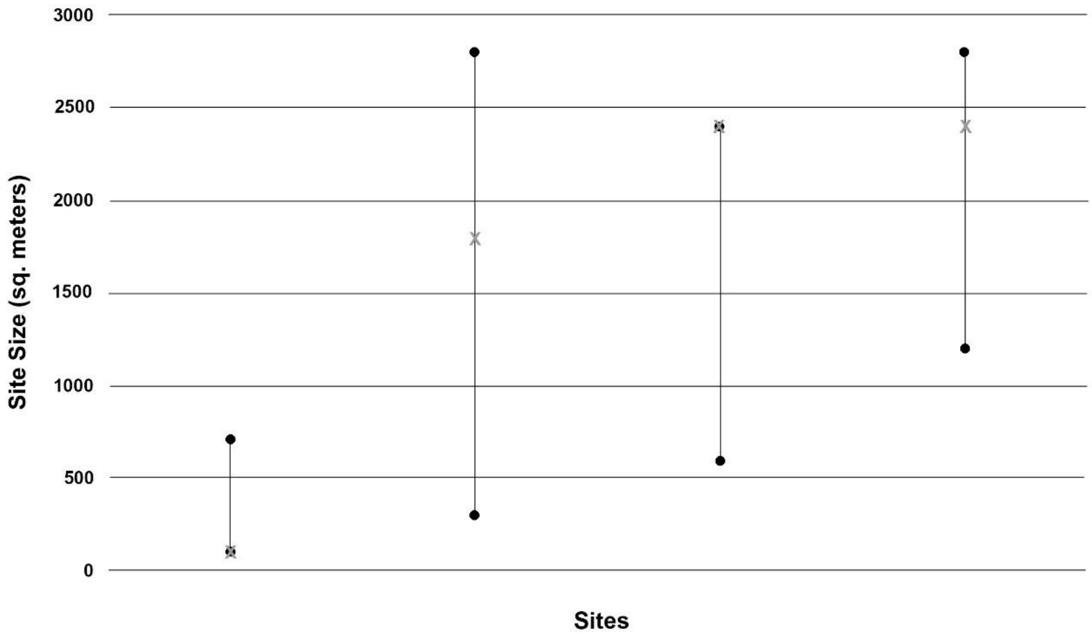

Figure 4.7. Graph showing changes in site size when comparing shovel testing with STs on a 10-m cruciform, STs on a 10-m grid, and STPs on a 10-m grid among four sites from study 3.

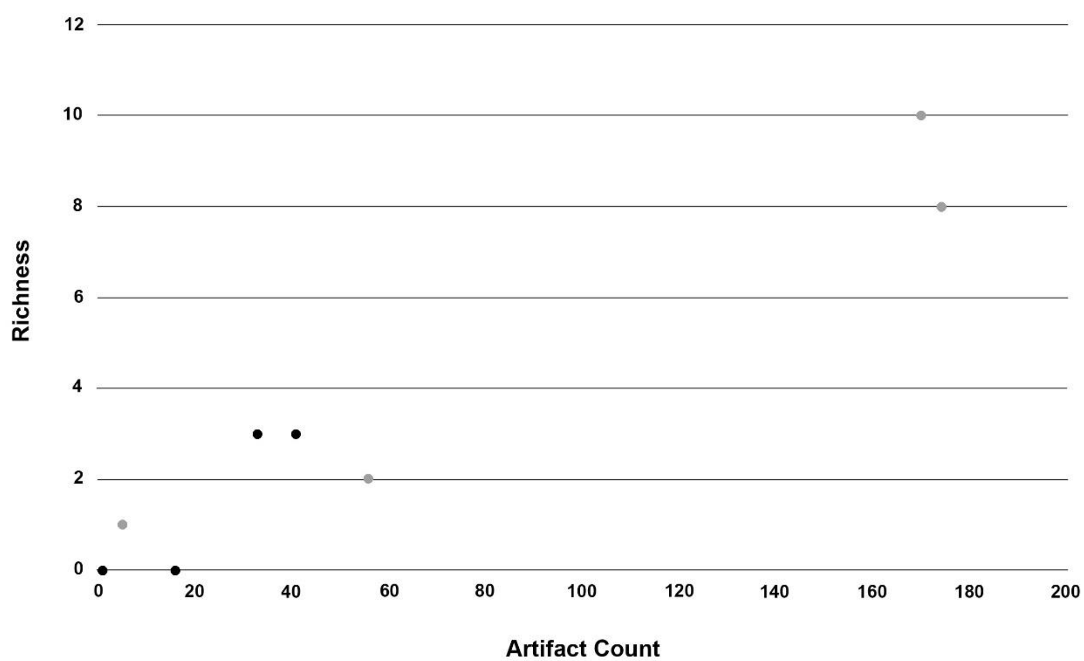

Figure 4.8. Graph showing the difference values in artifact count and artifact type richness when comparing shovel testing with STs on a 10-m cruciform, STs on a 10-m grid, and STPs on a 10-m grid among four sites from study 3. Black dots represent differences between STs on 10-m cruciform and STs on 10-m grid. Gray dots represent differences between STs on 10-m cruciform and STPs on 10-m grid.

The results from Stage II testing show that changes to either occupational duration or function occurred in two of the four assemblages (50%) with duration and function being affected in both cases. Stage III sampling resulted in either duration or function being affected among all four assemblages (100%). This includes changes of occupational duration among two sites (50%) and changes of occupational function among all four sites (100%).

Table 4.6. Summary table showing percentage of sites that saw increases in site size, artifact count, and artifact type richness among the three studies.

	Study 1	**Study 2**		**Study 3**	
	10-m cruciform to 10-m grid	**10-m cruciform to 10-m grid**	**10-m grid to 5-m grid**	**10-m cruciform to 10-m grid**	**STs to STPs on 10-m grid**
Sites that showed increase in size	80%	50%	100%	75%	75%
Sites that showed increase in artifact count	87%	50%	100%	100%	100%
Sites that showed increase in artifact type richness	50%	10%	80%	50%	100%

Discussion

This study has demonstrated that sampling methods routinely employed during Phase I and II investigations often lead to the production of incomplete occupational models that preclude the accurate determination of site significance in the context of assessing NRHP eligibility. These methods fail in their ability to identify the horizontal boundaries of artifact clusters, thereby misrepresenting the spatial dimension of archaeological occupations and sites. This failure not only prevents archaeologists from identifying the spatial extent of the “population of interest” represented by the artifacts and features that comprise an archaeological site, thereby undermining their ability to devise effective sampling strategies for further site investigation, but also compromises the ability of cultural resource managers to insure the avoidance of such resources by future ground-disturbing activities.

It is clear that the principle that larger samples more accurately reflect the population of interest needs no empirical demonstration. Another truism, however, is that when sampling from a population there is a strong correlation between sample size and the resulting estimates of richness represented by the sample, a fact long recognized by archaeologists (Jones et al. 1983; Lyman and Ames 2004). The results presented here clearly demonstrate that standard approaches to the sampling of archaeological sites during Phase I cultural resources survey suffer from the problem of undersampling, which leads to inaccuracy in the critical measures of occupational variability that are central to the evaluation of a site's eligibility for inclusion on the National Register.

Results from the three studies demonstrate that shovel testing on either a 10-m cruciform or grid pattern results in frequent mischaracterizations of site occupations in terms of their spatial, temporal, and formal attributes. These failures inevitably contribute to the construction of occupational models that are compromised in their ability to represent the occupation(s) present at some archaeological locus and that fail to characterize even basic occupational dimensions such as duration or function. Comparisons were made between the results of shovel testing on a 10-m cruciform and a 10-m grid at all 44 sites investigated during this study. Thirty-two of the 44 sites (73%) saw an increase in site size, with an average increase of 184% per site. Numbers of artifact types recovered during testing on a 10-m grid changed in such a way that occupational duration or function were affected at 16 of the 44 sites (36%). While such results provide a strong case for the abandonment of shovel testing on a cruciform pattern as a sampling strategy, further intensification of sampling on a 5-m grid casts doubt on the usefulness of sampling on a 10-m grid, as further increases in site size are seen at all 10 sites when sampling is expanded to a 5-m grid. Even more striking is the average increase in site size from 10-m to 5-m grid sampling, which shifts to a startling 395%. Similarly, striking changes are seen in the numbers of artifact types recovered during testing on a 5-m grid, where occupational duration or function were affected at 8 of the 10 sites (80%).

Determining the appropriate sample size for any particular research program can be a daunting task for archaeologists. Inevitably, however, the question of whether we have "sampled to redundancy" (Dunnell 1984; Leonard 1987; Lyman and Ames 2004, 2007) provides a valuable guiding principle for making such determinations. Cumulative frequency graphs were constructed for the 10 sites investigated in Study 2 to demonstrate the relationship between shovel-testing intensity and artifact type richness (Figure 4.9). The results demonstrate that only two of the 10 sites (22CS1212 and 22SM1440) have been sampled to redundancy despite having been investigated/delineated on a 5-m grid, which represents the highest level of sampling intensity represented in the current study and greatly exceeds the level of sampling intensity employed in most Phase I cultural resource surveys. These findings should provide a cautionary tale for archaeologists when considering the validity of the occupational models that result from the use of standard shovel testing strategies.

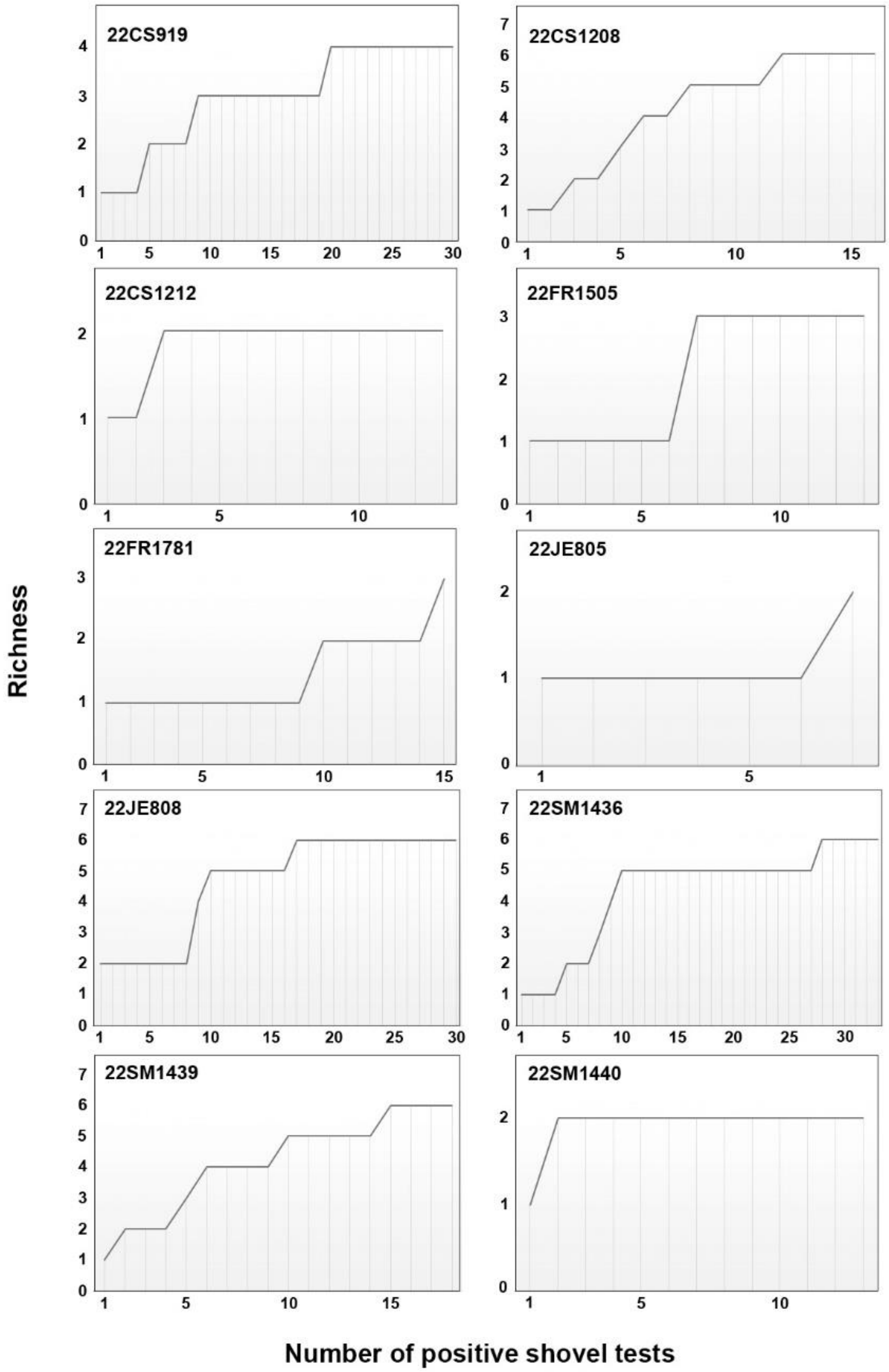

Figure 4.9. Cumulative richness of artifact types across cumulative numbers of positive shovel tests from ten sites investigated/delineated on a 5-m grid.

Some may argue that increasing the intensity of shovel testing beyond a 10-m grid represents an impractical strategy for Phase I cultural resources survey, given the time and money that are generally available to accomplish the goals of this work, and that such intensive testing is best undertaken during later phases, when excavation and mapping techniques incorporate more precise spatial control. If such a position is to be taken, however, it is critically important that archaeologists operate with considerably more caution in their Phase I determinations about which sites should receive further testing through Phase II investigations, as the results presented here clearly demonstrate that standard Phase I sampling strategies often compromise our ability to make proper significance determinations at this level of investigation. The findings certainly support the position that the use of shovel testing on a cruciform should be abandoned in favor of testing on a grid pattern of some size.

Conclusions

Archaeology would be well served if we developed a better appreciation for the fact that investigations in the context of Phase I cultural resources survey constitute the primary means by which we evaluate the archaeological record. Every day, hundreds of archaeologists across the country are engaged in discovering and investigating sites, many of which will never be revisited once the investigations are complete. We have historically conceived of this undertaking as only the beginning phase within a series of investigations whose purpose is to determine the significance and NRHP eligibility of cultural resources found to be endangered by some proposed development. Efforts during Phase I are integral to this process but also represent a scale of investigative undertaking that can contribute invaluable data for addressing landscape-scale research questions that have historically existed beyond our reach due to the demands of collecting such large and diverse datasets.

We have seen in recent years how large datasets of radiocarbon dates, most of which were generated in the context of CRM, have contributed to studies of paleodemographic change involving the use of summed probability distributions (SPDs) (e.g., Attenbrow and Hiscock 2015; Bevan et al. 2017; Boulanger and Lyman 2014; Buchanan et al. 2008; Chaput and Gajewski 2016; Collard et al. 2010; Downey et al. 2014; Peros et al. 2010; Riede 2009; Robinson et al. 2019; Selden and Pertulla 2013; Shennan and Edinborough 2007; Timpson et al. 2014). These efforts have demonstrated the value of large regional-scale datasets, but they also reveal the potentially deleterious effects of inadequate sampling as one of the greatest potential weaknesses of studies employing SPDs and that this weakness is related to the representativeness of the collection of radiocarbon dates used in some study. Data collection in Phase I cultural resources survey holds equally promising and equally dangerous potential. The data we collect during these investigations can contribute to our efforts at answering landscape-scale research questions but can also compromise our models of settlement-subsistence organization if the effects of undersampling are too great.

Results presented here have exposed the potential for inadequate sampling strategies to affect our models of archaeological occupations and, therefore, the significance we assign to them. We must acknowledge that our efforts to accomplish the grander ambitions of archaeological research will be compromised so long as we fail to accurately characterize the spatial, temporal, and formal dimensions of archaeological occupations, which represent the basic building blocks of archaeological inference.

Chapter 5

Conclusions

The research presented above provided archaeological studies of three distinct but interrelated topics that challenged existing ideas about paleodemographic change in the Mississippi River valley during the region's prehistory. This research demonstrated that long held beliefs about the relationship between maize agriculture and population growth during the Mississippi Period are largely unfounded. Additionally, new evidence was brought to bear on the Vacant Quarter phenomenon seen throughout much of the Midwest and Southeast, which demonstrated that settlement reorganization in response to climatic and environmental change plays an important role in the explanation of population declines that occurred from AD 1300-1500. Finally, standard methods of shovel testing were assessed in terms of their success in accurately modeling the occupations present at 44 archaeological sites in Mississippi. This research presents findings on the relationship between shovel-testing strategies and the accuracy and usefulness of the models of archaeological occupations that result from the information collected during shovel testing. These results demonstrate that some common approaches to shovel testing lead to faulty models that fail to accurately represent important occupational variables, thus compromising our ability to make valid significance determinations.

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VITA

Jeffrey S. Alvey was born in Columbus, Mississippi on March 17, 1975. He graduated from New Hope High School in 1993. In 1998 and 2003, he received his B.A. and M.A. degrees in anthropology from Mississippi State University (MSU), respectively. His master's thesis focused on identifying the nature of Middle Archaic settlement organization in the upper Tombigbee River valley. After finishing his M.A., he began employment with the Cobb Institute of Archaeology, MSU where he was hired to create and manage a program in cultural resource management (CRM), which was named the Office of Public Archaeology (OPA). The mission of the program is to provide opportunities for undergraduate and graduate students at MSU to gain experience in the field of CRM, while also providing a source of financial support for students during their academic career at MSU. During OPA's 15-year history, the program has been awarded more than 450 contracts and grants representing approximately 3 million dollars in research funding.

In 2013, through support from the Cobb Institute, Jeffrey entered graduate school at the University of Missouri to pursue his PhD.