To the Graduate Council:

I am submitting herewith a thesis written by Jonathan Witcoski entitled "An Analysis of the Spatial Distribution of Chiefdom Settlements: Modeling the Mississippian Culture in the Tennessee River Valley." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geography.

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Thomas Bell, Major Professor

We have read this thesis
and recommend its acceptance:

__ Bruce Ralston_________

__ Nicholas Herrmann_____

Accepted for the Council:

_Carolyn R. Hodges_______________

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

An Analysis of the Spatial Distribution of Chiefdom Settlements: Modeling the Mississippian Culture in the Tennessee River Valley

A Thesis
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Abstract

Location-allocation models based on optimization criteria are appropriate tools for the analysis of archaeological settlement patterns. In early agricultural societies, elite classes might maximize their control of the population and resources by optimally situating their primary settlements. Location-allocation models can simulate the multiple factors that potentially underlie settlement site location decisions. I describe several maximal covering models and their applicability to understand the degree of political centralization in the Upper Tennessee River Valley during several Mississippian archaeological cultural phases (900 to 1600 A.D.). My results support the notion that the main objective of the Mississippian elite in choosing sites for administrative centers was to maximize control of the local population and the supporting agricultural economy. The results also support the work of anthropologists and archaeologists regarding the variable degrees of political complexity during time periods of the Mississippian culture. Cultures during the earliest time period (1000-1200 A.D.) and the northern part of the study area during the latest time period (1450-1600 A.D.) in the analysis were found to be the least complex, resembling simple tribal societies unable to maximize their control over the entire Valley population and its resources. Factors such as the location of trade routes and selected resource deposits were not accounted for in the location-allocation models developed for this research and may account for the less-than-optimal results in settlement system control.

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Chapter 1. Introduction

1.1 Subject of the Thesis

When a differentiated elite class of individuals controls a population and resources within an area, it is assumed that they would do so in a predictable fashion so as to maximize their control within their limited power base. Central place theory and its underlying organizing principles suggest that, given uniform environmental conditions, settlement spacing is predictable in such hierarchically based societies. Using central place principles, archaeological studies demonstrated that centralized control might have existed in prehistoric societies (Flannery 1972; Hodder 1972; Marcus 1973). Further studies employing central place principles have developed location-allocation models to test theories of prehistoric political structures (Steponaitis 1978; Church and Bell 1988). This thesis will be an effort to extend location-allocation modeling using a geographic information system (GIS) and computer programming applications to determine how close-to-ideal elite settlement locations of the Mississippian phase (900 to 1600 A.D.) chiefdoms in the Southeast were in controlling both their resources and the populations over which they exercised hegemonic control.

1.2 Purpose and Objective of the Thesis

Using GIS, I mapped the distribution of contemporaneous Mississippian phase sites seeking to model their settlement pattern within a regional context. The study area for my thesis research involved a section of the upper Tennessee River valley as shown in Figure 1. During the Mississippian time period (900 to 1600 A.D.) the study area has been distinguished by a number of archaeological cultures concentrated within it. The archaeological sites of contemporaneous Mississippian culture should be hierarchically distributed in terms of their importance as political, economic, and social centers based upon the archaeological components found at each site. An agricultural potential model of chiefdom settlement sites using a 1-km (.6 mile) buffer as developed by Steponaitis (1978) was replicated for my study area to determine the influence of potential agricultural fertility on the spatial distribution of settlements. Finally, the thesis uses linear programming to develop a location-allocation model that will simulate the decision-making processes responsible for the spatial arrangement of administrative centers based on this hierarchical level and the agricultural productivity under their control.

It was assumed that my thesis modeling results would reinforce many of the contentions of field archaeologists about the nature of Mississippian culture as a society. The spatial patterns of the settlement hierarchy were evaluated using location-allocation covering models. The ultimate goal of this thesis was to determine what effect the administrative/economic roles of settlements might have played in the prehistoric chiefdom societies of the upper Tennessee River valley.

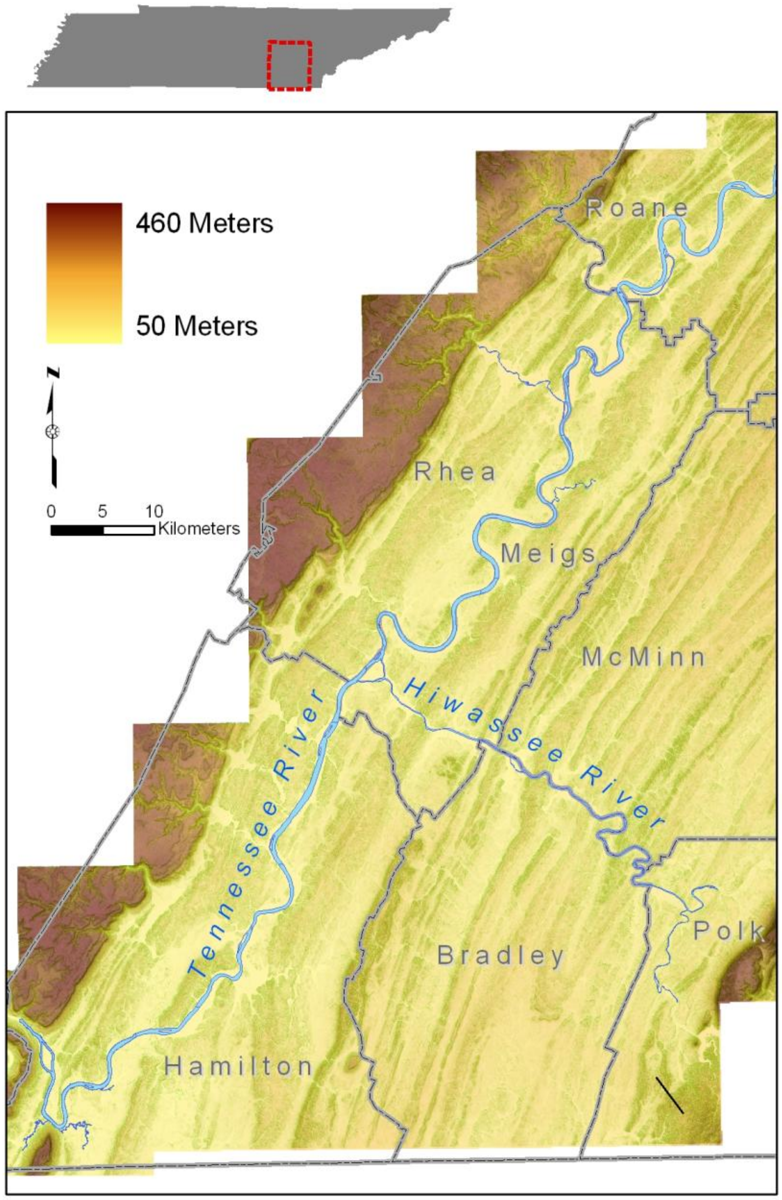


Figure 1. The Elevation, Topography, and County Divisions of the Study Area.

1.3 Assumptions

Archaeological data have practical limitations when judged on one or more of the following criteria: 1) imprecise temporal control that would assure contemporaniety; 2) sites that might have been present but are undocumented or not recorded; 3) sites that contain incomplete information pertaining to their economic conditions. These limitations affect any sort of analysis that can be done with the data. Assumptions of relative completeness and accuracy of the information must nevertheless be made in order to derive any significant conclusions from an archaeological data set. For my thesis, I assume that the archaeological sites can be classified into a meaningful hierarchical order based on the artifacts found. The hierarchy of sites is, therefore, based on the differential degrees of dominance in the overall marketing system implied by the presence (or absence) of certain rank-ordered goods. For example, the DeArmond mound site (40RE12) shown in the upper right hand corner of Figure 1 is assigned to the second highest level of simple chiefdom settlement hierarchy (level 2) based on the presence of a platform mound in addition to house structures and pottery.

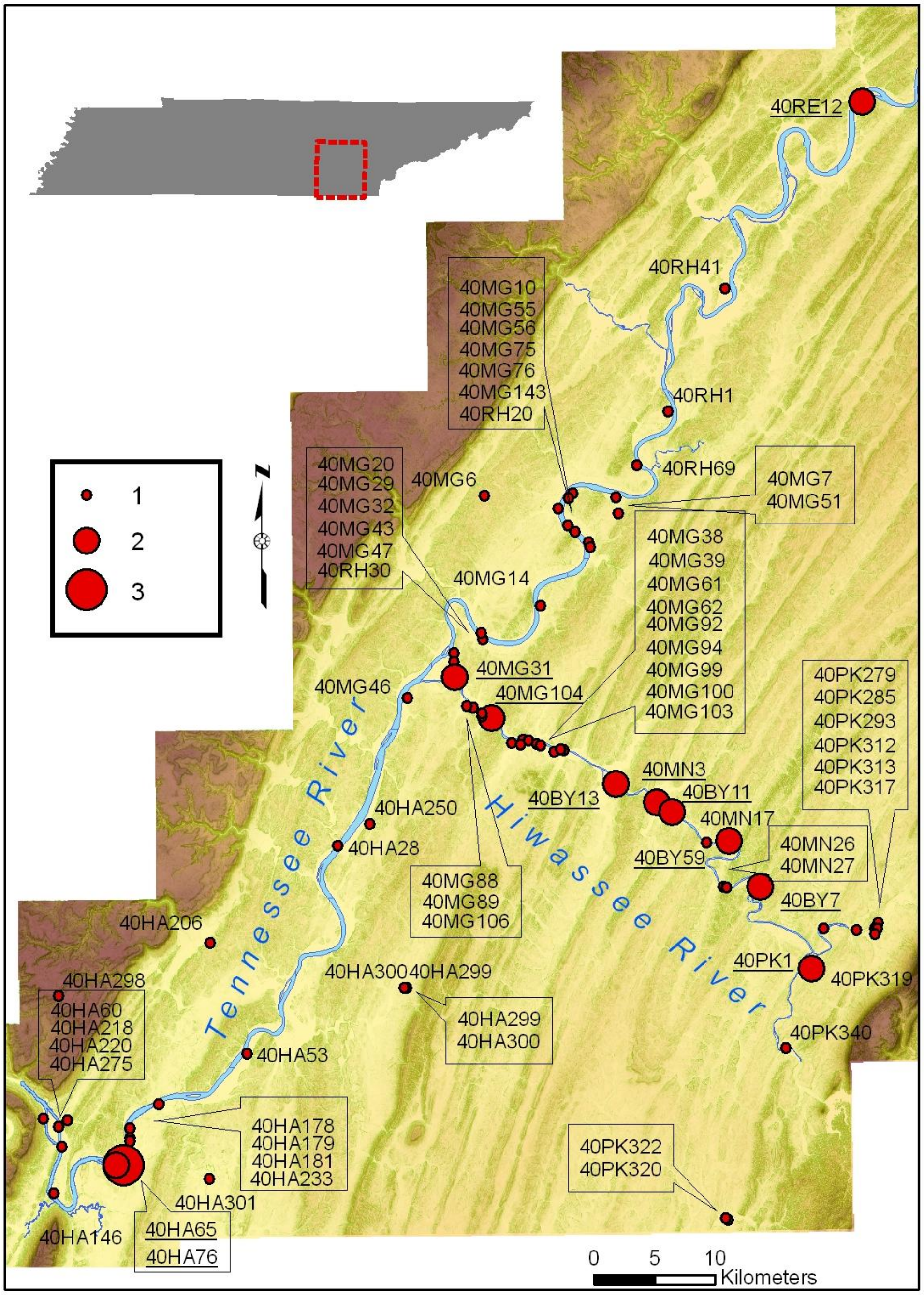


Figure 2. A Settlement Hierarchy of Late Dallas (1500-1600 A.D.) and Mouse Creek (1450 - 1600 A.D.) Sites.

In addition to possible flaws in the archaeological data, unrealistic assumptions about the environment (e.g., isotropic surfaces), movement and consumer behavior (e.g., distance minimization) have thwarted the ability of classic geographic theories to provide new theoretical insights into prehistory except in a normative sense (Church and Bell 1988). These hindering assumptions of classic central place theory can be overcome by constructing models that employ central place principles but also account for more diverse sets of interrelationships. These models can be constructed in a linear programming environment that assesses interrelationships among a complex set of variables.

1.4 Study Area

The study area for this investigation involves a section shown in Figure 2 of the upper Tennessee River valley. The area has been surveyed several times and multiple excavations have occurred. The projects were supported financially by federal government projects under the auspices of the Tennessee Valley Authority (TVA). I assumed that regional analysis of the archaeological materials might provide insights into the political structure of the Mississippian phase cultures in the region.

Various archaeological excavations and surveys mean that the study area has been extensively documented and researched. The inundation of the valleys by the TVA dams along with various New Deal works projects of the 1930s and 1940s have provided archaeologists in the area considerable monetary resources to complete work on many major sites (Lyon 1996). Many of the cultural resources that would eventually be covered by rising waters were recorded and were sometimes excavated. Almost all of the materials and reports from these projects are curated at the Frank H. McClung Museum located at the University of Tennessee.

1.5 Thesis Organization

This thesis is organized as follows: Chapter 2 discusses the literature that is applicable and relevant to this study with emphasis on central place theory, predictive modeling in archaeology, chiefdom political structures, Mississippian cultural political structures, and the physiographic attributes of the study area and the eastern Tennessee archaeological cultural history; Chapter 3 discusses the methodology used in developing a hierarchical distribution of sites based upon the archaeological components of the sites, the methodology used in estimating prehistoric agricultural productivity, the methodology used to develop a location-allocation models, and finally the methodology used in statistical analyses; Chapter 4 presents the results of the study; Chapter 5 discusses the relevancy of these results for Mississippian settlements and potential future research.

Chapter 2. Literature Review

2.1 Central Place Theory

Walter Christaller formulated Central Place Theory during his study of market centers in southern Germany. He first wrote about his findings in his unpublished 1933 Ph.D. dissertation *Die zentralen Orte in Süddeutschland*. In 1966, Carlisle Baskin translated his entire dissertation into English (Christaller 1966). Christaller's theory allows one to model an ideal arrangement of central market place sizes so that it can be compared to a real world setting. Since its inception, the theory has provided countless scholars the opportunity to explore market distributions. Beyond the economic realm, the theory has been extended by social scientists to understand social behavior such as marriage and kinship patterns (Jackson 1976; Fox 1976; Crissman 1976), caste systems (Beck 1976), and political systems (Appleby 1976).

Pre-modern economic models in agrarian societies have been of particular interest to anthropological and archaeological researchers. Economic stratification is considered a key characteristic of both modern and pre-modern agrarian societies. Economic stratification seems to result from differential access to, or control over, the means of exchange (Smith 1976). In rural China, Skinner (1964, 1965) was one of the first to study premodern societies using central place principles and others have followed his lead (Smith 1976; Stuart 1976). Different categorical stages have been developed to describe these rural agrarian market economies in their transition to modern economies.

These models can mirror the tremendous economic variability that premodern societies manifest.

Archaeologists have also shown a keen interest in central place theory and its underlying organizing principles. They have used it in the ancient Near East (Johnson 1972, 1975; Tobler and Wineberg 1971), Roman Britain (Hodder 1972), Gaul (Crumley 1974), prehispanic Mesoamerica (Bell and Church 1987; Evans and Gould 1982; Flannery 1972; Hammond 1974; Marcus 1973, 1976; Steponaitis 1981), and prehistoric southeastern United States (Steponaitis 1978). Their usage of a capitalist market-based theory for a model of prehistoric site settlement is never perfect. Steponaitis (1978) argues that modifications must be made to central place theory so that it can be used in non-market (i.e., pre-capitalist) settings.

A modification of central place studies in modern and prehistoric settings involves the development of models using discrete space instead of continuous space. While continuous space enables human movement throughout a two-dimensional plane, discrete space links fixed settlements together in a more realistic way that replicates the actual patterns of human movement, especially in complex societies (Flannery 1972; Wright 1977, 1978; Gorenflo and Bell 1991). The studies of societies treating their discretely spaced transportation network and certain facets of that network's organization as a graph provide a means of assessing fundamental characteristics of network structure and human behavior (Gorenflo and Bell 1991). One of the first to study a prehistoric society in discrete space was Steponaitis (1978) in the Black Warrior River Valley of the Southeast. He developed a locational model that is applicable to settlement hierarchies in complex prestate societies or complex chiefdoms.

In addition to the discrete modification of central place studies, prehistoric interactive systems differ greatly from modern competitive market economies in other ways. Steponaitis (1978) points out that hinterlands of chiefly centers do not shift according to the relative positions of chiefly centers. Instead, corporate land-use rights vested in a particular kin group are the primary factor in establishing hinterlands. Centers within a single, well-integrated political system lack any competition and there is no process to favor centers that are located at maximum distances from one another. Finally, Steponaitis (1978) argues that consumers travel only to their nearest lower-order centers and not directly to higher-order centers as they would in market economies. Goods or services thus pass through the entire hierarchy of administrative sites.

2.2 Predictive Modeling in Archaeology

In archaeological research, central place theory has been used to predict settlement patterns according to certain normative assumptions about human behavior. A predictive locational model is based both on assumptions about human behavior and propositions concerning the structure of the environment (Hay et al.1982: 14). "Predictive locational models attempt to predict, at a minimum, the location of archaeological sites or materials in a region, based either on a sample of that region or on fundamental notions concerning human behavior." (Kohler and Parker 1986).

Predicting settlement patterns in a regional context requires a series of rules, principles, and assumptions in order to develop replicability. Kvamme (1990:267-268) lists the fundamental principles of regional archaeological modeling: 1) The parcel of land and not the archaeological site should be the elementary unit of investigation; 2) a mutually exclusive and exhaustive collection of events should be defined to reflect various classes of archaeological phenomena; 3) decision rules should be adopted for non-archaeological characteristics; 4) prediction should occur when land parcel units of unknown archaeological classes are assigned in the model; and 5) actual archaeological class membership should be compared against the model's predictions in independent random samples of locations where both can be determined. Along with the fundamental principles of regional archaeological modeling, Kvamme (1990:288) stresses that a researcher must include operational definitions for archaeological modeling. These include: 1) the scale of the unit of analysis; 2) the definition of the dependent archaeological events; 3) the definition of the independent characteristics of the units of analysis; and 4) the specific format and derivation of the model's decision rules.

Simplifications of the bewildering array of economic, social, and political factors that potentially affect prehistoric settlement size and geographic location within a hinterland are made in predictive modeling. Most individuals responsible for developing the models have achieved simplification in their predictions by concentrating on the economic component of site location. Kohler and Parker (1986: 400) summarized most current predictive models when they explained that it is usually "argued or assumed that in prehistoric societies the most important economic transactions for most people were with the environment." The predictive model used in this study not only uses an environmental component of site locations but also a very simplistic demographic component of the same locations.

Independent factors or variables used in models to predict site location are derived deductively from ethnographic or historic literature and inductively from previous archaeological work (Zimmerman 1977:15). For Mississippian settlements in the Southeast, it is assumed that historic trade routes were associated with the more ancient sites in their immediate vicinity (Limp 1990). Empirical correlative studies of Mississippian settlements have also identified well-drained agricultural soils as predictive variables in locating agriculturally based sites (Baden 1985).

Perhaps the most complicated variables, and ones seldom used in archaeological predictive modeling, are based on purely social and political factors. Social and political factors can only be used when there is enough temporal data to establish contemporary sites. The lack of temporal data for locating contemporary sites is a key reason why social and political factors are normally not used (Kvamme 1990: 273). Archaeologists have acknowledged that subtle social determinants of location are probably at work in all settlement systems (Kohler and Parker 1986: 401). Modelers use economic theories such as central place theory to subsume social determinants of archaeological site locations.

2.3 Chiefdom Political Organization

Six centuries before the first Europeans set foot upon southeast North America, hundreds of elite leaders ruled that landscape in a mosaic of small and large polities. These polities have been commonly defined as chiefdoms ruled by hereditary elites known as chiefs. The most common definition of chiefdom is “an autonomous political unit comprising a number of villages or communities under permanent control of a paramount chief” (Carneiro 1981:45). These regional polities have institutional governance and some display social stratification (Carneiro 1981; Earle 1987,1997). In a social evolutionary framework, a chiefdom is an intermediate-level polity, bridging the evolutionary gap between small, village-based polities and large, bureaucratic states (Johnson and Earle 1987, Earle 1997).

Chiefdom is an anthropological political concept used to depict an idealized form of political organization. It is an effort by anthropologists to measure how societies differ in political organization (Blitz and Lorenz 2002). The term chiefdom first came into use during the late 1950s (Oberg 1955; Steward and Faron 1959). It was formally defined and most widely applied after the publication of Service’s (1962) influential work on the evolution of human social organization (King and Meyers 2002). It is commonly used to describe the scale of political complexity in Mississippian societies.

The chiefdom’s ruling elite was known as a chief. The chief had control over production and exchange of subsistence and wealth thus creating the basis for political power (Earle 1991a). Control rested first and foremost on dominating labor, the limiting factor in production in non-industrial societies (Price 1984; Earle 1991b). The domination of labor was achieved by irrigation technologies that many early states and chiefdoms had developed. Irrigated areas were productive and had a delimited resource base. In Mesopotamia, Adams (1966) calculated that only two percent of the land that was the most productive during the development of irrigation was used (Earle 1991b). Control was achieved in the form of tribute by providing protection from attack from social predators including the leaders themselves (Sahlins 1958; Orans 1966; Ford 1974, 1977; Cordy 1981; Gilman 1991; Earle 1997; Anderson, Stahle, and Cleaveland 1995). Agricultural surpluses occurred at levels necessary to maintain elite agendas and prerogatives along with keeping a supply in reserve for production shortfalls (Burns 1983 as cited in Anderson, Stahle, and Cleaveland 1995)

Chiefly offices were characteristically highly generalized such that a chief could lead in affairs of politics, religions, and economics (Earle 1991a). The office of chief was a permanent position that transcended the individual officeholder commanding a certain amount of legitimacy and authority. Unlike leaders in states, chiefs did not hold an institutionalized monopoly on the use of force. Although they might have had greater access to force, they often shared the right to exercise it with other individuals or subgroups in society (Earle 1973 as cited in King and Meyers 2002).

The role of chief was an inherited position. The position was not fully granted upon the death of the chief to a successor. A considerable amount of politics and warfare was associated with succession (Carneiro 1981 as cited in Earle 1991a). Chiefdoms were therefore, more volatile than states to the extent that many centers of power shifted throughout a region frequently. In the Oconee and Savannah River valleys of eastern Georgia where chiefdoms have been well documented archaeologically (Anderson 1990), researchers have described the short-term nature of the political landscape as a series of "blinking Christmas tree lights" (Williams 1992 as cited in Anderson 1994). Ethnographic research has shown that the ability to maintain political integration was never achieved under limited high-status positions such as in chiefdoms. A chief never had full control of a polity leading to inherently competitive political situations (Earle 1978, 1991a)

Chiefdoms are measured on a scale with at least two dimensions: political organization and the degree of centralization (Blitz and Lorenz 2006). The largest group that can act as a political unit is the measure of the political organization of a chiefdom. The amount of political authority each social group possesses can be used to measure the degree of centralization or power that is concentrated in a social group (Peregrine and Melvin 2002). Chiefly societies in southeastern North America ranged in political complexity from small chiefdoms in Appalachia to large complex chiefdoms in the American Bottom region on the banks of the Mississippi River.

Studying chiefdom societies allows scientists to examine and understand how leadership developed and expanded. Scientists study societies collectively by looking at all elite interactions. This is known as the study of peer polity interactions (Renfrew 1982a). The peer polity interactions are smaller parts of much larger world economic systems (Rowlands, Larsen, and Kristiansen 1987 as cited in Earle 1991a). It is important to understand how chiefdoms, using finite resources, could maximize their control of large populations and interact with other polities. Studying early agricultural societies such as those found in this study allows geographers and archaeologists the chance to examine core principles of economic geography such as the economic exchange and control of resources.

2.4 Mississippian Chiefdoms

The Mississippian period culture represents a time span in southeastern North America of more than seven hundred years (900 to 1600 A.D.). During this time agricultural chiefdom societies dominated the area. Mississippian societies have been characterized by intensive maize cultivation, sedentary communities with earthen platform-mound-and-plaza arrangements, extensive exchange networks of raw materials, shared symbolism, and hierarchical social organization (Griffin 1985; Steponaitis 1986; Blitz 1993).

The Mississippian culture has a number of distinguishing characteristics that can be found through the archaeological material used to distinguish it from earlier (e.g. Archaic, Woodland) or later (e.g. Overhill Cherokee, Historic) cultures. Stone tools, domestic structures, and ceramic vessels are arranged to provide a chronological typology of stylistic designs that distinguish each stylistic culture. Mississippian period pottery is distinguished from others period styles in that it uses crushed shell instead of limestone in its temper to strengthen the pottery vessels. The presence or absence of artifacts can also help to distinguish the Mississippian culture. Evidence of agricultural fields have been found in aerial photographs in areas where agricultural was practiced. These fields are absent from pre-agricultural societies that were not agriculturalists (Fowler 1969; Knight 2004).

Mississippian societies have been categorized as socially ranked. Early historic accounts of powerful native leaders and archaeological materials such as monumental earthworks and rich burial treatments for a privileged few have been used as evidence for this theory. The communities are believed to have been composed of high-rank and low-rank groups whose leaders represented corporate group interests (Knight 1990; Scarry 1996; Blitz and Lorenz 2006).

In the Southeast, the easiest identifiers of Mississippian cultural segregation are the earthworks they created. Earthen mounds were commonly used by elites for residential or burial purposes. Archaeologists have used mounds as an indicator that one sector of society controlled the labor of others (e.g. Peebles and Kus 1977; O'Brien 1989; Trigger 1990; Trubitt 2000). The most widely speculated opinion is that the presence of such mounds in addition to other elite archaeological materials indicated centrality in those Mississippian phase societies (Steponaitis 1978). There is considerable archaeological and historical evidence that Mississippian sites with earthen mounds mark the political-ceremonial centers of chiefdoms (Blitz and Lorenz 2006). Hally (1993, 1996) argued that Southeastern chiefdoms did not exist very long without a mound. King (1999:113) expanded on this notion to suggest that, "the presence of a mound can be used to infer the existence of a prehistoric chiefdom and identify its capital". Peebles and Kus (1977) state that platform mounds in Mississippian culture are evidence of centrally organized activities that include the entire population. Additionally, a hierarchy of settlement types and sizes should exist. In most Mississippian societies there were numerous habitation sites, but few sites with mounds (Meyers 2002:185).

Mississippian platform mounds are flat-topped earthen pyramids enlarged by repetitive construction episodes over extended periods. They supported the remains of buildings often larger in size and functionally different than non-mound buildings. These are usually interpreted as "public" structures, elite residences, chief's houses, and mortuary temples (Payne 1994; Blitz and Lorenz 2006). Archaeological investigations and early European observations of platform mounds indicated that many contained elite charnel (mortuary) houses. Others were depositories for valuables, foods, and weapons (DePratter 1991:96-119; Blitz and Lorenz 2006). A majority of mounds have contained human remains. Subsets of these mound burials have been found with non-local materials. These adornments indicated individuals who were high ranked or had leadership status (Peebles 1971; Blitz and Lorenz 2006). Historic, linguistic, and archaeological evidence suggests that platform mounds were symbols of earth associated with rejuvenation and fertility (Knight 1986; Blitz and Lorenz 2006).

Mound sites range widely with respect to the number and size of mounds present (Meyers 2002). The most important mound site where the highest-ranking elite members lived is known as the capital. Payne (1994) found the Mississippian capitals shared specific characteristics of structure. Capitals were the largest settlement in the polity marked by earthen mounds. A chief's house stood on the largest and tallest (main) mound. Buildings on main mounds were larger than non-mound buildings. Mortuary temples were placed on smaller platforms at sites with two or more mounds. The mortuary temple buildings were roughly similar in size to the chief's house (Payne 1994; 225-227; Blitz and Lorenz 2006).

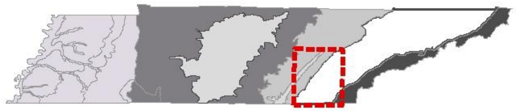
In addition to earthen mounds, defensive fortifications are associated with Mississippian period settlements. Palisades, bastions, and ditches give archaeologists reason to speculate that intensive warfare was occurring at many sites (Larson 1972:384-8: DePratter 1983:48-9). The objective of Mississippian warfare was the seizure of a town that controlled the surrounding agriculturally rich land. Without gunpowder or the ability to lay siege to a palisaded towns, they were virtually impossible to conquer (Larson 1972: 389).

Southeastern archaeologists use the chiefdom concept to specify the scale of political complexity in Mississippian societies. The concept emphasizes the material aspects of communities, identifiable as archaeological sites, and territory (Blitz and Lorenz 2006). Archaeologists use the presence and distribution of monumental constructions and prestige goods to document the evolution of chiefly societies (Creamer and Haas 1985; Earle 1987; Peebles and Kus 1977; Renfrew 1973; 1974 as cited in Earle 1991a). To conform minimally to the chiefdom concept, Blitz and Lorenz (2006: 4) expect a Mississippian population to be composed of ranked kin-groups in multiple communities or dispersed households, united into a permanent official polity.

2.5 Physiographic Attributes of the Study Area

The area of study for this thesis, as shown in Figure 3, is located in the Ridge and Valley physiographic region. This area is commonly referred to as the valley of east Tennessee. The average width of this province is 64 to 72 kilometers (Floyd 1965:5). The total area included in the province covers approximately 23,800 square kilometers (Case 1925: 1). In general, the valley floors are favorable to agriculture and settlement and the many parallel mountain ridges and ranges limit communication and freedom of movement. The rivers and their subsequent valleys provide easy avenues for which to travel.

The current climate in the study area is similar to what it was during the Mississippian period. The regional climate of east Tennessee is temperate continental and can be classified as humic neothermal, characterized by a definite seasonal rhythm (Thornthwaite 1948). Palynological investigations at Anderson Pond on the eastern Highland Rim of Tennessee suggest that the climatic conditions may have been generally stable throughout most of humankind's known occupancy of the study area (Delcourt 1979:268-271).



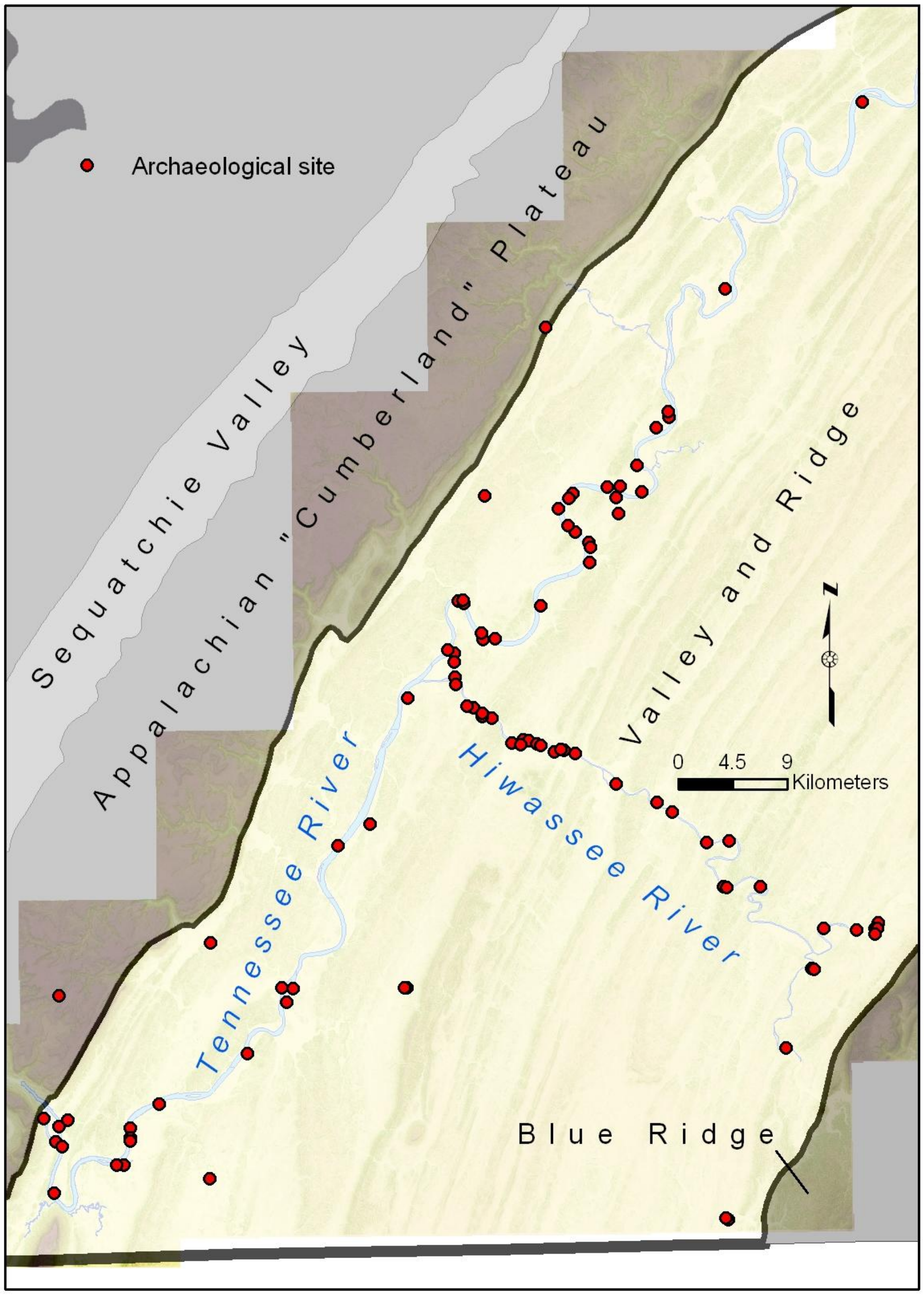


Figure 3. The Physiographical Aspects of the Study Area With Archaeological Sites Having a Mississippian Component.

The Ridge and Valley province of east Tennessee is flanked on the east by the Blue Ridge province and on the west by the Appalachian Plateau province. Riverine access to the valley of east Tennessee from the west was either up the Tennessee River from Alabama, or by way of the Cumberland River to the north of the plateau through the Cumberland Gap and down the Powell River Valley to where the stream flows into the Tennessee River. The region to the east is the Appalachian mountain range that forms a great barrier which limited communication except in a few favorable places such as the deep narrow gorges of the Hiwassee and Little Tennessee rivers near the Chickamauga Basin and the French Broad and Holston gorges to the north (Lewis et al. 1995: 40).

The most important feature of the region for travel is the many rivers. The Tennessee River flows southwest through the Ridge and Valley region. The other principal rivers that flow into the Tennessee River originate in either the Appalachian Plateau or Blue Ridge Mountains. These include the Clinch, French Broad, Holston, Hiwassee, and Little Tennessee Rivers (Swain et al. 2004). Before the advent of the steam or combustion engine, the rivers were the most efficient means of travel.

Within the valley of east Tennessee, linear bands of ridges and valleys further limit the accessibility of areas in the region. Valley elevations are about 225 to 300 meters above sea level with ridges dividing them ranging from heights of 450 to 900 meters above sea level. Both valleys and ridges are elongated forming northeast-southwest parallel bands. The intervening valleys are rolling surfaces with restricted floodplains, and the ridges are narrow and steep-sided. The ridges vary in length from a few too many miles. This barrier of topography did not permit easy communication outside the river drainage system (Lewis et al. 1995: 40).

The diversity of natural resources in the valley of east Tennessee and surrounding plateau provides two very distinctive physiographic life zones. The upland “life zone” is characterized by lush forest, attendant plant foods, and the presence of large and small game mammals. The lowland “life zone” is distinctively different possessing rich soils, diversified vegetation, and a riverine environment. (Hood 1977: 31-32).

The valley lowland life zone regions of the valley of east Tennessee can be subdivided into floodplain and river terraces. The terrace lands developed as a result of water-deposited benches that originally bordered steams but later occupied higher positions not subject to flooding. This condition developed as a result of the river channel gradually deepening (Elder et al. 1958:7-8). The bottomlands compose the present floodplain that is being subjected to occasional flooding. They are elevated only a few feet above the streams and are level or nearly level, the gradient being two percent or less (Hubbard et al. 1950:31 as cited in Hood 1977:14). The second terrace because of its location, would have been a more dependable habitation area than the bottom lands which experience intermittent flooding during the winter and spring months.

Alluvial soils possess a high degree of fertility for the production of crops (Elder et al. 1958). Ten alluvial terrace surfaces have been identified along the lower Little Tennessee River and represent over 25 meters in vertical separation (Delcourt 1980: 115). The active floodplain is seldom greater than 15 meters in width, first and second terraces are up to 900 and 1200 meters wide in some areas. In general the first terrace is usually less than 150 meters wide. (Davis 1986:50).

Following the Early Woodland period (ca. 200 B.C.), the terraced lands were progressively used by aboriginal populations. Forests were cleared to increase the density of usable, herbaceous plants and to create more browse for sustaining a larger deer population. The alluvial terraces also offered rich, arable soils that were well-suited to intensive agriculture. With the deforestation of much of the bottomland by Mississippian times, the immediate upland environs probably became more important as a source of wood and fuel (Davis 1986:64).

The upland life zone characterized by lush forests has an oak-chestnut faciation. In recent years the chestnut trees have all but disappeared due to lumbering and blight introduced from Asia (Shelford 1963:38-39 as cited in Hood 1977:19). Even if this area was not used directly by indigenous populations, the uplands could have served as a game reserve repopulating depleted wild game stock in areas near settlements.

Food in the study area could be obtained or grown from a variety of species. Wild game from the valley of east Tennessee and surrounding area provided indigenous populations with an abundant source of faunal food products. Shellfish, fish, and smaller aquatic invertebrates and vertebrates were also abundant in the nearby rivers (Hood 1977:25). Well-drained and irrigated soils suitable for agriculture were found in river valleys. The lack of lakes and major marsh areas seriously limited the amount of waterfowl that would have been available as food sources. There are a large number of birds that inhabit the area, both permanent and migratory, but the majority of these birds were of the small perching variety (Wetmore 1939: 175-243). The environment could and did support large indigenous populations except for occasional years of exceptional weather events.

2.6 Cultural History of the Study Area

The data used in this study were gathered from various excavations conducted in the valley of east Tennessee beginning in the early twentieth century. Cyrus Thomas and Clarence B. Moore, early pioneers in archaeology, excavated some archaeological sites in the area at the turn of the 20th century. The University of Tennessee, Knoxville however has done the majority of the fieldwork within the last fifty years. The construction of TVA reservoirs initiated large-scale salvage archaeology projects (Sullivan 1999). Within the last decade, more refined regional chronologies have begun to appear as material from earlier surveys and excavations are reanalyzed. The sites found in the study area are listed in Table 1 and each chronological time period is shown in Figures 4 through 8.

The Mississippian time period has been broadly divided into four large phases for most of the valley of east Tennessee. Lewis and Kneberg first developed cultural sequences based primarily on excavations from the Chickamauga Basin in southeastern Tennessee (Lewis and Kneberg 1946; Lewis et al. 1995). Additional archaeological projects after the 1940s in the area, primarily in Tellico Reservoir, allowed Kimball and Baden (1985) to reorganize the chronological sequence based on the combined ceramic sherd data and site radiometric dates (Korner 2005). The chronological sequence Kimball and Baden (1985) developed is shown in Table 2.

Table 1. List of Sites.

Site Name	Nickname	Archaeological Settlement Type	Order	Cultural Phase	Temporal Determination	Source
40BY7		Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990
40BY11	Rymer	Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990, Sullivan 1986
40BY13	Ledford Is.	Mound Center	2	Hiwassee Is.	Radio Carbon Dating and Artifacts	Elliott 1993
40BY13	Ledford Is. 2	Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990, Sullivan 1986
40BY59		Mouse Creek Town	2	Mouse Creek	Diagnostic Pottery	Elliott 1993
40HA1	Dallas/ Yarnell site	Mound Center	2	Early Dallas	Radio Carbon Dating and Artifacts	Sullivan 2001
40HA2	Davis	Mound Center	2	Early Hiwassee Is.	Radio Carbon Dating and Artifacts	Sullivan 2001
40HA3	Hixon	Mound Center	2	Late Hiwassee Is.	Radio Carbon Dating and Artifacts	Koerner 2006; Sullivan 2001
40HA28		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA53		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA60		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA65	Citico	Mound Center	2	Early Hiwassee Is.	Diagnostic Artifacts	Hatch 1976; Sullivan 2001
40HA65	Citico 2	Multiple Mound Center	3	Late Dallas	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990, Hatch
40HA76		Dallas Village		Dallas Village	Diagnostic Pottery	State Site Report
40HA146	Hampton Place A	Town	2	Late Dallas	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990, Moore 1915; Hatch 1976
40HA178		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA179		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA181		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA206		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA218		Hamlet	1	Late Dallas	Diagnostic Pottery	State Site Report
40HA220		Hamlet	1	Dallas	Diagnostic Pottery	State Site Report
40HA225		Hamlet	1	Hiwassee Is.	Diagnostic Pottery	State Site Report
40HA233		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA250		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA275		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report

Table 1. List of Sites

Site Name	Nickname	Archaeological Settlement Type	Order	Cultural Phase	Temporal Determination	Source
40HA298		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA299		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA300		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40HA301		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG6		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG7		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG10		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Elliott 1993
40MG12		Hamlet	1	Early Hiwassee Is.	Diagnostic Pottery	Sullivan 2007
40MG14		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG20		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Elliott 1993
40MG29		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Elliott 1993
40MG30		Hamlet	1	Early Hiwassee Is.	Diagnostic Pottery	Sullivan 2007
40MG31	Hiwassee Is.	Multiple Mound Center	3	Early Hiwassee Is.	Radio Carbon Dating and Artifacts	Lewis and Kneberg 1979; Elliott 1993
40MG31	Hiwassee Is. 2	Mound Center	2	Early and Middle Dallas	Radio Carbon Dating and Artifacts	Sullivan 2001
40MG31	Hiwassee Is. 3	Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990
40MG32		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG38		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG39		Hamlet	1	Dallas	Diagnostic Pottery	State Site Report
40MG43		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG46		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG47		Hamlet	1	Dallas	Diagnostic Pottery	State Site Report
40MG51		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG55		Hamlet	1	Dallas	Diagnostic Pottery	State Site Report
40MG56		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG61		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG62		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG75		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG76		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG81		Hamlet	1	Hiwassee Is.	Diagnostic Pottery	Elliott 1993

Table 1. List of Sites

Site Name	Nickname	Archaeological Settlement Type	Order	Cultural Phase	Temporal Determination	Source
40MG88		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG89		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG92		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG94		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG99		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG100		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG103		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Elliott 1993
40MG104		Small Town	2	Late Dallas	Diagnostic Pottery	Elliott 1993
40MG106		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MG143		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Sullivan 2007
40MG216		Hamlet	1	Late Hiwassee Is.	Diagnostic Pottery	Sullivan 2007
40MN3	Mouse Creek	Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990, Sullivan 1986
40MN17		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MN26		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40MN27		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK1	Henry Cox/ Ocoee	Mouse Creek Town	2	Mouse Creek	Radio Carbon Dating and Artifacts	Hally, Smith, and Langford 1990
40PK279		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK285		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK287		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK293		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK312		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK313		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK317		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK319		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK320		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK322		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40PK340		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40RE12	DeArmond mound	Mound Center	2	Late Hiwassee Is.	Diagnostic Pottery	Koerner 2006; Sullivan 2001
40RE12	DeArmond mound 2	Mound Center	2	Late Dallas	Radio Carbon Dating and Artifacts	Koerner 2006

Table 1. List of Sites

Site Name	Nickname	Archaeological Settlement Type	Order	Cultural Phase	Temporal Determination	Source
40RE186		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40RH1		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	Elliott 1993
40RH12		Hamlet	1	Hiwassee Is.	Diagnostic Pottery	Elliott 1993
40RH14		Hamlet	1	Hiwassee Is.	Diagnostic Pottery	Elliott 1993
40RH15		Hamlet	1	Hiwassee Is.	Diagnostic Pottery	Elliott 1993
40RH20		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40RH30		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40RH41	Upper Hampton	Hamlet	1	Late Dallas	Radio Carbon Dating and Artifacts	
40RH6	Leuty	Mound Center	2	Early Hiwassee Is.	Radio Carbon Dating and Artifacts	Schroedl 1978; Elliott 1993
40RH66		Hamlet	1	Middle Dallas	Diagnostic Pottery	Sullivan 2007
40RH69		Hamlet	1	Uni. Mississippian	Diagnostic Pottery	State Site Report
40RH7	McDonald	Mound Center	2	Early Hiwassee Is.	Radio Carbon Dating and Artifacts	Schroedl 1978a
40RH78		Mound Center	2	Hiwassee Is.	Diagnostic Pottery	Elliott 1993
40RH176		Hamlet	1	Early Hiwassee Is.	Diagnostic Pottery	Sullivan 2007

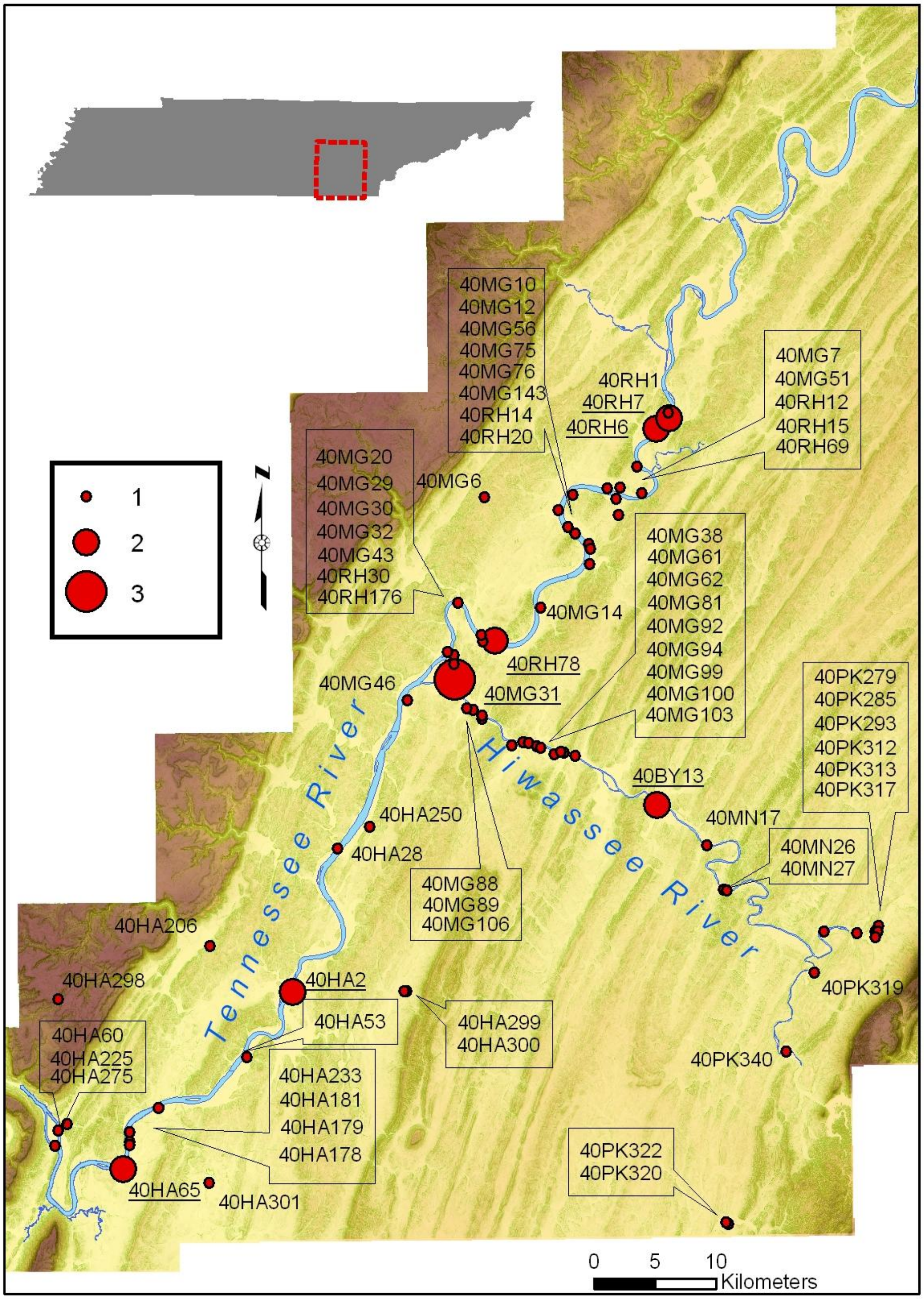


Figure 4. Map of Early Hiwassee Island Phase (1000-1200 A.D.)

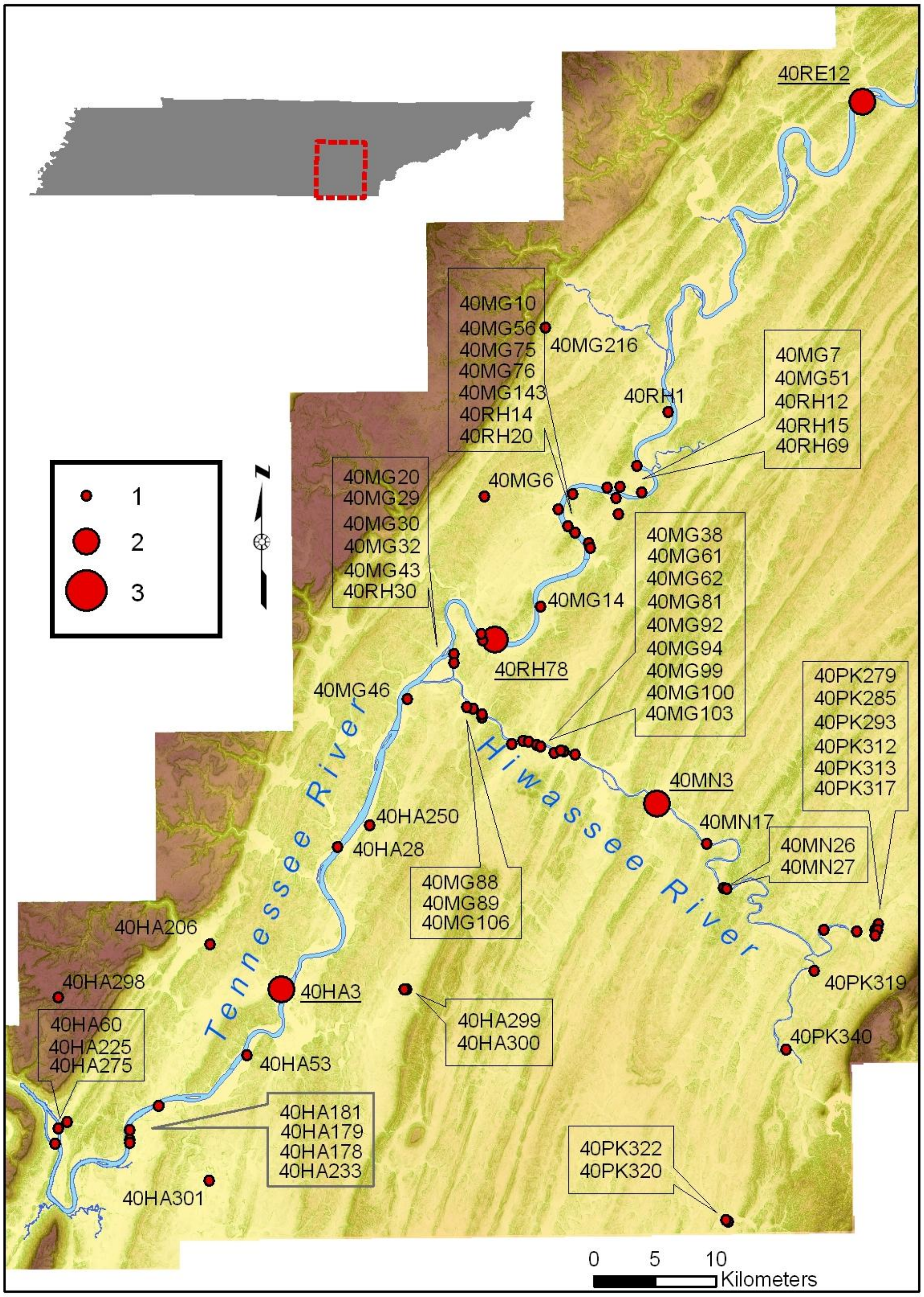


Figure 5. Map of Late Hiwassee Island Phase (1200-1300 A.D.)

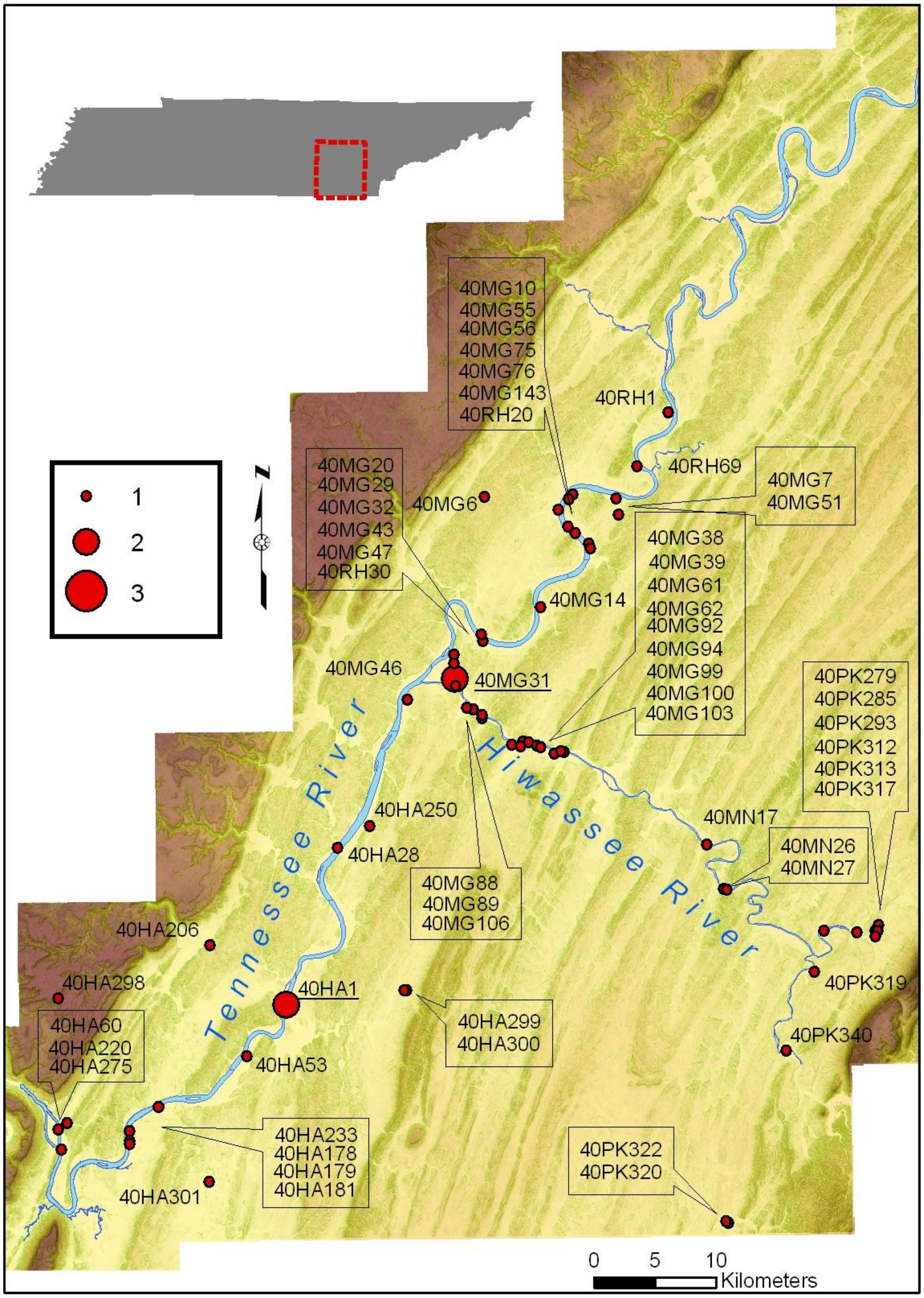


Figure 6. Map of Early Dallas Phase (1300-1400 A.D.)

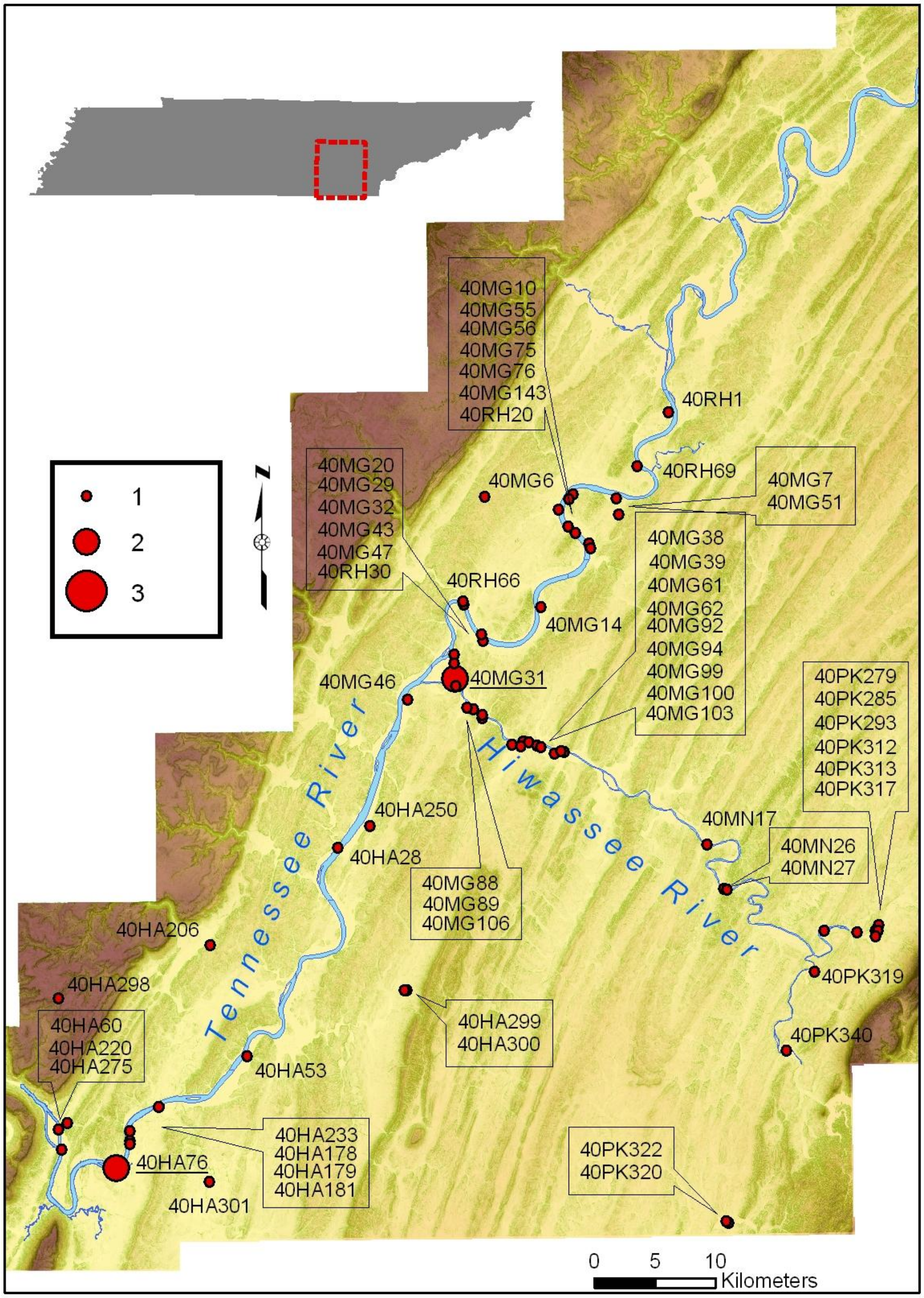


Figure 7. Map of Middle Dallas Phase (1400-1500 A.D.)

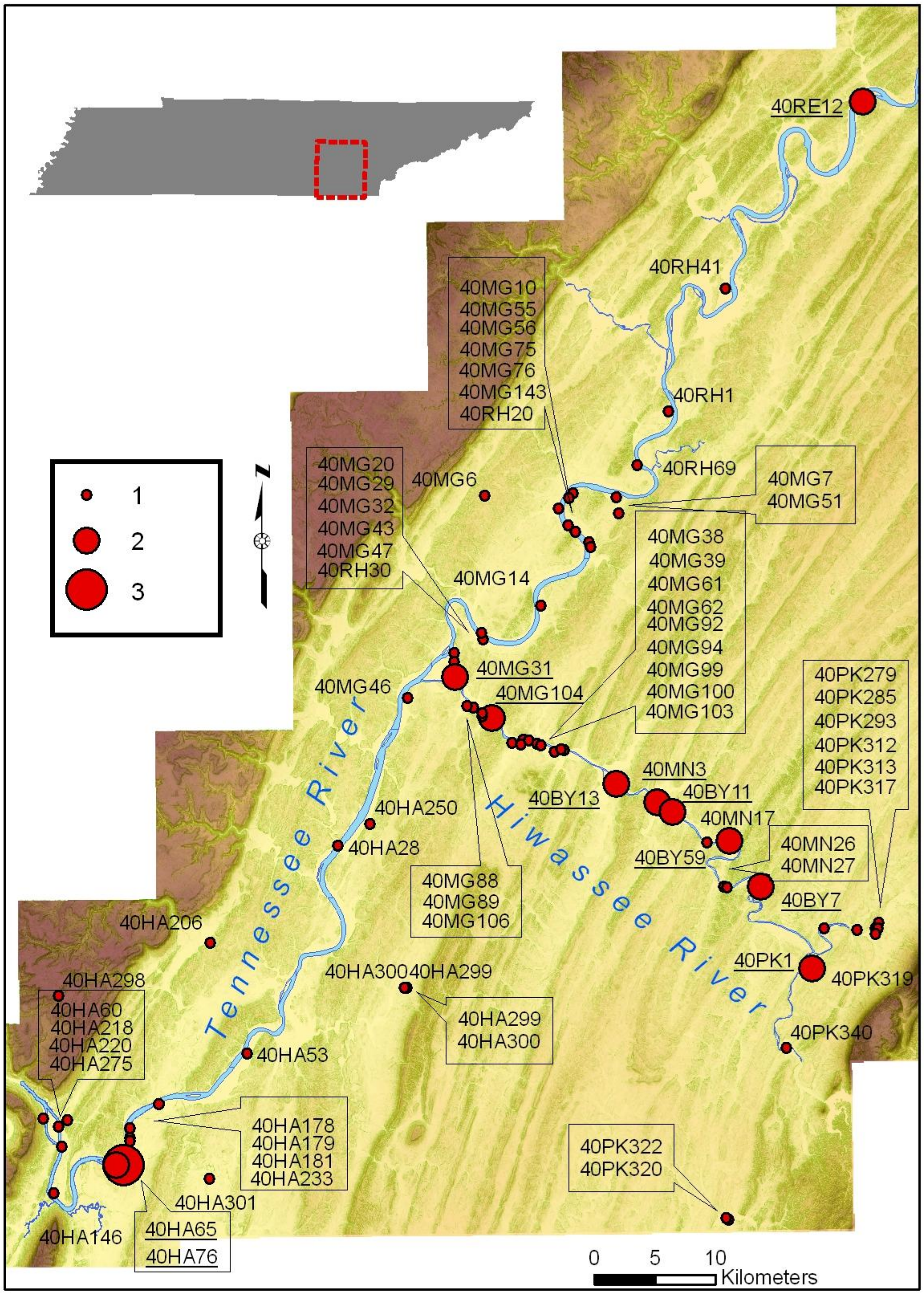


Figure 8. Map of Late Dallas Phase (1500-1600 A.D.) and Mouse Creek Phase (1450-1600 A.D.)

Table 2. Kimball and Baden's (1985) Chronological Sequence of the Valley of East Tennessee Based on the Tellico Reservoir Survey.

Cultural Phase	**Time Period**
Martin Farm phase	(900- 1100 A.D.)
Hiwassee Island phase	(1000 – 1300 A.D.)
Dallas phase	(1300 – 1600 A.D.)
Mouse Creek phase	(1450 – 1600 A.D.)

The political organization of the valley of east Tennessee is roughly parallel to stylistic cultural phases as defined by Kimball and Baden (1985). This interpretation is based on the nature of the archaeological materials. The political organization can generally be described as emerging from small egalitarian tribes to very simple chiefdoms, with little social status differentiation. After developing into chiefdoms, the political organization of the area becomes increasingly more complex as populations increased and settled in villages and hamlets located on rich alluvial terraces. Socio-political status differentiation and its biocultural effects (i.e. mortuary treatment, diet, stature, and stress) are clearly evident in the valley of east Tennessee during the Mississippian time phases (Hatch 1974, 1976; Hatch and Willey 1974; Hatch and Geidel 1983; Hatch et al. 1983; Helmkap 1985).

The emergence of chiefdom societies is generally postulated to have occurred during the Martin Farm phase (900-1100 A.D.). The increased maize cultivation and increasing populations brought about social change from the previous small tribal bands. The increased populations are probably the result of the aggregation of dispersed Woodland period tribal groups (Muller 1978a, 1986b, 1994 as cited in Muller 1997:179). Evidence for this hypothesis comes from burial mounds. Radiocarbon dates from burial mounds show a continuous usage from 700 to 1200 A.D. overlapping both tribal Woodland, and chiefdom Mississippian cultures (Schroedl, Boyd, and Davis 1985: 183).

The best evidence for social and political change in the archaeological record was the decreasing accessibility of public structures for the population as a whole. Helkemp (1985) found that access to pubic townhouse structures became more limited and restricted during the Martin Farm phase and early Hiwassee Island phase. The earliest town houses (circa 900 A.D.) at DeArmond, Hiwassee Island, and Hixon sites averaged over 140 square meters and were easily accessed. At the beginning of the Hiwassee Island phase (circa 1000 A.D.) Helkemp (1985:45) found that the townhouses averaged less than 90 square meters. Barriers such as steep-walled substructure mound foundations, inner palisades, entry vestibules, and easily regulated entry-ramps became common.

Chiefdom emergence in the valley of east Tennessee is followed by further restructuring of the society from very simple chiefdoms into more structured and complex political organizations. In later years of the Hiwassee Island phase, some centers begin to contain multiple summits with multiple buildings. By 1200 A.D., elite materials are found in significant quantities at gravesites indicating a clearly defined social hierarchy. In the valley of east Tennessee a particular set of motifs is found that researchers have identified with elite burials. These motifs are called the Southeastern Ceremonial Complex (SECC). SECC motifs on complicated stamped pottery from this time period suggest interactions with groups in what is now northern Georgia. Items found on Hiwassee Island include engraved shell gorgets (pendants), monolithic axes, and copper ornaments and headdresses. Hiwassee Island phase political systems were still considered very simple. Elliott (1993:187) suggests that small, poorly integrated chiefdoms characterized the Hiwassee Island phase in eastern Tennessee. Only the Hiwassee Island site contains multiple platform mounds.

With the establishment of each new political organization a new center was almost always established. Hiwassee Island located in an agriculturally rich crossroad of two rivers (the Hiwassee River and Tennessee River) is an exception to this general rule of abandonment since it was occupied for much of the Mississippian time period. The establishment of new centers is hypothesized as evidence for a new elite group coming to power. Sullivan (2001), using data from three mound centers occupied from 1100 to 1450 A.D. located within a 1.5 miles of each other in the Tennessee River Valley (Dallas, Davis, and Hixon sites), found that each center was occupied and probably controlled the area for approximately 100 to 150 years. The abandonment of one center coincided with the occupation of another.

The very simple, small chiefdoms of the Hiwassee Island phase are succeeded by larger and possibly more politically complex chiefdoms of the Dallas phase (1300 – 1600 A.D.) culture and less politically complex societies of the Mouse Creek phase (1450 – 1600 A.D.) culture. Outlying settlements, defined as hamlets, began supporting individual families that surrounded nucleated and palisaded villages around platform mounds in the Dallas phase centers. In the Mouse Creek phase, villages routinely had palisades, but with a central plaza and what were presumed to be large, ground-level presumptive community buildings. Mouse Creek villages lack elite mound architecture and significant distinctions between individuals in grave goods, two missing key archeological traces of chiefdom organization. This archaeological evidence suggests that Mouse Creek phase social and political structures were less complex than Dallas phase societies (Lewis et al. 1995; Sullivan 2001). Kimball and Baden (1985), Schroedl (1986), and Smith (2003) have even postulated that the Mouse Creek phase political structure was similar to the historic Cherokee’s loose confederation of tribal villages rather than Mississippian chiefdoms.

Between 1540 and 1567 A.D., the interactions of the valley of east Tennessee with other regions are documented by the de Soto, de Luna, and Pardo expeditions. Most speculate that three relatively independent chiefdom groups can be distinguished from these accounts and archaeological materials. Narratives from the first Spanish expeditions led by de Soto describe the area as under indirect control of the Coosa chiefdom in present-day northern Georgia. This polity of Coosa stretched approximately 400 kilometers along the Coosa and Tennessee River valleys (see Figure 9). Archaeologists have identified as many as seven site clusters. These site clusters have been interpreted as individual chiefdoms that paid tribute to the paramount chief in Coosa (Anderson 1994: 151, Hally, Smith, and Langford 1990:129-130). In the valley of east Tennessee these site clusters, or chiefdoms, are located in the Chickamauga Basin, Little Tennessee River, and Hiwassee River. Within twenty years of contact between de Soto and the de Luna expeditions there is ample evidence in the historical accounts to hypothesize that the complex chiefdom of Coosa had collapsed and the smaller clusters reemerged as small independent chiefdoms (Anderson 1994: 154).

The Chickamauga basin located near the present day city of Chattanooga was home to a group called the "Napochies" during the Spanish expeditions. This group was identified in the accounts of Dávila Padilla, a member of the de Luna expedition, as a group of rebellious former tributaries. The Spanish group helped Coosa by attacking them to regain control of the region (Dávila Padilla 1596:251ff; Anunciación et al. 1560

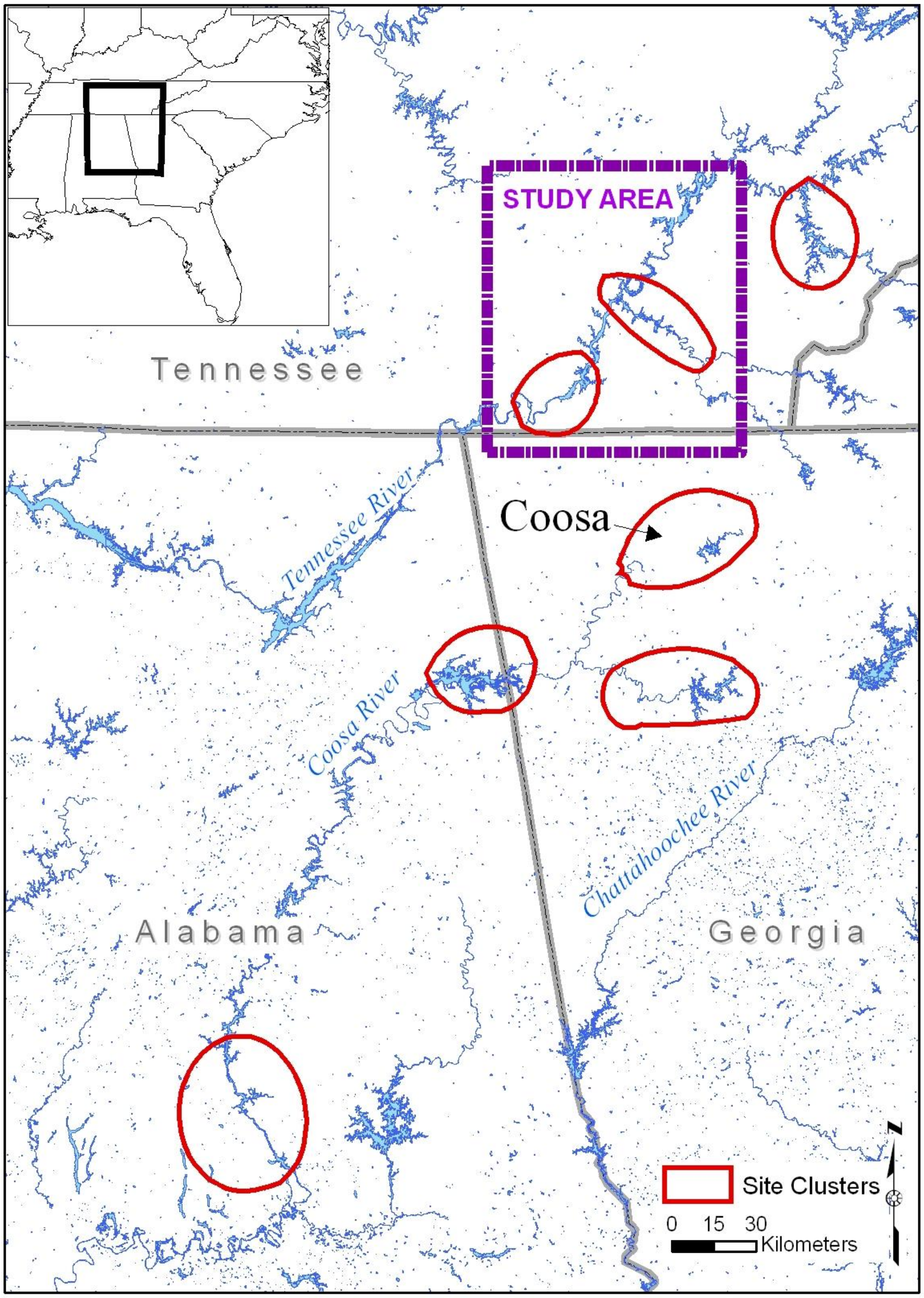


Figure 9. The Polity of Coosa With Site Clusters as Identified by Hally, Smith, and Langford (1990:123)

in Priestley 1928:I:230,y 1936:130). Hally, Smith, and Langford (1990:123) using rattlesnake gorgets (pendants), mask gorgets, and the DeArmond Incised ceramic type attempted to further refine the chronology of eastern Tennessee to determine sites occupied during the time of Spanish contact. In doing so, they identified the archaeological site of Citico as a possible chiefly center. Their evidence rested upon the two mounds located there and the site's centrality with respect to other known sites in the cluster (Hally, Smith, and Langford 1990:131).

Until the devastation caused by European arrival in North America in the 16th and 17th century, the population and political complexity of the area had increased. Europeans introduced smallpox, measles and many other Old World epidemic diseases in the 16th century. These diseases may have resulted in mortality rates on the order of 25 to 30 percent over a period of years (Gottfried 1983:5-6 as cited in Muller 1997:159).

The recent work of many archaeologists at re-dating many of the sites in the Chickamauga Basin (and lack of chronological control in other areas of east Tennessee) was the primary basis of choosing this area for study. The Chickamauga Basin is identified as an area of a site cluster or possible subsidiary chiefdom of Coosa. Hally (1993, 1994, 1996) used discrete temporal data from Mississippian mound sites throughout northern Georgia to evaluate basic definitions of Mississippian political structure. This study uses different temporal snapshots of the area (1000-1200 A.D., 1200-1300 A.D., 1400-1500 A.D., and 1500-1600 A.D.) to test whether central place principles will be more pronounced as the political complexity of the area increases and less pronounced as the political complexity decreases.

Chapter 3. Methodology

3.1 Methodology Introduction

The purpose of this thesis is to construct a settlement model to test whether the settlement locations of chiefdom centers in the upper Tennessee River valley were situated in the theoretically best locations. A model was constructed taking into account prehistoric economic settlement systems in addition to historic and archaeological data. This model was then independently validated with settlement data from the study area.

Christaller (1966) described three central place systems in terms of marketing, transportation, and administrative spatial organizational principles. Models for central place systems, developed by economic geographers have varied widely based on the three fundamental principles of spatial organization used to elaborate the settlement systems. Various other models have used combinations of the principles to describe additional systems that may occur (e.g., Berry et al. 1988; Parr 1985). The principal component of the model developed for this research was the transportation principle developed by Christaller (1966). Empirical evidence provided in prehistoric societies by Skinner (1964, 1965) has shown this principle to be accurate of some settlement systems in China, especially those in hilly or mountainous areas as are found in the southeastern Tennessee study area. Knowledge from previous archaeological investigations and available historic sources of the study are used to modify the central place system model based on the transportation principle.

3.2 Archaeological Information Retrieval and Categorization Methodology

The archaeological sites in the study area are not aggregated into a proper database to permit regional analysis. The most time-consuming task of the thesis was the development of a geodatabase from archaeological site information. ArcGIS, a commercial GIS software product of Environmental Systems Research Institute, Inc. (ESRI), was used to create the geodatabase. The archaeological materials and reports used in this study were available from the extensive Frank H. McClung Museum collection and the archaeological site files developed from the Tennessee Division of Archaeology.

Archaeological site boundaries and pre-reservoir river levels were the first observations collected. Topographic maps that had this information recorded on them were part of archaeological reports from surveys done before and after TVA dams inundated many of the lower valleys. Maps were scanned, georeferenced, and digitized. After being georeferenced, archaeological site boundaries and pre-reservoir river levels on the maps found to be relevant to the study were digitized into a geodatabase.

Archival research of archaeological reports began once all the information had been recorded from the topographic maps. Information related to the time period of site occupation were gleaned from the literature. If the initial period was found to be in the Mississippian period, additional chronological data and measures of centrality were recorded. Once this information was obtained, it was combined with the archaeological site spatial attributes within the geodatabase.

A hierarchical distribution of sites was developed based upon the archaeological components of the site. The two-level and/or three-level settlement hierarchies were defined by the presence (or absence) of certain rank-ordered goods It was not possible to develop a rank-size distribution using settlement size as first done by Berry (1961) for modern market centers and Pearson (1978) for Mississippian settlements, because the sizes of site areas in the study area are poorly defined. An alternative approach, stressing the existence and number of certain components that are correlated to chiefly centers was used. The components that have been found to correlate with chiefly political centers are platform and burial mounds, fortifications, nucleated villages, exotic goods mostly found in burial contexts, and elite burials. Using archaeological components to build a site hierarchy first allowed me to separate non-centralized locations without chiefly attributes from those that do possess them. Centralized locations can then be distinguished as high-level centers of chiefdom political power based upon aggregated numbers of archaeological attributes that distinguish the archaeological site from contemporary centers. Multiple mound centers and those centers that contained large numbers of elite burials were the archaeological material correlates used to define high-level centers of chiefdom political power. The study follows previous settlement models of Mississippian culture political organization (e.g. Anderson 1994; Blitz 1999; Blitz and Lorenz 2006; and Steponaitis 1986) using three levels of a settlement hierarchy. Simple chiefdoms will have a two-tiered settlement size hierarchy consisting of (1) households and (2) small mound centers with one or two platform mounds. Complex chiefdoms will have an additional larger multiple-mound site occupying the third level of hierarchy (Blitz and Lorenz 2006).

3.3 Estimating Pre-Historic Agricultural Yields Based on Modern Soil Maps

The agricultural productivity of the soil is an important predictive variable for settlement locations in Mississippian cultures. In the valley of eastern Tennessee, second river terrace soils are the most desirable areas for agriculture. In prehistoric time periods these terrace locations would have been a more dependable habitation area as compared to the bottom lands that experience intermittent flooding during the winter and spring months. The alluvial soils on the second terraces possess a high degree of fertility for the production of crops (Elder et al. 1958: 85). An agricultural potential model of chiefdom settlement sites using a 1-km (.6 mile) buffer as done by Steponaitis (1978) was replicated for my study area to determine the influence of a non-uniform distribution of agricultural soils on the settlement spatial distribution. Prime farmland soil boundaries with capability index classifications of I, II, IIe, and IIw were obtained from the SSURGO Soil Map Coverage data available from the United States Department of Agriculture. Mississippian cultures using minimal technologies could have used these soils effectively for agricultural purposes. The amount of harvest per acre on each soil type was estimated based on Baden's (1985) doctoral research on Mississippian agricultural systems in the Little Tennessee River Valley. Baden found that modern maize yields could be equated with expected prehistoric yield of 18.8 bushels/ha to estimate the aboriginal yields of each soil type (Baden 1985:104). A list of soil types and their attributes are shown in Table 3.

Table 3. Soil Productivity Data for the Study Area Under Aboriginal Conditions.

County	Soil Type	Soil Symbol	Capability Index	(Bushels per acre)	
				Yield	**Estimated Indian Yield**
Bradley	Apison silt loam, undulating	Af	IIe	85	16.01
Bradley	Apison silt loam, eroded undulating	Ac	IIe	80	15.07
Bradley	Barbourville fine sandy loam	Ba	IIe	120	22.60
Bradley	Barbourville loam	Bb	IIe	120	22.60
Bradley	Capshaw silt loam	Ca	IIe	75	14.12
Bradley	Cotaco silt loam	Co	IIe	110	20.72
Bradley	Cotaco loam	Cn	IIe	110	20.72
Bradley	Cumberland silty clay loam	Cr	IIe	95	17.89
Bradley	Decatur	Dg	IIe	60	11.30
Bradley	Dewey silt loam	Dk	IIe	85	16.01
Bradley	Emory silt loam	Ea	IIe	110	20.72
Bradley	Etowah silt loam	Ed	IIe	95	17.89
Bradley	Etowah silt loam	Ec	IIe	90	16.95
Bradley	Farragut silty clay loam	Fc	IIe	70	13.18
Bradley	Fullerton silt loam	Ft	IIe	75	14.12
Bradley	Greendale silt loam	Gb	IIe	100	18.83
Bradley	Greendale cherty silt loam	Ga	IIs	100	18.83
Bradley	Hamblen silt loam	Ha	IIw	95	17.89
Bradley	Hermitage silt loam	Hd	IIe	95	17.89
Bradley	Hermitage silt loam	Hc	IIe	90	16.95
Bradley	Holston loam	Hf	IIe	85	16.01
Bradley	Huntington silt loam	Hh	IIw	130	24.48
Bradley	Huntington loam	Hg	IIw	130	24.48
Bradley	Jefferson loam	Jb	IIe	95	17.89
Bradley	Leadvale	Lc	IIe	70	13.18
Bradley	Leadvale	Lb	IIe	70	13.18
Bradley	Lindside silt loam	Ll	IIw	125	23.54
Bradley	Litz	Lo	IIe	70	13.18
Bradley	Minvale silt loam	Mg	IIe	85	16.01
Bradley	Minvale silt loam	Me	IIe	80	15.07
Bradley	Monongahela silt loam	Mh	IIe	100	18.83
Bradley	Muse silt loam	My	IIe	110	20.72
Bradley	Muse silt loam	Mw	IIe	110	20.72
Bradley	Neubert loam	Na	IIe	110	20.72
Bradley	Pace silt loam	Pe	IIe	95	17.89
Bradley	Pace silt loam	Pd	IIe	95	17.89
Bradley	Sequatchie loam	Sa	IIe	110	20.72

Table 3. Soil Productivity Data for the Study Area Under Aboriginal Conditions.

County	Soil Type	Soil Symbol	Capability Index	(Bushels per acre)	
				Yield	Estimated Indian Yield
Bradley	Staser silt loam	Sh	IIw	100	18.83
Bradley	Staser loam	Sq	IIw	100	18.83
Bradley	Whitwell loam	Wd	IIw	90	16.95
Bradley	Wolftever	We	IIe	65	12.24
Hamiliton	Capshaw silt loam	CaB	IIe	75	14.12
Hamiliton	Crossville loam	CrB	IIe	90	16.95
Hamiliton	Dewey silt loam	DeB	IIe	90	16.95
Hamiliton	Emory silt loam	Ec	I	110	20.72
Hamiliton	Ennis cherty silt loam	En	IIw	70	13.18
Hamiliton	Etowah silt loam	EtB	IIe	95	17.89
Hamiliton	Hamblen silt loam	Ha	IIw	95	17.89
Hamiliton	Holston loam	HoB	IIe	90	16.95
Hamiliton	Humphreys cherty silt loam	HuB	IIe	90	16.95
Hamiliton	Lily loam	LiB	IIe	85	16.01
Hamiliton	Lonewood silt loam	LnB	IIe	90	16.95
Hamiliton	Lobelville chery silt loam	Lo	IIw	70	13.18
Hamiliton	Minvale cherty silt loam	MnB	IIe	85	16.01
Hamiliton	Newark silt loam	Ne	IIw	95	17.89
Hamiliton	Nesbitt silt loam	NsB	IIe	80	15.07
Hamiliton	Roane	RoA	IIw	60	11.30
Hamiliton	Roane cherty silt loam	RoB	IIe	55	10.36
Hamiliton	Sequatchie loam	SeB	IIe	110	20.72
Hamiliton	Sequatchie loam	SfB	IIe	110	20.72
Hamiliton	Sewanee Variant silt loam	Sn	IIw	80	15.07
Hamiliton	Staser loam	St	IIw	110	20.72
Hamiliton	Waynesboro	WaB	IIe	105	19.77
Hamiliton	Whitwell loam	Wh	IIw	85	16.01
McMinn	Alcoa	AaB2	IIe	95	17.89
McMinn	Bellamy	BeB	IIe	105	19.77
McMinn	Corryton	CrB	IIe	90	16.95
McMinn	Decatur	DcB2	IIe	115	21.66
McMinn	Dewey	DeB	IIe	105	19.77
McMinn	Emory	Ea	IIw	110	20.72
McMinn	Etowah silt loam	Eo	IIw	110	20.72
McMinn	Etowah silt loam	EtB	IIe	110	20.72
McMinn	Fullerton	FcB2	IIe	80	15.07
McMinn	Hamblen silt loam	Ha	IIw	95	17.89
McMinn	Neubert loam	Ne	IIw	95	17.89
McMinn	Pettyjon	Pe	IIw	120	22.60

Table 3. Soil Productivity Data for the Study Area Under Aboriginal Conditions.

County	Soil Type	Soil Symbol	Capability Index	(Bushels per acre)	
				Yield	Estimated Indian Yield
McMinn	Shady	ShB	IIe	120	22.60
McMinn	Steadman	St	IIw	120	22.60
McMinn	Tasso	TaB	IIe	95	17.89
McMinn	Toccoa	To	IIw	110	20.72
McMinn	Waynesboro	WaB2	IIe	90	16.95
McMinn	Waynesboro	WbB2	IIe	100	18.83
McMinn	Wolftever	WoB	IIw	75	14.12
Meigs	Beason silt loam	Be	IIw	60	11.30
Meigs	Capshaw silt loam	CaB	IIe	75	14.12
Meigs	Chagrin silt loam	Ch	I	125	23.54
Meigs	Decatur	DaB2	IIe	80	15.07
Meigs	Egam silty clay loam	Eg	I	80	15.07
Meigs	Emory silt loam	Em	I	110	20.72
Meigs	Ennis silt loam	En	I	75	14.12
Meigs	Ennis cherty silt loam	Eo	Iis	75	14.12
Meigs	Etowah silt loam	EsB	IIe	95	17.89
Meigs	Etowah gravelly silt loam	EtB	IIe	95	17.89
Meigs	Holston loam	HoB	IIe	90	16.95
Meigs	Humphreys silt loam	HuB	IIe	90	16.95
Meigs	Lindside silt loam	Ln	I	125	23.54
Meigs	Lobelville chery silt loam	Lv	IIs	70	13.18
Meigs	Newark silt loam	Ne	IIw	110	20.72
Meigs	Staser fine sandy loam	St	I	110	20.72
Meigs	Tarklin silt loam	TlB	IIe	90	16.95
Meigs	Tarklin cherty silt loam	TnB	IIe	90	16.95
Meigs	Whitwell loam	WtB	IIe	85	16.01
Meigs	Wolftever	WvB	IIe	65	12.24
Polk	Suches	Ar	IIw	115	21.66
Polk	Decatur	DeB2	IIe	80	15.07
Polk	Emory	Ea	IIw	110	20.72
Polk	Hamblen silt loam	Ha	IIw	95	17.89
Polk	Leadvale	LeB	IIe	75	14.12
Polk	Sequatchie	SeB	IIe	110	20.72
Polk	Suches	Su	IIw	135	25.42
Polk	Tate	TeB	IIe	105	19.77
Polk	Toccoa	To	IIw	90	16.95
Polk	Waynesboro	WbB2	IIe	100	18.83
Polk	Whitwell	Wt	IIw	85	16.01
Rhea	Allegheny	Ac	IIw	100	18.83

Table 3. Soil Productivity Data for the Study Area Under Aboriginal Conditions.

County	Soil Type	Soil Symbol	Capability Index	(Bushels per acre)	
				Yield	Estimated Indian Yield
Rhea	Allen	AeB	IIe	90	16.95
Rhea	Altavista	AnB	IIe	115	21.66
Rhea	Capshaw	CaB	IIe	70	13.18
Rhea	Dewey	DeB	IIe	105	19.77
Rhea	Egam	Eg	I	100	18.83
Rhea	Etowah	EtB	IIe	110	20.72
Rhea	Fullerton	FuB	IIe	80	15.07
Rhea	Hamblen	Ha	IIw	95	17.89
Rhea	Holston	HoB	IIe	100	18.83
Rhea	Lily	LhB	IIe	95	17.89
Rhea	Lonewood	LnB	IIe	100	18.83
Rhea	Pope and Philo	Pp	IIw	100	18.83
Rhea	Shady	ShB	IIe	120	22.60
Rhea	Shady	Sm	IIw	120	22.60
Rhea	Staser	St	I	120	22.60
Rhea	Minvale	TmB	IIe	100	18.83
Rhea	Waynesboro	WbB2	IIe	90	16.95
Rhea	Wolftever	WfB	IIe	75	14.12
Roane	Ealy	EcB	IIw	90	16.94
Roane	Etowah	EtB	IIe	95	17.89
Roane	Hendon	HeB	IIe	105	19.77
Roane	Lily	LbB	IIe	95	17.89
Roane	Lonewood	LoB	IIe	110	20.71
Roane	Pope and Philo	Pp	IIw	130	24.48
Roane	Shady	Sd	IIe	120	22.59
Roane	Swafford	SwB	IIw	110	20.715
Roane	Waynesboro	WaB	IIe	105	19.77

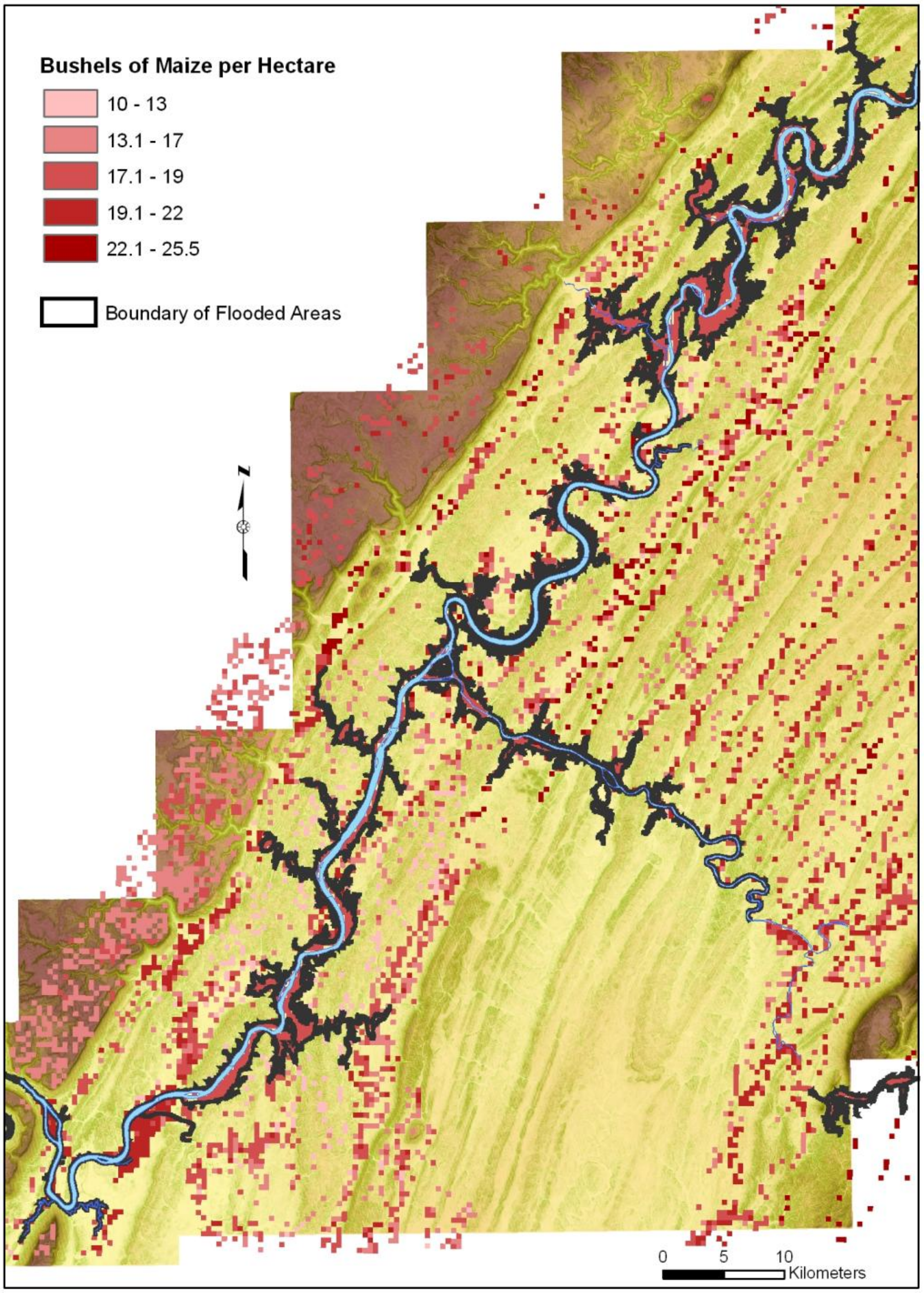


Figure 10. The Distribution of Estimated Yields.

A significant problem encountered during this thesis was missing digital SSURGO soil data. Soil maps in Bradley County were not available digitally at the time of the study. Soil map boundaries were obtained for this county, scanned, geo-referenced, and then digitized with respect to areas within one kilometer from archaeological sites. Areas flooded from the various TVA dams were also missing soil information. It is assumed that these soils were agriculturally productive due to their spatial proximity to alluvial deposits from rivers. The flooded area was extracted by eliminating the pre-TVA river boundaries obtained from topographic maps and assigned an expected prehistoric yield of 18.8 bushels/ha. The predicted pre-historic agricultural yield is displayed in Figure 10.

3.4 Location-allocation Model

Location-allocation models are an extension of earlier archaeological applications of central place theory. Earlier archaeological applications placed their emphasis on geometric configurations that coincided with idealized models of central place. The emphasis in location-allocation modeling is on the properties of the solution rather than the deduced, and often transformed, geometry common in earlier archaeological applications (Skinner 1964). Location-allocation models can be used, for example, to test central place principles of spatial efficiency and optimal location of facilities with regard to time and/or distance measures of transport or information flow cost.

Location-allocation models have been directed towards simple societies of hunter-gathers (e.g. Reidhead 1976, 1979, 1980; Keene, 1979, 1981). In a few cases, location-allocation models have also been applied to more complex cultural systems (Bell and Church 1987; Bell, Church, and Gorenflo 1986; Church and Bell 1988; Kauffman 1981). Location-allocation models can be used to test whether observed archaeological settlement patterns are similar to those that can be generated given certain assumptions about underlying locational forces and environmental circumstances (Bell and Church 1987: 77-78).

The type of location-allocation model that is used for this study is a maximum covering model. The maximum covering model attempts to maximize the coverage of demand points (settlements) from a designated number of supply (administrative) centers. I am using this model because it assumes that a central authority exerted maximal control over a population through regional administrative (i.e., supply) centers (Bell and Church 1987). Toregas and ReVelle (1972) introduced the Location Set Covering Problem (LSCP) to resolve such questions and it was later refined and expanded as the Maximal Covering Location Problem (MCLP) by Church and ReVelle (1974; 1976). The MCLP model addresses how a whole group of demand points reacts to a certain configuration of supply centers and the model may be less sensitive to slight changes in the location of administrative (supply) centers than other location-allocation models based solely on minimizing the total aggregated cost of movement (e.g., the solution to the p-median problem).

The model developed to examine settlement patterns in the Tennessee River Valley and surrounding areas employs a desired-service-distance concept first proposed by Church and ReVelle (1974). Bell and Church (1987) applied a similar covering model to prehistoric Aztec societies in the northeastern Basin of Mexico. Food production and site type based on a designated settlement hierarchy are included as variables. The model is expressed as:

$$\text{Max } Z = \sum_{j \varepsilon I} (w_1 \text{prod}_i) Y_i + \sum_{j \varepsilon J} (w_2 v_j X_j) \qquad (3.1)$$

Subject to:

$$\sum_{j \varepsilon N_i} X_j \geq Y_i \qquad (3.2)$$

$$\sum_{j \varepsilon J} X_j \geq p \qquad (3.3)$$

$$Xj = (0,1) \text{ for all } j \varepsilon J \qquad (3.4)$$

$$Yi = (0,1) \text{ for all } j \varepsilon I \qquad (3.5)$$

Where

N_i = $j \; \varepsilon \; J \mid D_{ij} < S$

I = denotes the set of demand nodes (sites to be covered),

J = denotes the set of administrative nodes,

D_{ij} = the shortest distance from node i to node j,

S = the distance beyond which a demand node is considered "uncovered",

w_1 = objective-function weight for agricultural productivity (non-negative),

w_2 = objective-function weight for site type (non-negative),

Y_i = denotes the coverage of settlement i (1 if covered, 0 if otherwise),

v_j = denotes the relative importance of the site type,

$prod_i$ = denotes the maize productivity at settlement *i*,

X_j = denotes if an administrative center is allocated to *j* (1 if an administrative center, 0 if otherwise),

p = the number of administrative centers to be located,

In equation (3.1), varying the weights (w_1 and w_2) allows differential emphases on the importance of agricultural productivity or site hierarchy, through the manipulation of weighted values. N_i is the set of sites eligible to cover demand node *i*. A demand point is covered when the closest administrative center is at a distance less than or equal to *S*. The coverage Y of settlement *i* by an administrative center was developed using a formula developed by Tobler (as cited in Bell and Church 1987) that relates walking speed to slope. The formula to approximate the coverage distance is as follows:

$$v = 6e^{-3.5\,|s + .05|} \qquad (2.6)$$

where

v = velocity

s = slope.

Coverage distances were restricted to distances of 1.0, 1.5, and 2.0 hours of travel.

Varying the relative emphasis on productivity and hierarchical centrality variables in the model through the manipulation of weighted values can be used in an attempt to recover the possible decision values that prehistoric administrators placed on the location of regional administrative centers. It is assumed that the optimal solution falls somewhere along the efficiency frontier (non-inferior set) with the values of w_1 and w_2 between 0 and 1. Emphasizing the values of agricultural productivity (w_1= 1) and ignoring completely the impact of hierarchical level ($w_2 = 0$), thus allowing the administrative facilities to be placed at any site, would illustrate whether the administrative sites were selected to maximize the control of the agricultural resources. Alternatively, weighting the administrative centers heavily ($w_2 = 1$) with no emphasis on agricultural productivity ($w_1 = 0$) would show the degree to which efficiency in the location of important administrative centers had primacy in maximizing control of the population. Finally, assigning both objective weighted values so that both preference valuations would countervail with each other can be used to show the degree to which centers were placed to control both the population and resources of an area simultaneously. For this study the mean predicted prehistoric agricultural yield (593 bushels) was used to calculate the weight of the production value ($w_1 = 0.00169$) so that it would countervail with the values of administrative centers having a weight value (w_2) of 1.

A location-allocation model can be used to help understand the spatial configuration of settlements in past societies. Hypotheses from previous research regarding the causality of the spatial configuration can be tested empirically to determine their likelihood of being correct. However, location-allocation models are not a substitute for more meaningful methods of archaeological research, such as analysis of archaeological materials that further refine time sequences and highlight cultural change. It is hoped that this modeling effort will serve to help direct further research in the upper Tennessee River valley study area to understand better this important indigenous culture.

3.5 Statistical Analysis

To measure the efficiency of chiefdom locations based on the location-allocation model, fifty randomly generated chiefdom settlement systems for each Mississippian phase were generated using Microsoft Excel 2000. The last time period was subdivided into a northern (Mouse Creek) and southern (Late Dallas) settlement systems as defined by the occurance of Mouse Creek cultural components.The number of randomly generated chiefdom centers coincided with the same number of real chiefdom centers serving as a sample of the thousands of possible combinations settlement systems that could be generated. During the Early Hiwassee Island period, 7 of the 73 archaeological sites occupied during this time were randomly chosen as chiefdom centers. Replicating the method an additional forty-nine times, this sample of fifty settlement systems was used to represent the 1,629,348,612 possible combinations. The randomly generated settlement systems used a linear programming optimization unlike Bell and Church's (1988) randomly generated settlement systems that used a heuristic method that did not guarantee optimality but was capable of generating many more solutions in a reasonable amount of computational (i.e., CPU) time.

Chapter 4. Results

4.1 Introduction

The results of the location-allocation model application are detailed and discussed in this chapter. This chapter is structured so as to match the methodology section. Outcomes are interpreted as to what they might reveal about the archaeological cultures examined. A brief comparison of the results with the hypotheses of field archaeologists is then made. Finally, the results for each method are scrutinized so as to reveal how closely the model reflects the theoretical views of archaeologists.

4.2 Archaeological Information Retrieval and Categorization

A geodatabase of archaeological site information was retrieved from topographic maps, state archaeological reports, various cultural resource management reports, and academic papers. A center point was located for each site found on topographic maps to allow for uniform sampling criteria of environmental and locational data. Contradictions of site boundaries, chronological timeframe, and site content inevitably occurred for a number of archaeological sites using numerous data sources. I assumed that the latest interpretations were the most accurate for each site because scientific interpretations like these are based on improving upon past theories and hypotheses. A total of 92 archaeological sites were found in the study area having a Mississippian cultural component. All the sites interpreted as having a general Mississippian cultural component that had materials found at the University of Tennessee Frank H. McClung Museum were reexamined by Dr. Lynn Sullivan, head of the museum, to try to interpret a more refined chronological timeframe. The final product of this part of the thesis was a number of separate hierarchically defined site points based upon the chronological timeframe to which each archaeological site could be interpreted.

Almost all of the larger archaeological sites (i.e. anything interpreted as a villages or a chiefdom center) have been documented with archaeological literature interpreting their chronological extent and function they probably served. Many have been extensively excavated. The rest of the sites, mainly smaller ones that do not contain large prevalent features (i.e. mounds or other earthworks, remains of house structures), have little information pertaining to their role in the settlement systems. The smaller sites contain few pottery sherds and some debris from stone tool manufacturing. A handful of these smaller sites included human burials or food storage pits. Dr. Lynn Sullivan graciously helped reexamine many of these smaller sites' pottery remains to try refining their occupation dates. Shell tempered pottery; the key characteristic of the Mississippian culture pottery, was subdivided by a stylistic typology that Dr. Sullivan and her students have established from the reexamination of many of the larger archaeological sites (e.g., Koerner 2005).

The area chronology is only partially complete for the study area. Many newly discovered sites are not listed in the state archaeology register at the Tennessee Department of Archaeology or in the McClung Files. Materials from other sites already in the Tennessee archaeological site file are not curated at the Frank H. McClung Museum and other facilities around the Southeastern United States as they are said to be in their reports. The archaeology database and chronology used in this study is, however, the best interpretation of the material from archaeological research in the study area.

4.3 Results of Estimating Pre-historic Agricultural Yields Based on Modern Soil Maps

Agriculture is seen as one of the main economic elements that societies with central place principles control. The agricultural productivity of 1-kilometer was found for each site. All of the sites containing Mississippian cultural components were found to have at least some agricultural productivity. Elite centers, villages, and hamlets were found intermingled throughout the range of agricultural productivity found. High individual site yields were not seen as a significant determinant of more complex sites. Missing data from flooded areas caused by TVA dams on the Tennessee River is a cause of some error in the data, but without pre-reservoir soil survey data, only a rough estimation of the agricultural yield for those areas could be completed. Table 4 shows the results of 1-km buffer for agricultural yield.

Table 4. Results of 1-km Buffer for Agricultural Yields.

Site Name	Estimated Bushels	Estimated Bushels With Flooded Areas
40BY7	396	426.9
40BY11	77.4	394.1
40BY13	160	169
40BY59	157.9	165.2
40HA1	37.4	902.3
40HA2	151	946.2
40HA3	465.2	482.7
40HA28	111.5	646.8
40HA53	330.5	354.5
40HA60	601.3	633.7
40HA65	0	833.1
40HA76	773.9	793.3
40HA146	950.9	967.4
40HA178	705.8	726.4
40HA179	689.3	715.3
40HA181	316.7	324.3
40HA206	417.8	438.3
40HA218	588.7	650.6
40HA220	586.2	655.3
40HA225	1017.5	1067
40HA233	290.6	347.4
40HA250	372.4	435.2
40HA275	430.9	432.9
40HA298	863.6	866.3
40HA299	819	821.7
40HA300	23.2	712.8
40HA301	36.9	182.1
40MG10	154.5	178.6
40MG12	362.9	737.4
40MG14	266.4	639.8
40MG20	50.1	500.9
40MG29	133.1	515.8
40MG30	110.1	492.8
40MG31	162.1	684.3
40MG32	120.8	899
40MG38	197.7	908.7
40MG39	81.4	927.2
40MG43	187.1	532.7
40MG46	115.7	603.2
40MG47	547.3	612.5

Table 4. Results of 1-km Buffer for Agricultural Yields.

40MG51	440.2	479.7
40MG55	454	476.8
40MG56	127.6	624.2
40MG6	241.6	242.5
40MG61	89.6	533.7
40MG62	43.3	976.1
40MG7	443.8	643.1
40MG75	366.1	537.2
40MG76	80.8	396.9
40MG81	38.4	769.9
40MG88	9.2	14.2
40MG89	141.4	925.8
40MG92	175.6	814.4
40MG94	122	827.8
40MG99	120.6	780.6
40MG100	44.4	722.4
40MG103	3.4	783.9
40MG104	425.8	708.5
40MG106	725.9	803.7
40MG143	475.3	769.5
40MG216	100.6	100.6
40MN3	188.8	398.1
40MN17	230.2	234.3
40MN26	552.7	653
40MN27	255.2	259.1
40PK1	116.2	714.2
40PK279	594.8	636
40PK285	0	0
40PK287	586.5	632.1
40PK293	637.3	688.6
40PK312	620.7	673.5
40PK313	693.7	750.4
40PK317	0	143.4
40PK319	902.1	935.3
40PK320	912.6	946.1
40PK322	614.8	640.2
40PK340	543.5	558.1
40RE12	285.3	574.7
40RE186	704.1	841.3
40RH1	296.9	331.8
40RH6	553.1	636.5
40RH7	403.5	419.1
40RH12	708.3	739.1
40RH14	645.2	691.2

Table 4. Results of 1-km Buffer for Agricultural Yields.

40RH15	419.2	724.7
40RH20	413.8	805.4
40RH30	337.5	368.4
40RH41	0	356
40RH66	230.5	719.8
40RH69	55.8	83.2
40RH78	315.2	605.8
40RH176	244.9	542.5

Sites with Mississippian components were all located in fertile floodplains of the river valleys. Estimated yields for 1-kilometer areas ranged between 0 and 1066 bushels of maize with the average yield being approximately 593 bushels. Three sites had yields below 100 bushels of maize -- 40PK285, 40MG88, and 40RH69. These small sites are located in hilly upland environments in soil complexes not conducive to agriculture. The largest and most complex site in the area, Hiwassee Island (40MG31), has a predicted yield of 684. Based on a single sample t-test, the Hiwassee Island (40MG31) site yield is statistically significantly higher ($t = -3.58$, $p = .0006$) than the mean agricultural yield but not is not the largest agricultural yield found. As shown in Figure 11, many of the most predictive sites are located near the Hiwassee Island site (40MG31).

Sections of the study area were flooded by various TVA projects. To compensate for the missing information, all these areas were considered average in terms of growing maize. The three mound complexes of Dallas (40HA1), Davis (40HA2) and Hixon (40HA3) as shown in Figure 11 are located very close to each other. Hixon (40HA3) and Davis (40HA2) sites have yields of about 950 and 465 bushels of maize respectively before flooded areas were calculated and 967 and 482 afterwards. In contrast to this relatively stable estimates Dallas (40HA1) site has a very low yield of 151 bushels respectively before flooded areas were calculated and very high yields of 946 after flooded areas were taken into account. In future models more steps could be considered to better estimate the agricultural potential of these areas.

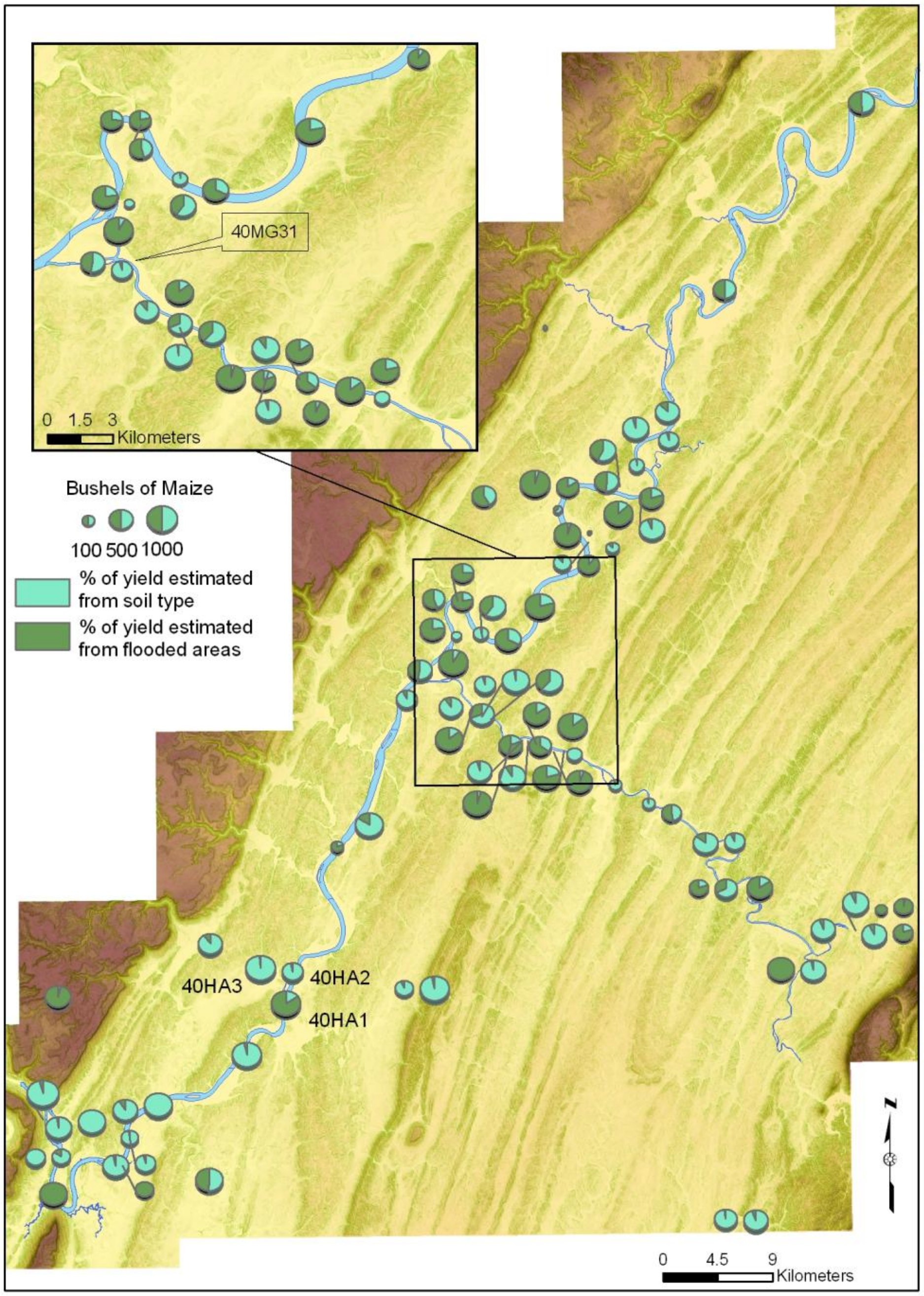


Figure 11. The Estimated Yields of All Sites in the Study Area.

One possibility of estimating the agricultural yields of flooded areas is to use non-flooded areas to estimate yields of areas similar in geomorphology. Average native yields of maize can be calculated for each of the non-flooded terraces and floodplain areas. The topography of the flooded areas, obtained from bathymetric data, can then be used to estimate the locations of various terraces and floodplain. The bathymetric data are currently available only on paper maps. Estimating the yields of the flooded areas in this manner would take a considerable amount of time and effort to gather these data. A constraint of money and time made such estimation infeasible but is something that future researchers might with to accomplish.

4.4 Location-allocation Model

The decision values that prehistoric administrators placed on the location of regional administrative centers can be expressed in the location-allocation model. The primary variables of the model are: 1) the coverage distance; and 2) the preference valuations. Running the model with each of these variables set at different values can inform us about the different role each of the variables might have played in the decision making strategies of prehistoric administrators. To test each settlement system's central place tendencies, the actual settlement system's output was compared with 50 randomly generated settlement systems. The number of higher-order administrative centers remained the same in each settlement system but their locations were randomly assigned among the set of settlements to be served. Great emphasis was placed upon maximally efficient coverage of settlements from higher-order administrative centers. Aggregating every model that was run, the cumulative distribution of the randomly generated settlement systems was found to conform statistically to a normal distribution.

The results of the location-allocation models are displayed in Table 5 and Figures 12 through 23. Tables 5 through 10 display tabular data about each run. Table 11 displays the tabular data about the overall results. Figures 12, 17, 22, 27, 32, 37 display the results of all the multivariate location-allocation models during each phase that was studied. Figures 13-16, 18-21, 23-26, 32-26, 38-41 displays the results of each model run in comparison to the randomly generated settlement systems in each phase. In the table and each figure, the first value displayed is “Coverage Area”. This value represents a general comparison of the area that was covered by different settlement systems under various distances and not an actual model run. Three model that were run for each settlement system are then displayed and named after the general goal of the model: Agricultural Coverage; Sites Covered; and Agriculture and Population Coverage. In the figures that follow, the bar graphs indicate the percentage of randomly generated chiefdom centers that the actual chiefdom centers had a larger score than.

Table 5. Randomly Generated Settlement System Results During the Early Hiwassee Island Phase (1000-1200 AD.).

Model Run	Coverage (hectares)	Agricultural Coverage (bushels)	Sites Covered	Agriculture and Population Coverage
1	11668.68	13512.83	41	63.84
2	11689.47	15112.92	44	69.54
3	8840.25	22081.68	53	90.32
4	7904.64	10557.40	36	53.84
5	7765.80	16509.63	42	69.90
6	10577.35	9294.39	34	49.71
7	10274.82	14953.79	43	68.27
8	8635.69	16847.11	45	73.47
9	10463.11	22673.80	55	93.32
10	7389.58	19234.18	47	79.51
11	9954.75	16677.49	45	73.18
12	12727.56	21912.06	53	90.03
13	8987.21	17147.76	45	73.98
14	7834.80	18554.61	47	78.36
15	10504.02	19565.21	49	82.07
16	7830.60	17566.89	46	75.69
17	9221.62	14441.02	39	63.41
18	9237.00	20436.19	50	84.54
19	13875.54	11681.76	37	56.74
20	11282.01	18893.87	49	80.93
21	11282.01	19737.64	50	83.36
22	11061.55	8256.86	32	45.95
23	10430.57	13512.83	41	63.84
24	9516.75	15112.92	44	69.54
25	10166.62	22081.68	53	90.32
26	10547.68	10557.40	36	53.84
27	7783.25	16509.63	42	69.90
28	11668.68	9294.39	34	49.71
29	8840.25	14953.79	43	68.27
30	7904.64	16847.11	45	73.47
31	12751.28	22673.80	55	93.32
32	5401.96	19234.18	47	79.51
33	8477.64	18834.17	50	81.83
34	9954.75	16677.49	45	73.18
35	12727.56	21912.06	53	90.03
36	7834.80	17147.76	45	73.98
37	10504.02	18554.61	47	78.36
38	7830.60	19565.21	49	82.07
39	9221.62	17566.89	46	75.69

Table 5. Randomly Generated Settlement System Results During the Early Hiwassee Island Phase (1000-1200 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
40	9237.00	14441.02	39	63.41
41	13875.54	20436.19	50	84.54
42	11282.01	21477.15	51	87.30
43	11994.75	11681.76	37	56.74
44	7532.35	18893.87	49	80.93
45	11061.55	14840.72	42	67.08
46	10430.57	16511.23	44	71.90
47	9516.75	22747.73	54	92.44
48	10166.62	12477.42	39	60.09
49	10547.68	19155.77	48	80.37
50	7783.25	11211.34	37	55.95

Table 6. Randomly Generated Settlement System Results During the Late Hiwassee Island Phase (1200-1300 AD.).

Model Run	Coverage (hectares)	Agricultural Coverage (bushels)	Sites Covered	Agriculture and Population Coverage
1	15918.0	7843.09	21	34.25
2	8006.8	15213.95	33	58.71
3	8987.2	13313.67	28	50.50
4	17819.1	14592.97	33	57.66
5	9045.3	17537.99	37	66.64
6	9093.4	16342.24	35	62.62
7	7618.9	12929.62	29	50.85
8	18641.1	15213.95	33	58.71
9	11378.1	13651.88	30	53.07
10	17514.7	16342.24	35	62.62
11	11288.6	12200.87	28	48.62
12	7807.8	8479.63	22	36.33
13	17094.1	10513.37	25	42.77
14	11910.6	11832.00	28	48.00
15	18084.4	9743.37	26	42.47
16	9657.7	9027.35	25	40.26
17	7805.4	6596.94	20	31.15
18	7543.3	7107.33	22	34.01
19	11473.2	11351.39	29	48.18
20	8811.4	11195.47	27	45.92
21	17514.7	17003.76	36	64.74
22	11288.6	16342.24	35	62.62
23	7807.8	14679.72	32	56.81
24	17094.1	15157.98	31	56.62
25	11910.6	13313.67	28	50.50
26	18084.4	13018.82	31	53.00
27	9657.7	13511.27	31	53.83
28	7805.4	8055.87	23	36.61
29	7543.3	7107.33	22	34.01
30	11473.2	7107.33	22	34.01
31	8811.4	16468.37	34	61.83
32	9116.7	17003.76	36	64.74
33	10713.9	16342.24	35	62.62
34	13159.0	14679.72	32	56.81
35	8581.8	15157.98	31	56.62
36	4947.2	13313.67	28	50.50
37	9765.1	13018.82	31	53.00

Table 6. Randomly Generated Settlement System Results During the Late Hiwassee Island Phase (1200-1300 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
38	8794.7	13511.27	31	53.83
39	10210.6	8055.87	23	36.61
40	10186.6	7107.33	22	34.01
41	18757.9	11195.47	27	45.92
42	11671.9	16468.37	34	61.83
43	7729.7	12803.49	30	51.64
44	8339.1	16342.24	35	62.62
45	19499.8	16311.58	34	61.57
46	10713.9	10694.78	27	45.07
47	8125.5	5053.51	18	26.54
48	10941.4	16342.24	35	62.62
49	8341.3	12869.34	28	49.75
50	11276.8	12869.34	28	49.75

Table 7. Randomly Generated Settlement System Results During the Early Dallas Phase (1300-1400 AD.)

Model Run	Coverage (hectares)	Agricultural Coverage (bushels)	Sites Covered	Agriculture and Population Coverage
1	4855.64	8096.12	15	28.68
2	6385.62	10900.34	21	39.42
3	6051.73	14057.83	23	46.76
4	6647.85	13919.70	25	48.52
5	8854.60	15439.57	26	52.09
6	6385.62	8706.77	18	32.71
7	6431.52	6309.94	14	24.66
8	8543.77	8096.12	15	28.68
9	5885.23	13619.02	21	44.02
10	7771.01	3712.89	9	15.27
11	6054.40	12669.43	21	42.41
12	4796.63	12099.15	20	40.45
13	8870.73	10900.34	21	39.42
14	4868.47	3712.89	9	15.27
15	6431.52	11265.55	19	38.04
16	6051.73	13086.10	24	46.12
17	8885.17	8706.77	18	32.71
18	8885.17	5902.56	12	21.98
19	6054.40	4349.42	10	17.35
20	7771.01	3712.89	9	15.27
21	6054.40	12363.22	20	40.89
22	5327.23	13919.70	25	48.52
23	6431.52	4142.26	9	16.00
24	7756.58	10686.55	19	37.06
25	6832.08	15439.57	26	52.09
26	7771.01	2528.87	5	9.27
27	6360.08	13919.70	25	48.52
28	7542.62	10900.34	21	39.42
29	6233.65	5605.23	11	20.47
30	6054.40	10686.55	19	37.06
31	6054.40	15439.57	26	52.09
32	7545.67	10281.88	18	35.38
33	8854.60	13578.10	22	44.95
34	3793.58	11265.55	19	38.04
35	5956.86	15439.57	26	52.09
36	8885.17	15439.57	26	52.09
37	7685.14	5398.06	10	19.12
38	3838.61	13149.16	22	44.22

Table 7. Randomly Generated Settlement System Results During the Early Dallas Phase (1300-1400 AD.)

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
39	8854.60	13919.70	25	48.52
40	7740.45	11265.55	19	38.04
41	7709.12	8096.12	15	28.68
42	5327.23	2528.87	5	9.27
43	3611.04	9079.79	16	31.34
44	3581.07	10206.81	18	35.25
45	3093.82	15439.57	26	52.09
46	7725.11	10281.88	18	35.38
47	4091.91	12099.15	20	40.45
48	4855.64	8096.12	15	28.68
49	6360.08	13919.70	25	48.52
50	4796.63	8096.12	15	28.68

Table 8. Randomly Generated Settlement System Results During the Middle Dallas Phase (1400-1500 AD.).

Model Run	Coverage (hectares)	Agricultural Coverage (bushels)	Sites Covered	Agriculture and Population Coverage
1	4855.64	8096.12	15	28.68
2	6385.62	10900.34	21	39.42
3	6051.73	14057.83	23	46.76
4	6647.85	13919.70	25	48.52
5	8854.60	15439.57	26	52.09
6	6385.62	8706.77	18	32.71
7	6431.52	6309.94	14	24.66
8	8543.77	8096.12	15	28.68
9	5885.23	13619.02	21	44.02
10	7771.01	3712.89	9	15.27
11	6054.40	12669.43	21	42.41
12	4796.63	12099.15	20	40.45
13	8870.73	10900.34	21	39.42
14	4868.47	3712.89	9	15.27
15	6431.52	11265.55	19	38.04
16	6051.73	13086.10	24	46.12
17	8885.17	8706.77	18	32.71
18	8885.17	5902.56	12	21.98
19	6054.40	4349.42	10	17.35
20	7771.01	3712.89	9	15.27
21	6054.40	12363.22	20	40.89
22	5327.23	13919.70	25	48.52
23	6431.52	4142.26	9	16.00
24	7756.58	10686.55	19	37.06
25	6832.08	15439.57	26	52.09
26	7771.01	2528.87	5	9.27
27	6360.08	13919.70	25	48.52
28	7542.62	10900.34	21	39.42
29	6233.65	5605.23	11	20.47
30	6054.40	10686.55	19	37.06
31	6054.40	15439.57	26	52.09
32	7545.67	10281.88	18	35.38
33	8854.60	13578.10	22	44.95
34	3793.58	11265.55	19	38.04
35	5956.86	15439.57	26	52.09
36	8885.17	15439.57	26	52.09
37	7685.14	5398.06	10	19.12
38	3838.61	13149.16	22	44.22

Table 8. Randomly Generated Settlement System Results During the Middle Dallas Phase (1400-1500 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
39	8854.60	13919.70	25	48.52
40	7740.45	11265.55	19	38.04
41	7709.12	8096.12	15	28.68
42	5327.23	2528.87	5	9.27
43	3611.04	9079.79	16	31.34
44	3581.07	10206.81	18	35.25
45	3093.82	15439.57	26	52.09
46	7725.11	10281.88	18	35.38
47	4091.91	12099.15	20	40.45
48	4855.64	8096.12	15	28.68
49	6360.08	13919.70	25	48.52
50	4796.63	8096.12	15	28.68

Table 9. Randomly Generated Settlement System Results in the Southern Section of the Study area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.).

Model Run	Coverage (hectares)	Agricultural Coverage (bushels)	Sites Covered	Agriculture and Population Coverage
1	418.59	2996.19	6	10.56
2	550.48	3350.98	6	11.66
3	521.70	4896.16	8	15.77
4	573.09	2340.89	5	8.62
5	763.33	3660.67	6	11.85
6	550.48	2060.84	4	7.82
7	554.44	3315.70	6	11.44
8	736.53	3735.50	6	12.48
9	507.35	5027.45	8	16.33
10	669.91	4264.79	7	13.71
11	521.93	3697.89	6	12.42
12	413.50	4858.55	8	15.71
13	764.72	3802.16	6	12.59
14	419.70	4114.10	6	13.45
15	554.44	4338.18	7	14.16
16	521.70	3895.10	6	12.92
17	765.96	3202.00	5	10.58
18	765.96	4531.31	7	14.66
19	521.93	2590.19	5	9.21
20	669.91	4189.33	7	13.91
21	521.93	4376.42	7	14.40
22	459.24	1830.79	4	7.09
23	554.44	2996.19	6	10.56
24	668.67	3350.98	6	11.66
25	588.97	4896.16	8	15.77
26	669.91	2340.89	5	8.62
27	548.28	3660.67	6	11.85
28	650.23	2060.84	4	7.82
29	537.38	3315.70	6	11.44
30	521.93	3735.50	6	12.48
31	521.93	5027.45	8	16.33
32	650.49	4264.79	7	13.71
33	763.33	4176.09	7	14.06
34	327.03	3697.89	6	12.42
35	513.52	4858.55	8	15.71
36	765.96	3802.16	6	12.59

Table 9. Randomly Generated Settlement System Results in the Southern Section of the Study area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
37	662.51	4114.10	6	13.45
38	330.91	4338.18	7	14.16
39	763.33	3895.10	6	12.92
40	667.28	3202.00	5	10.58
41	664.58	4531.31	7	14.66
42	459.24	4762.12	7	15.21
43	311.30	2590.19	5	9.21
44	308.71	4189.33	7	13.91
45	266.71	3290.63	6	11.23
46	665.96	3661.03	6	12.19
47	352.75	5043.84	8	16.19
48	418.59	2766.61	5	9.84
49	548.28	4247.40	7	13.84
50	413.50	2485.88	5	9.03

Table 10. Randomly Generated Settlement System Results in the Northern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
1	27446.40	11764.64	14	33.88
2	13805.63	22820.93	16	54.57
3	15496.08	19970.50	17	50.75
4	30724.29	21889.45	18	54.99
5	15596.25	26306.99	18	62.46
6	15679.15	24513.35	18	59.43
7	13136.83	19394.44	18	50.78
8	32141.63	22820.93	18	56.57
9	19618.59	20477.82	19	53.61
10	30199.42	24513.35	19	60.43
11	19464.17	18301.31	21	51.93
12	13462.52	12719.44	21	42.50
13	29474.22	15770.05	22	48.65
14	20536.70	17748.00	23	52.99
15	31181.74	14615.06	23	47.70
16	16652.15	13541.03	23	45.88
17	13458.44	9895.41	24	40.72
18	13006.42	10661.00	24	42.02
19	19782.49	17027.09	24	52.78
20	15192.90	16793.20	24	52.38
21	30199.42	25505.64	24	67.10
22	19464.17	24513.35	24	65.43
23	13462.52	22019.57	24	61.21
24	29474.22	22736.97	25	63.43
25	20536.70	19970.50	25	58.75
26	31181.74	19528.23	26	59.00
27	16652.15	20266.91	26	60.25
28	13458.44	12083.80	27	47.42
29	13006.42	10661.00	27	45.02
30	19782.49	10661.00	27	45.02
31	15192.90	24702.56	27	68.75
32	15719.43	25505.64	27	70.10
33	18473.31	24513.35	27	68.43
34	22689.21	22019.57	28	65.21
35	14796.99	22736.97	28	66.43
36	8530.19	19970.50	29	62.75
37	16837.35	19528.23	29	62.00

Table 10. Randomly Generated Settlement System Results in the Northern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.).

Model Run	**Coverage (hectares)**	**Agricultural Coverage (bushels)**	**Sites Covered**	**Agriculture and Population Coverage**
38	15164.21	20266.91	29	63.25
39	17605.55	12083.80	30	50.42
40	17564.19	10661.00	30	48.02
41	32343.03	16793.20	30	58.38
42	20125.08	24702.56	31	72.75
43	13327.77	19205.23	31	63.46
44	14378.54	24513.35	31	72.43
45	33622.25	24467.36	31	72.35
46	18473.31	16042.16	31	58.11
47	14010.25	7580.26	31	43.81
48	18865.49	24513.35	32	73.43
49	14382.36	19304.02	32	64.62
50	19443.95	19304.02	33	65.62

Table 11. The Results of the Location-allocation Models.

	Settlements	Chiefdom Centers	Coverage (hectares) 1 hour	1.5 hours	2 hours	%*	Agricultural Coverage (bushels) 1	1.5	2	%*	Sites Covered 1	1.5	2	%*
Early Hiwassee	73	7	11803	15859.1	20371.9	100%	10687.76	13071.41	17098.25	51%	26	29	36	37%
Late Hiwassee	68	4	5424	8966.9	13580.7	78%	5536.3	8391.1	13371.91	56%	6	22	33	71%
Early Dallas	68	2	4172	6017.9	8971.1	100%	5477.21	7660.24	15109.95	89%	10	13	25	80%
Middle Dallas	66	2	3300	5502.5	8351.3	85%	8113.32	9798	12893.84	68%	15	18	23	76%
Late Dallas	17	2	385	568.6	684.6	84%	1834.01	2484.57	4183.89	64%	4	5	7	84%
Mouse Creek	59	9	5424	8966.9	13580.7	17%	13604.36	16066.97	17731.81	35%	22	25	30	78%

	Agriculture and Population Coverage Value	%*
Early Hiwassee	64.8960	42%
Late Hiwassee	55.5985	63%
Early Dallas	50.5358	89%
Middle Dallas	42.7906	73%
Late Dallas	14.0708	74%
Mouse Creek	59.9668	56%

* Value refers to the percentage of randomly generated chiefdom centers that the actual chiefdom centers had a larger score than

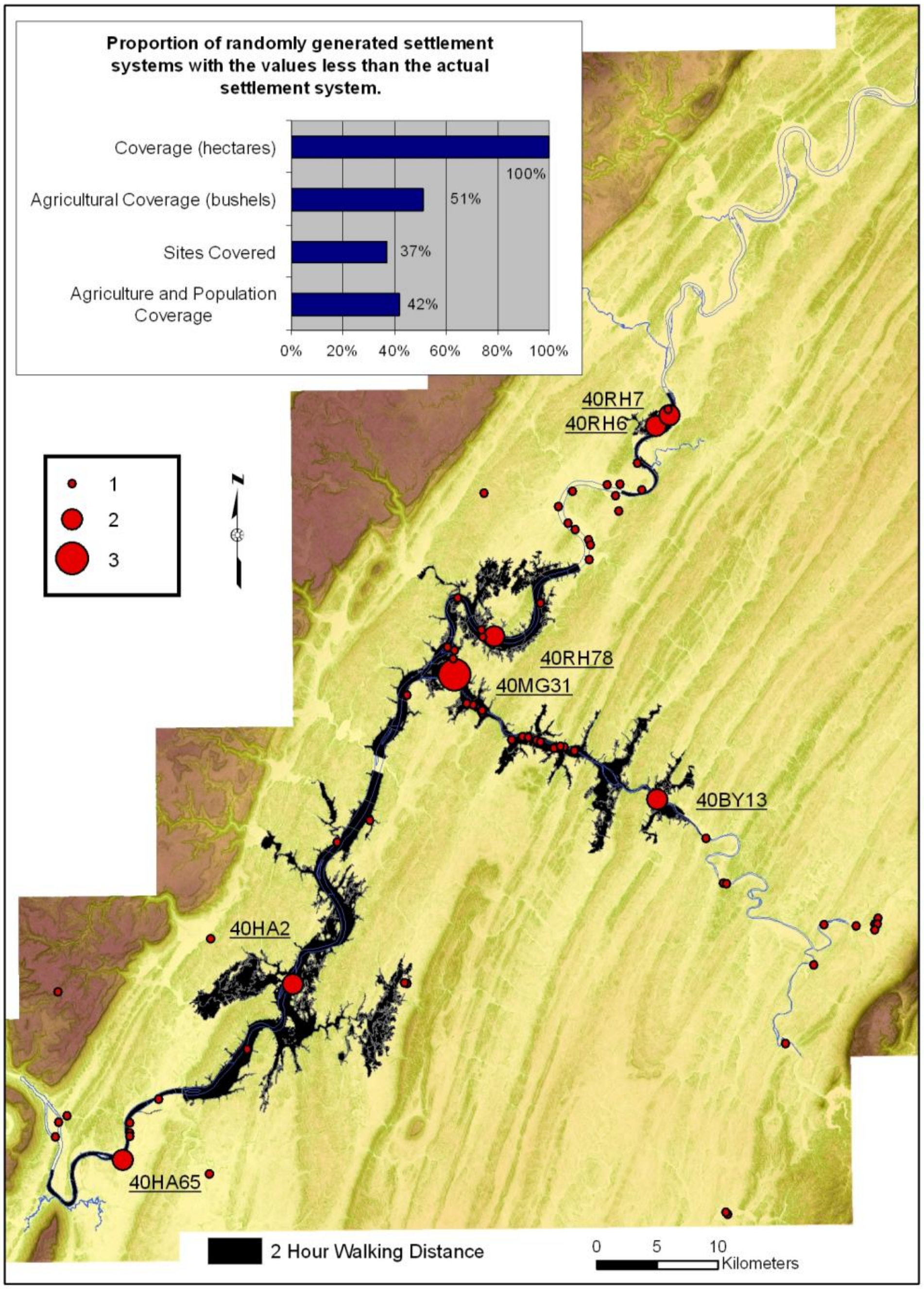


Figure 12. The Results of the Multivariate Location-allocation Model During the Early Hiwassee Island Phase (1000-1200 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour Walk of Those Locations.

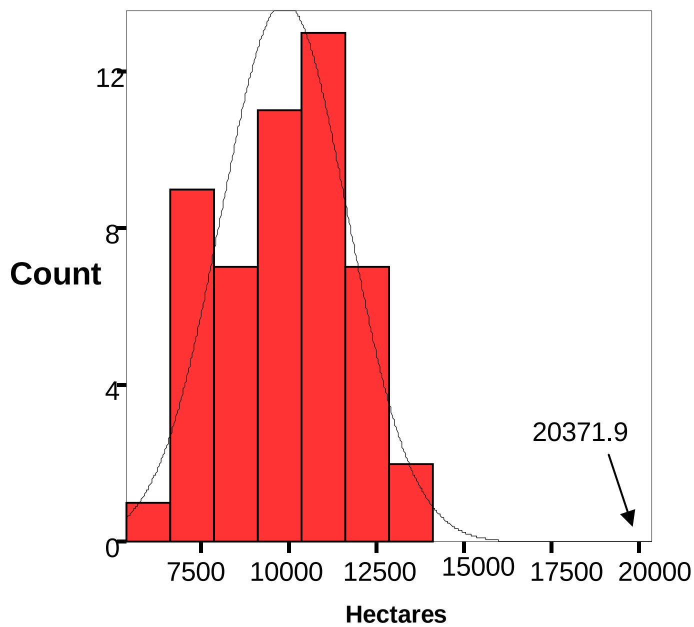


Figure 13. The Distribution of 50 Randomly Generated Settlement Systems Total Coverage Area During the Early Hiwassee Island Phase (1000-1200 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

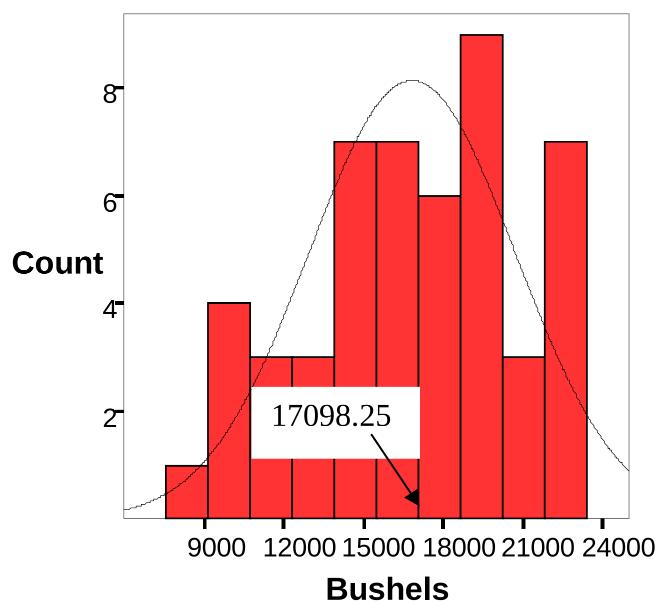


Figure 14. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural During the Early Hiwassee Island Phase (1000-1200 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

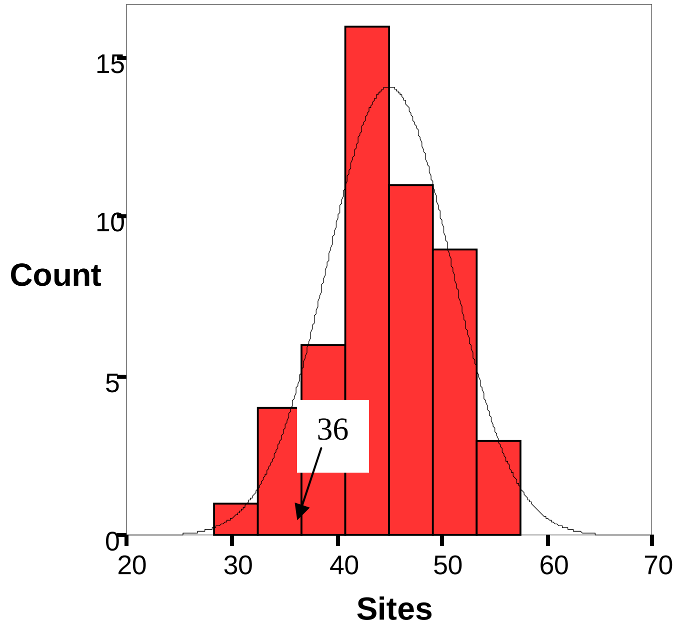


Figure 15. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Population During the Early Hiwassee Island Phase (1000-1200 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

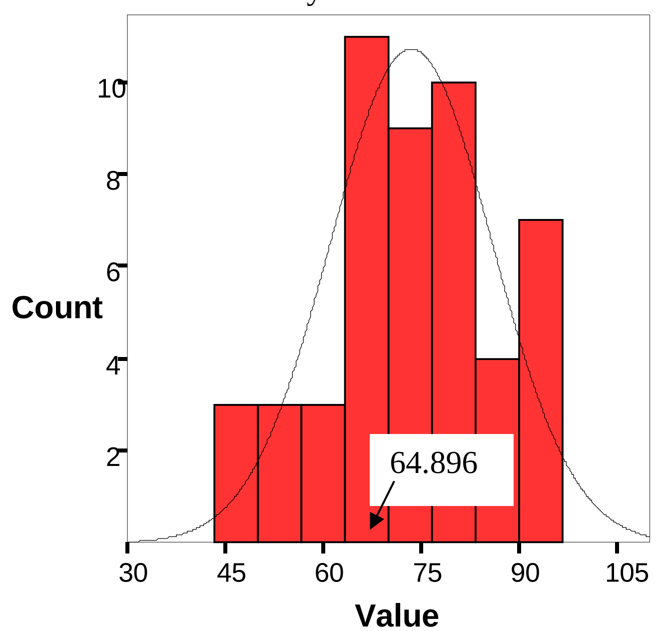


Figure 16. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural and Population During the Early Hiwassee Island Phase (1000-1200 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

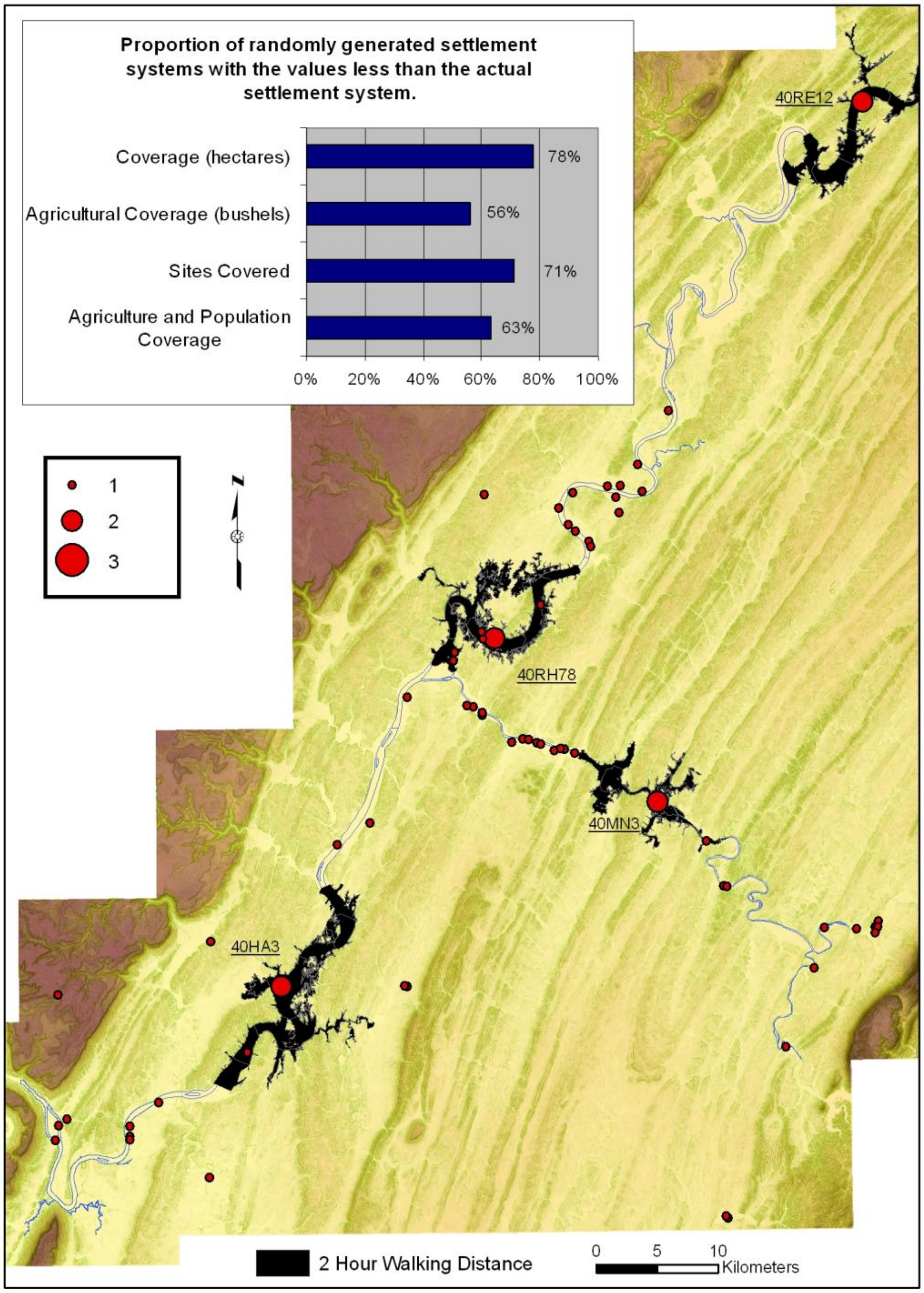


Figure 17. The Results of the Multivariate Location-allocation Model During the Late Hiwassee Island Phase (1200-1300 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour Walk of Those Locations.

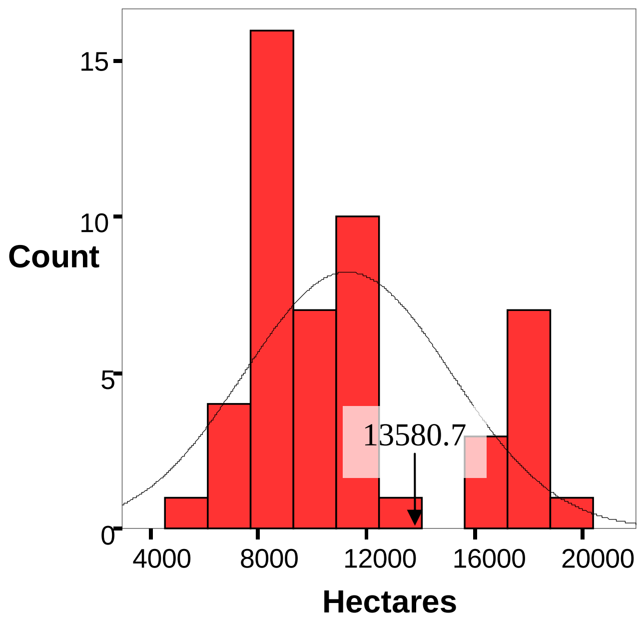


Figure 18. The Distribution of 50 Randomly Generated Settlement Systems' Total Coverage During the Late Hiwassee Island Phase (1200-1300 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

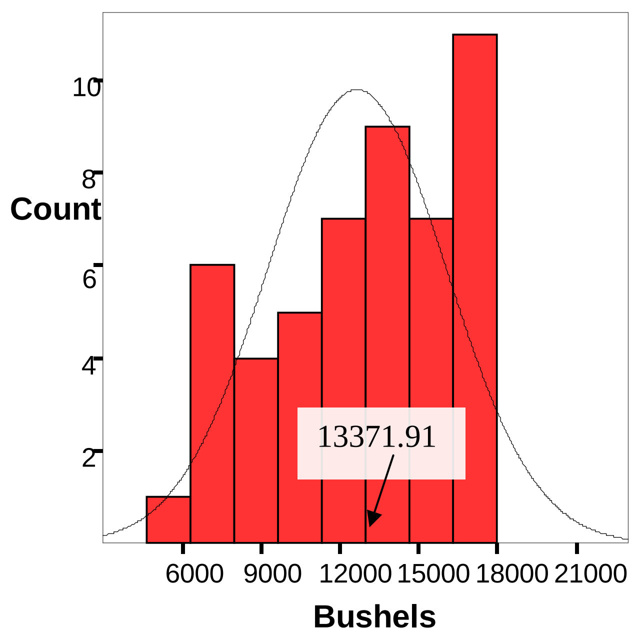


Figure 19. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural During the Late Hiwassee Island Phase (1200-1300 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

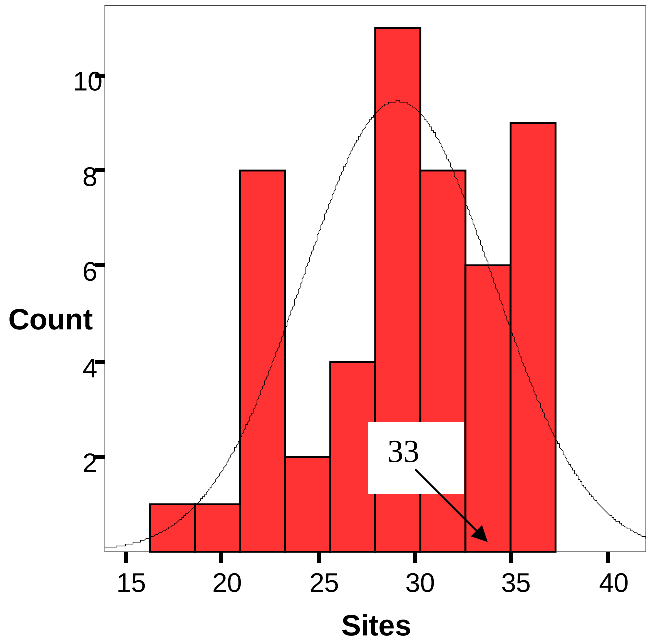


Figure 20. The Distribution of 50 Randomly Generated Settlement Systems’ Potential For the Control of Population During the Late Hiwassee Island Phase (1200-1300 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

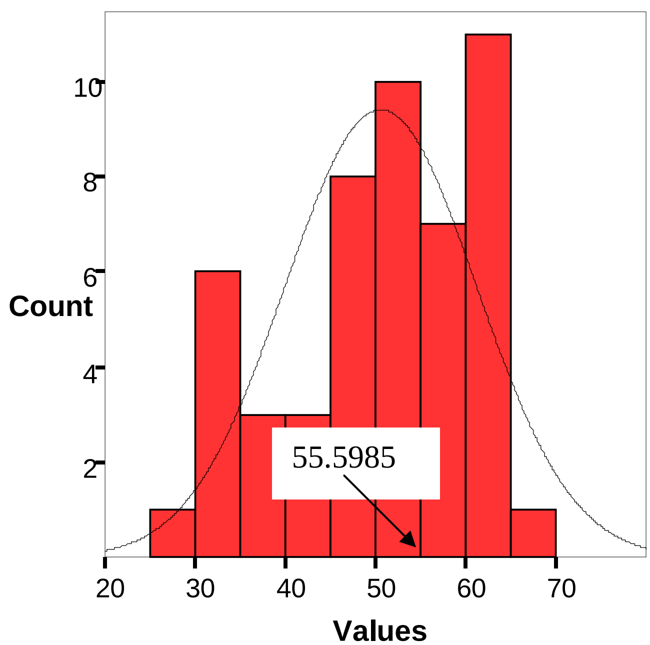


Figure 21. The Distribution of 50 Randomly Generated Settlement Systems’ Potential For the Control of Agricultural and Population During the Late Hiwassee Island Phase (1200-1300 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

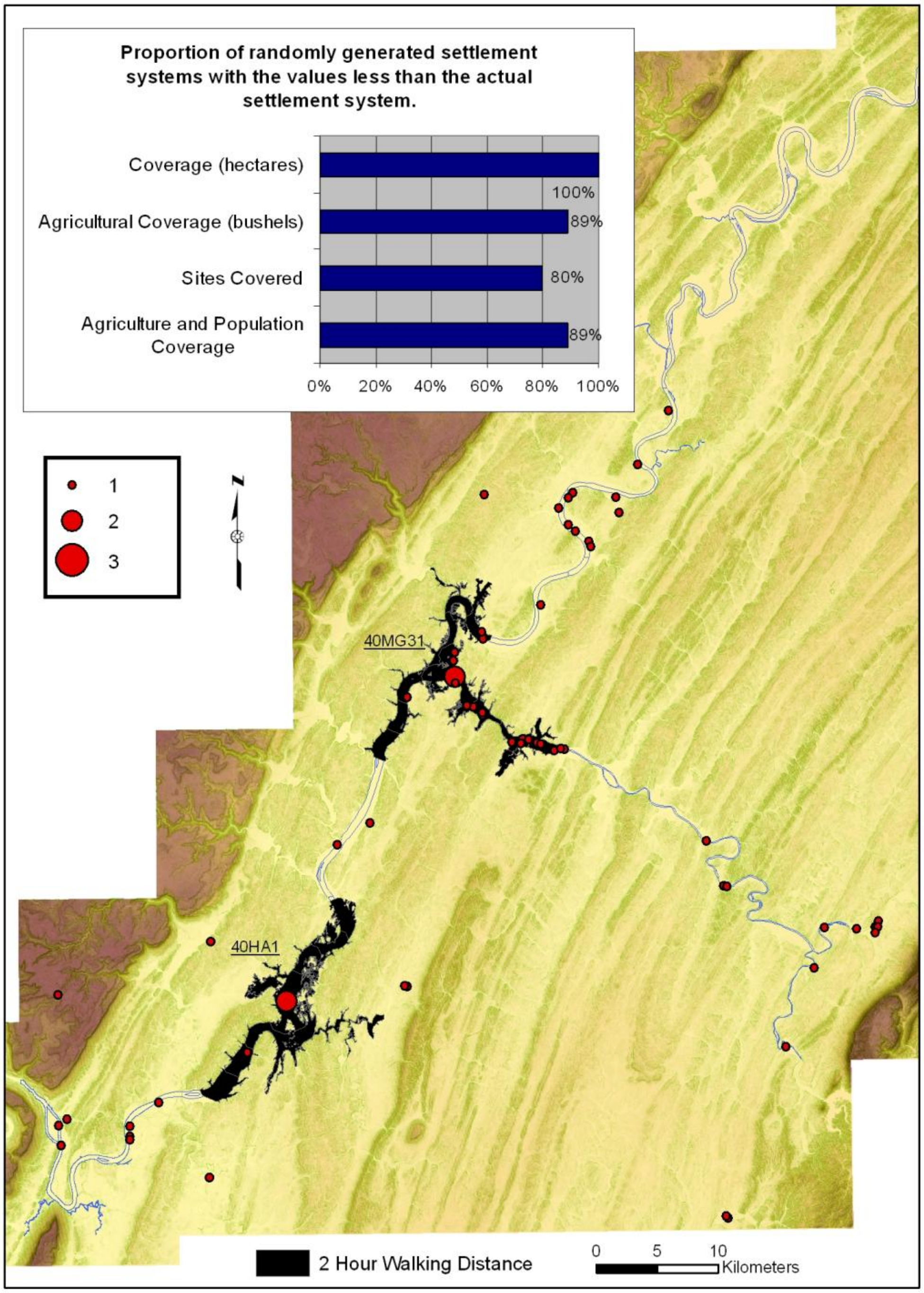


Figure 22. The Results of the Multivariate Location-allocation Model During the Early Dallas Phase (1300-1400 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour walk of Those Locations.

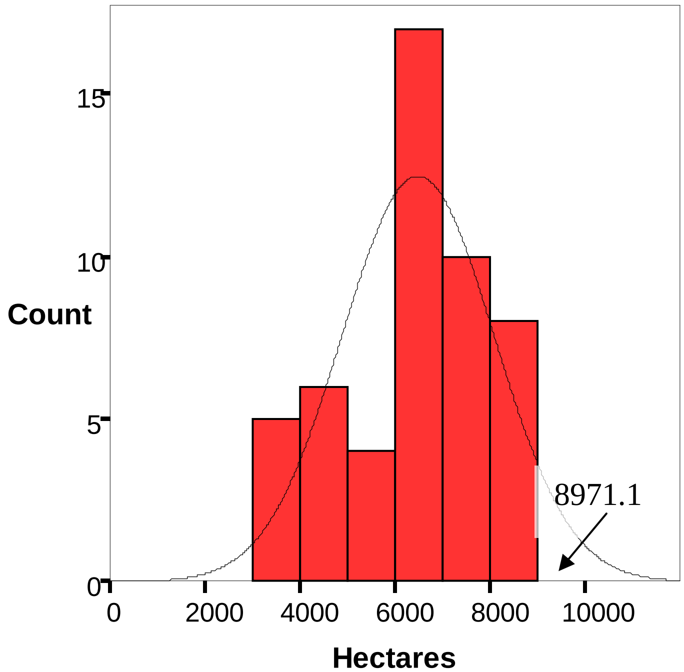


Figure 23. The Distribution of 50 Randomly Generated Settlement Systems' Total Coverage During the Early Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

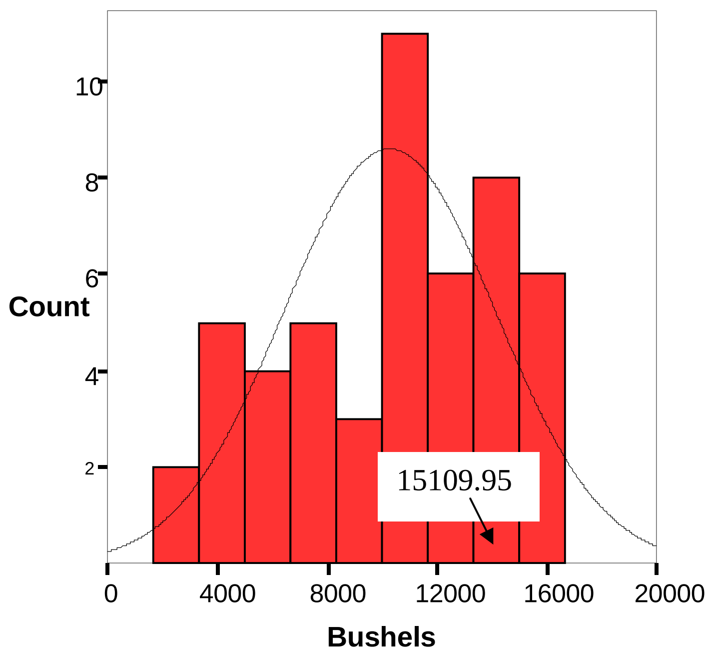


Figure 24. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural During the Early Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems

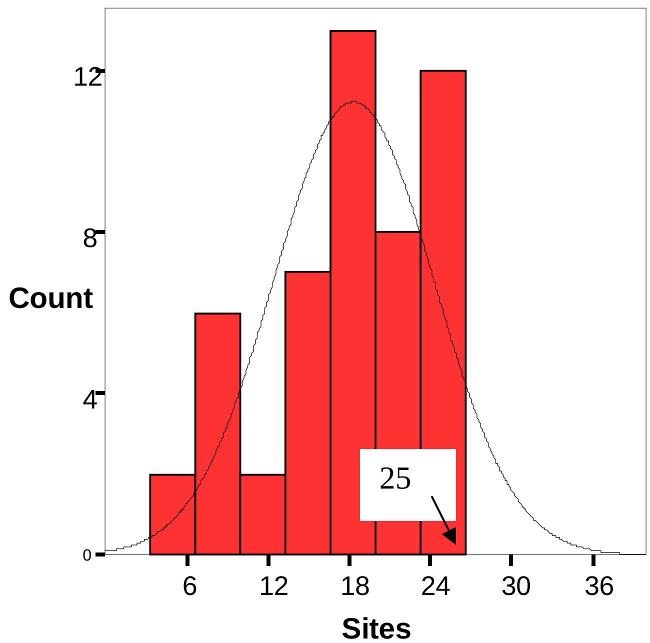


Figure 25. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Population During the Early Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems

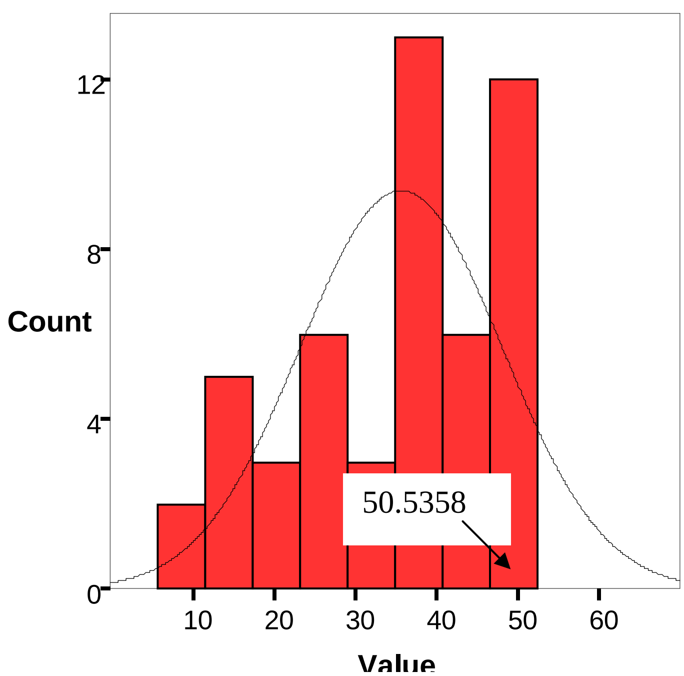
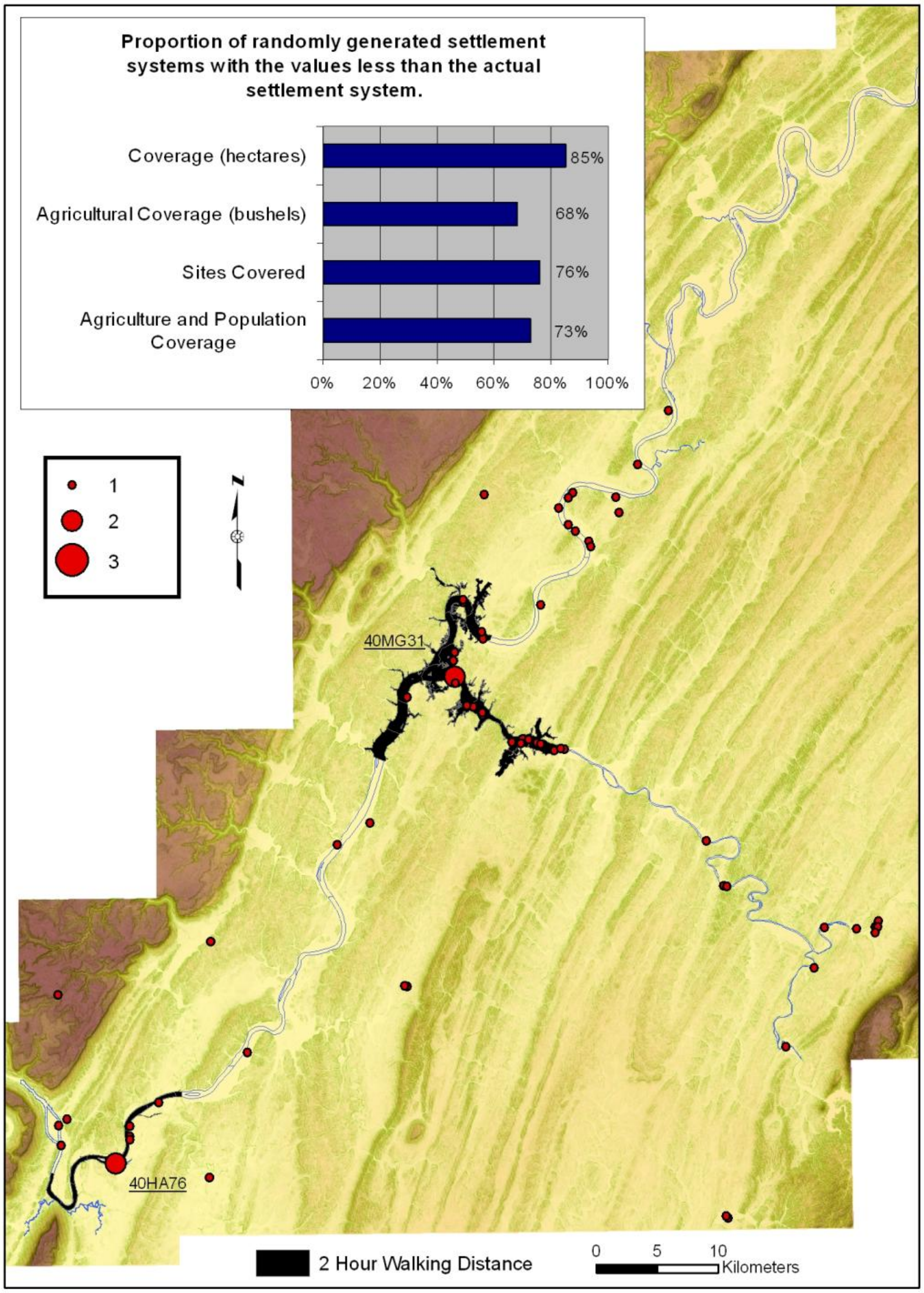


Figure 26. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural and Population During the Early Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.



Proportion of randomly generated settlement systems with the values less than the actual settlement system.
Coverage (hectares)
85%
Agricultural Coverage (bushels)
68%
Sites Covered
76%
Agriculture and Population Coverage
73%
0%
20%
40%
60%
80%
100%
1
2
3
40MG31
40HA76
2 Hour Walking Distance
0
5
10
Kilometers

Figure 27. The Results of the Multivariate Location-allocation Model During the Middle Dallas Phase (1300-1400 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour Walk of Those Locations.

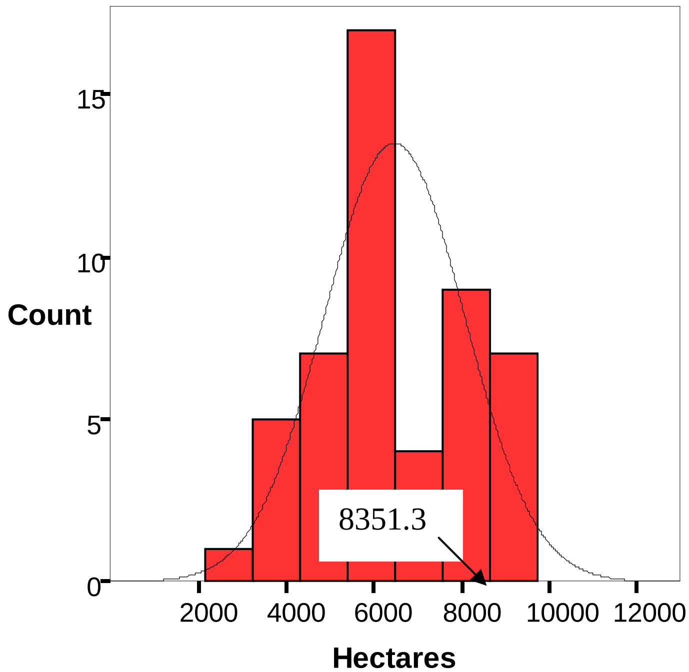


Figure 28. The Distribution of 50 Randomly Generated Settlement Systems' Total Coverage During the Middle Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

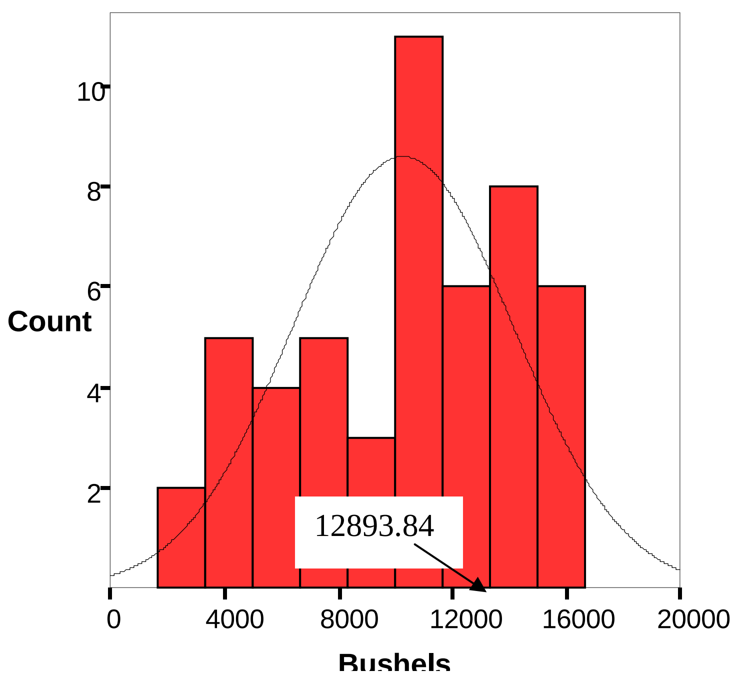


Figure 29. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural During the Middle Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

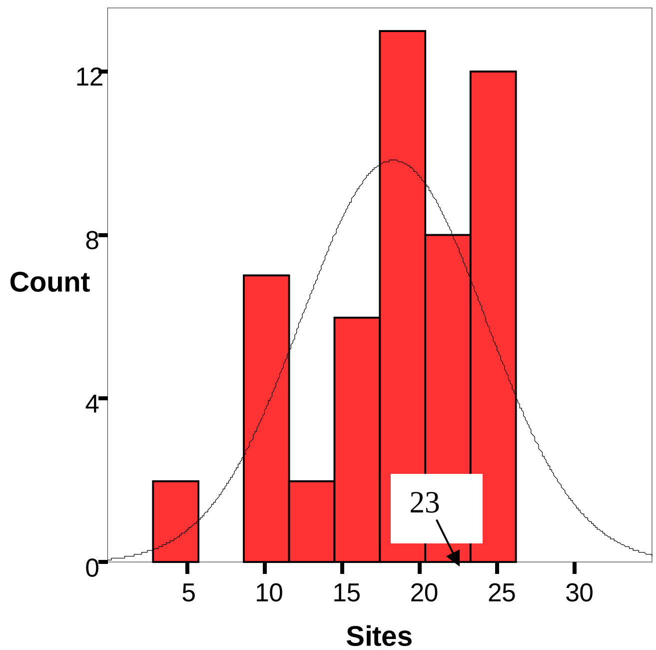


Figure 30. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Population During the Middle Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

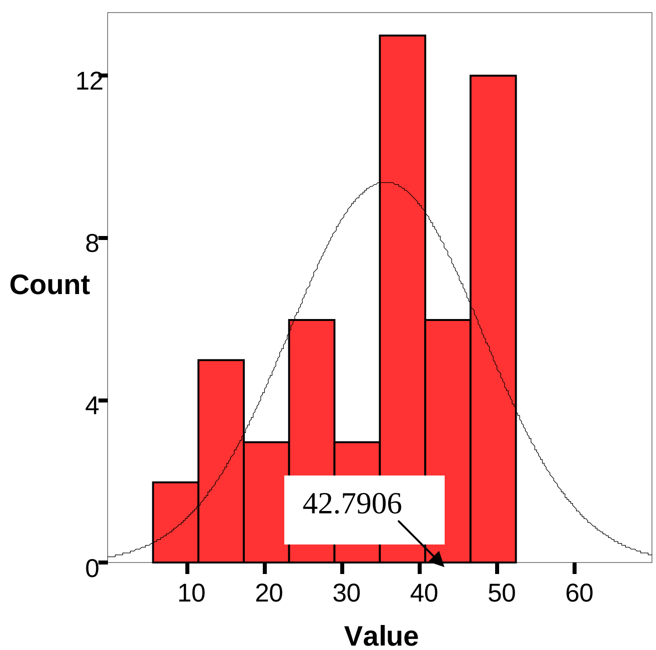


Figure 31. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agricultural and Population During the Middle Dallas Phase (1300-1400 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

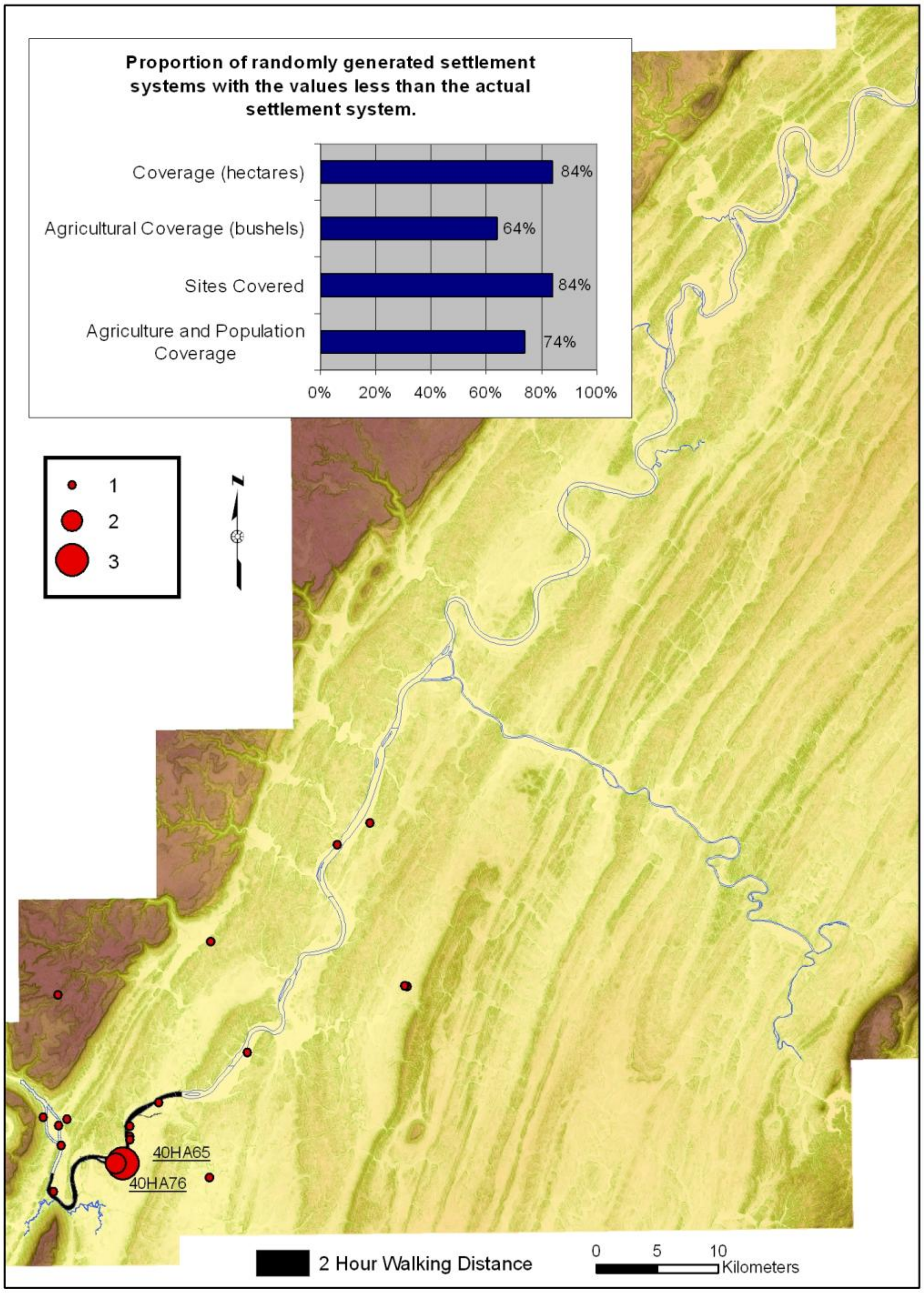


Figure 32. The Results of the Multivariate Location-allocation Model in the Southern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour Walk of Those Locations.

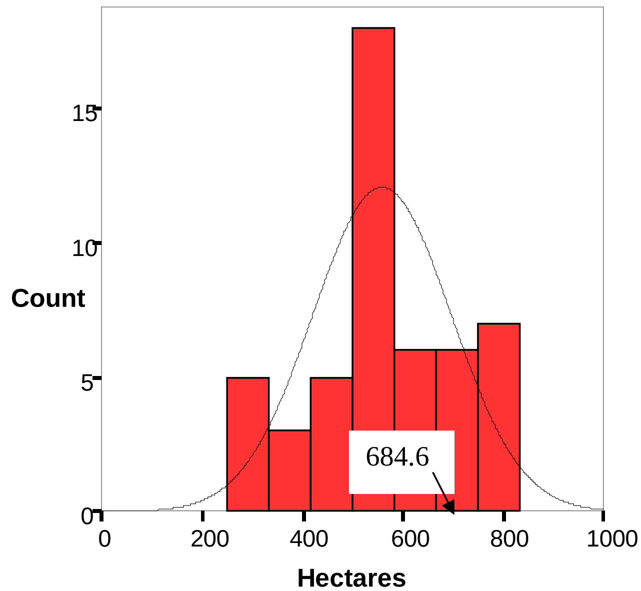


Figure 33. The Distribution of 50 Randomly Generated Settlement Systems' Total Coverage in the Southern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

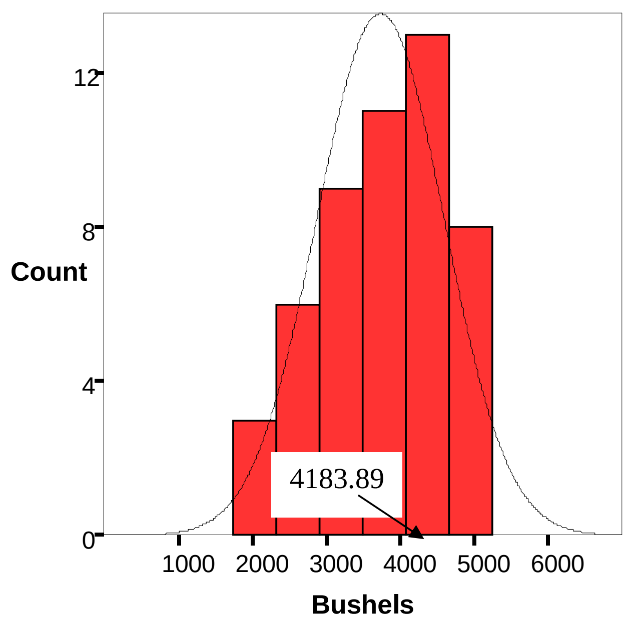


Figure 34. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agriculture in the Southern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

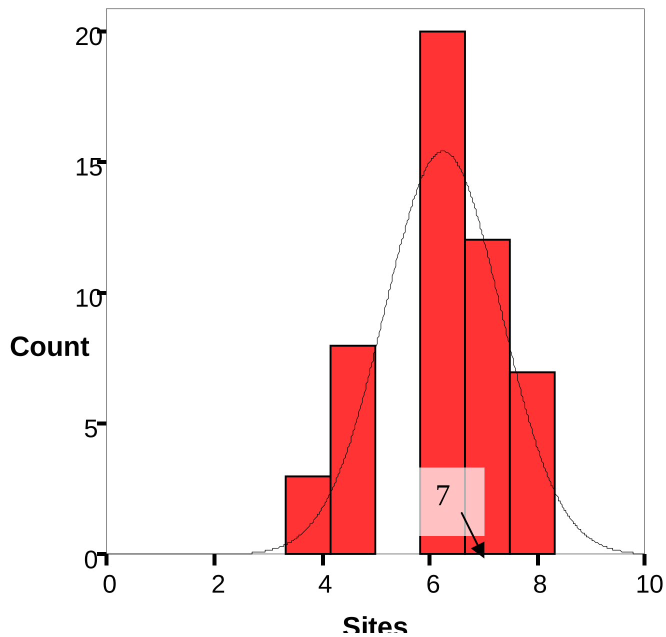


Figure 35. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Population in the Southern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

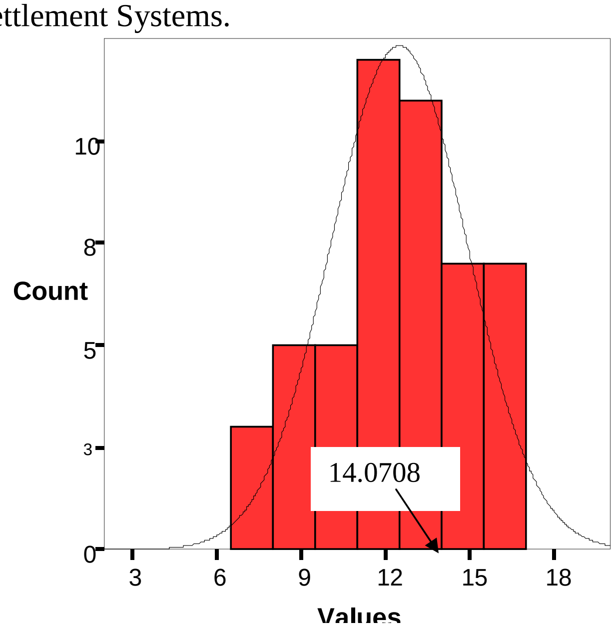


Figure 36. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agriculture and Population in the Southern Section of the Study area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

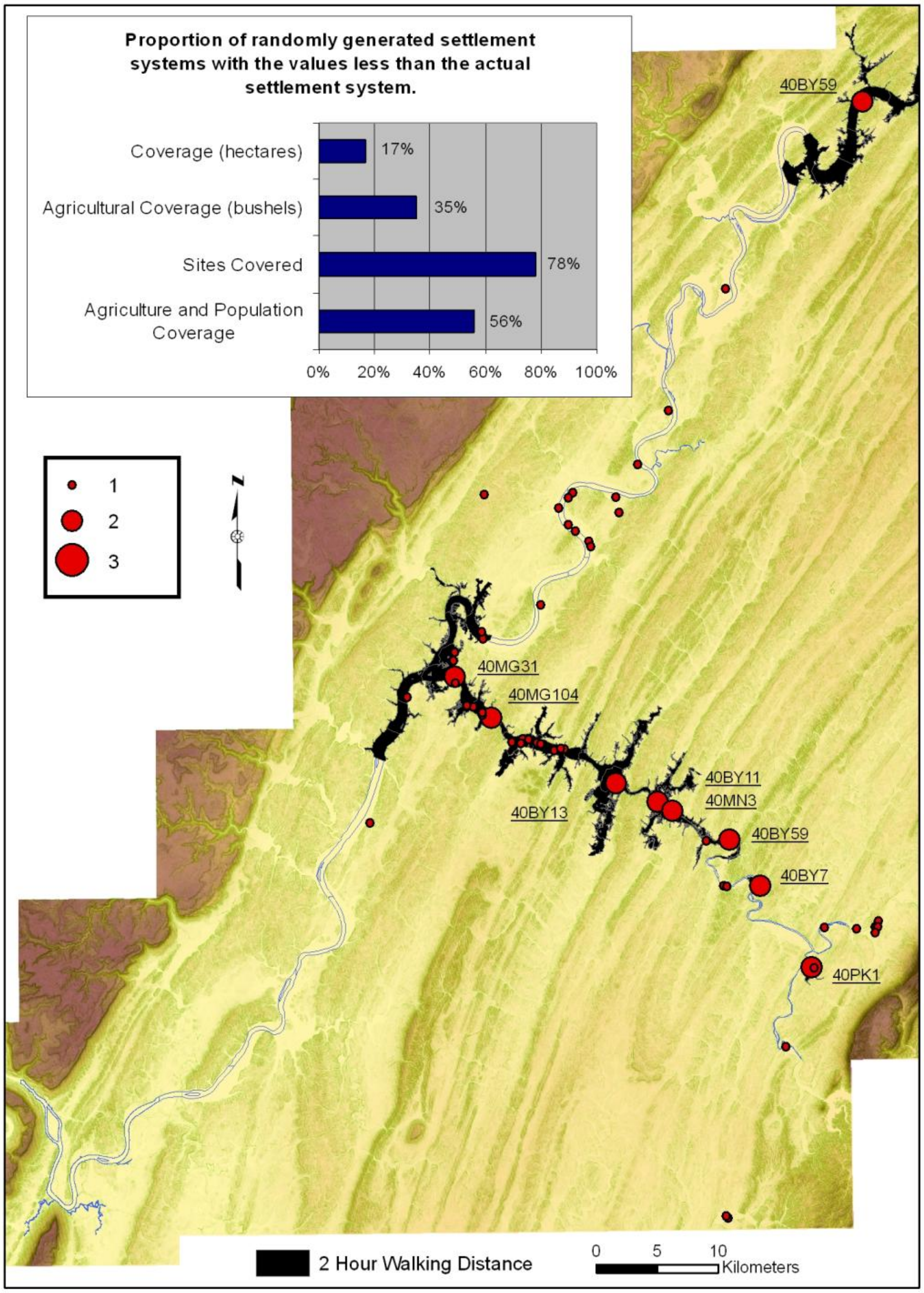


Figure 37. The Results of the Multivariate Location-allocation Model in the Northern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Map Highlights the Locations of the Actual Phase Settlements and the Areas Within a 2-hour Walk of Those Locations.

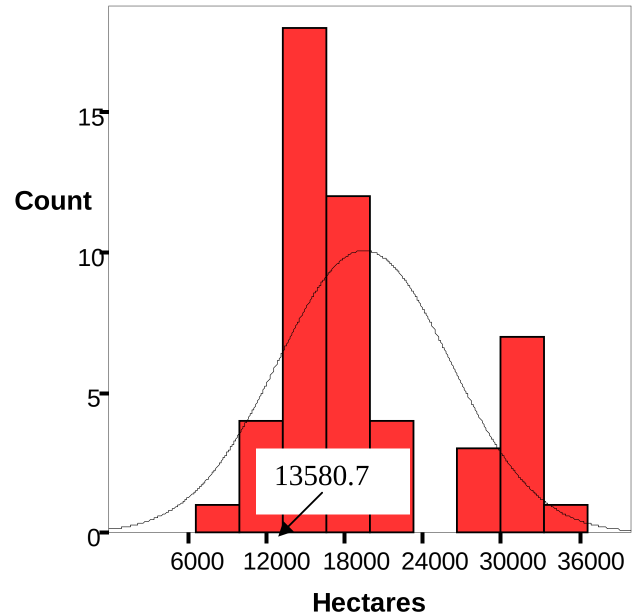


Figure 38. The Distribution of 50 Randomly Generated Settlement Systems' Total Coverage in the Northern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

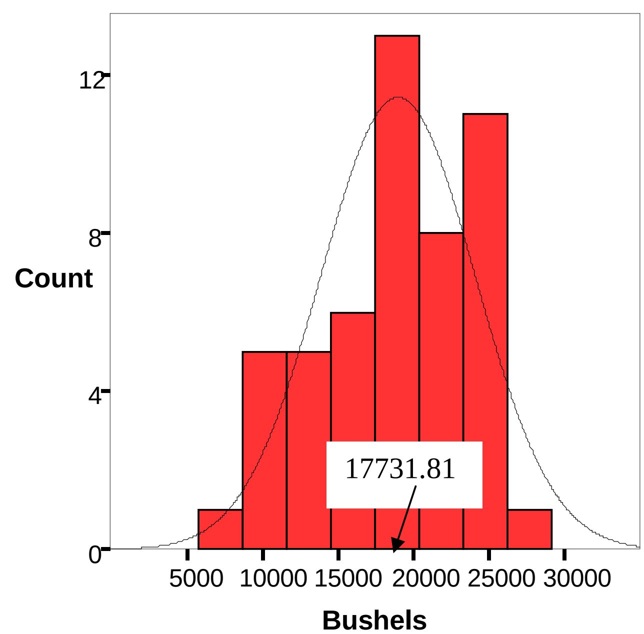


Figure 39. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agriculture in the Southern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

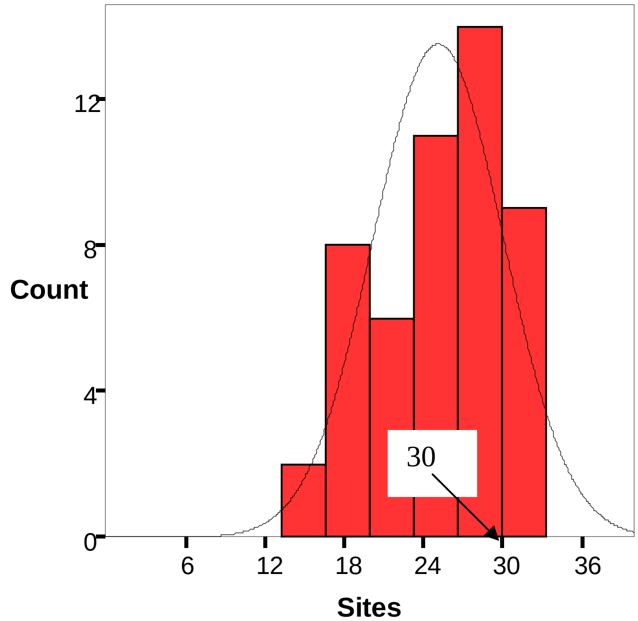


Figure 40. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Population in the Northern Section of the Study Area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

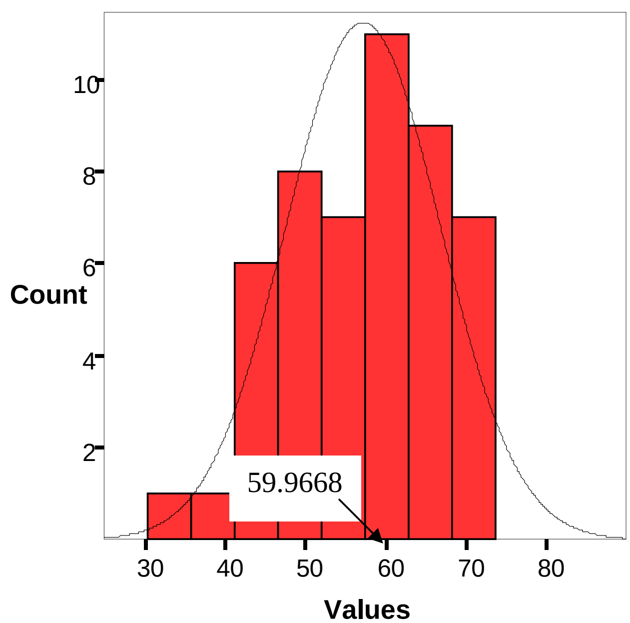


Figure 41. The Distribution of 50 Randomly Generated Settlement Systems' Potential For the Control of Agriculture and Population in the Northern Section of the Study area During the Late Dallas Phase (1500-1600 AD.) and Mouse Creek Phase (1450-1600 AD.). The Arrow Indicates the Actual Phase Settlement System in Relation to the Randomly Generated Settlement Systems.

4.4.1 Maximal Coverage Distance

The maximal covering distance was the first value run in the allocation model. There are no firm anthropological precedents about the area that administrators could effectively control. In a similar study done by Bell and Church (1987), Mesoamerican coverage distances were restricted to distances of 1.0, 1.25, and 1.5 hours of travel. Distances of 1.0, 1.5, and 2.0 hours were, therefore, used in this study. Both societies developed at approximately the same time and neither one used horses or pack animals until the Europeans arrived. On flat terrain distances that can be traversed in these time frames are approximately 5.0, 7.5, and 10.0 kilometers respectively. Figure 18 shows the coverage of the Hiwassee Island site (40MG31) using the various walking distances. Rivers were viewed as neither a hindrance nor an asset to travel in the model. Muller (1997:366) describes what is known about river travel during this Mississippian cultural time period:

> Large canoes are documented in historical times, and archaeological finds in the Southeast have shown that prehistoric Mississippian people made similar vessels. Lafferty (1977, 1994) concluded that considerable quantities of goods could have been moved long distances at relatively low cost using such canoes. Actually proving that large amounts of cargo were being moved from one locality to another is more difficult. Many major Mississippian centers are located in places that could have controlled major river routes for such exchange (as well as being fertile floodplains for horticulture).

The maximal coverage of river valleys was probably even greater considering that the cultures in question probably used a combination of river travel and overland trails. For the purposes of this thesis, riverine travel was ignored. Future researchers may wish to account for this type of travel in addition to overland travel.

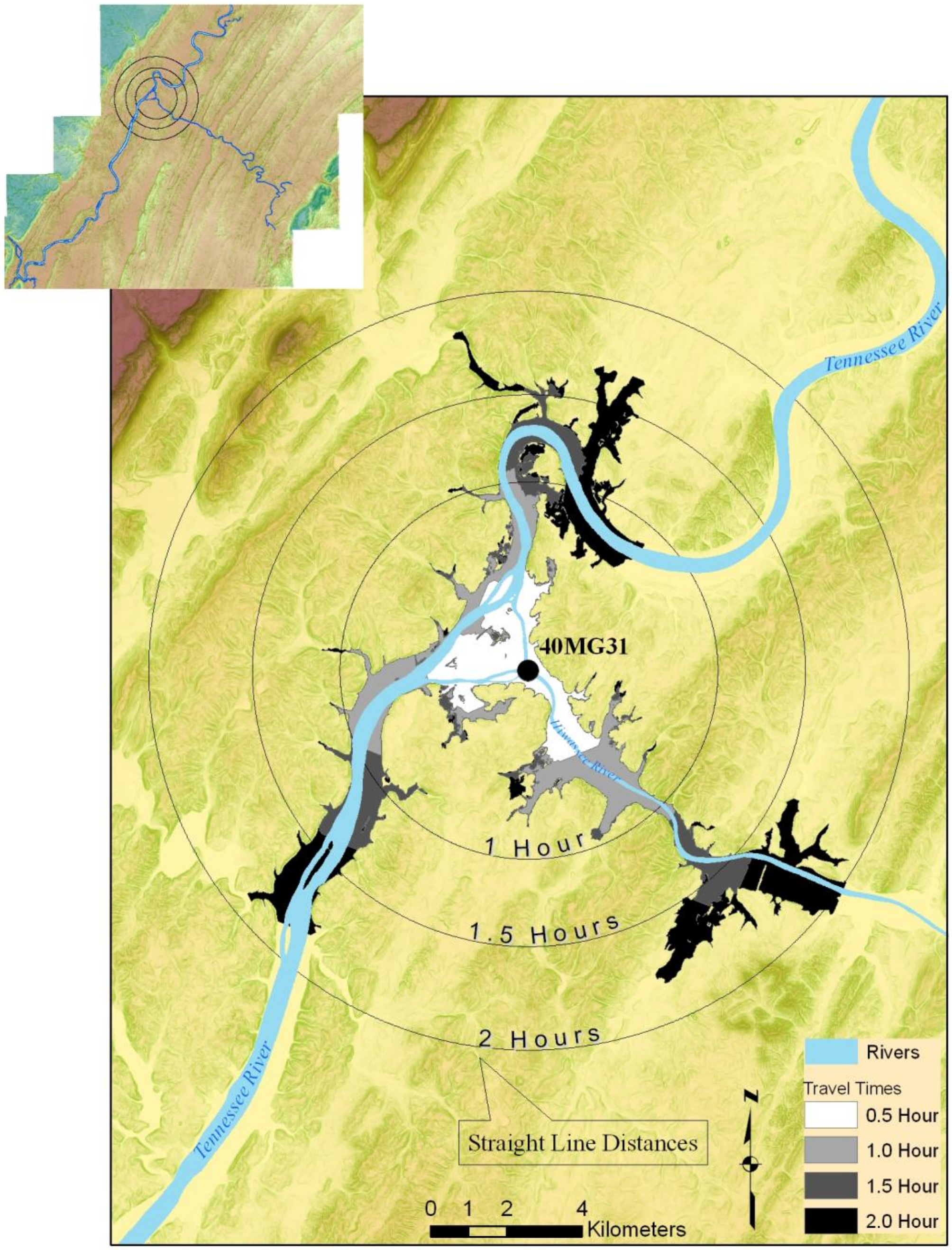


Figure 42. The Maximum Distance That Could be Achieved From the Hiwassee Island Site (40MG31) Using Tobler's Walking Calculation. Isotropic Surface Estimates are Displayed as Cylindric Circles. Note Distortion from Isotropic Surfaces Caused by Ridge and Valley Topography.

To test the significance of the positioning of Mississippian centers on the landscape, the archaeological hierarchy was compared with that of fifty randomly generated sets of centers for each time period. The two-hour walking distance was used to test against the randomly generated chiefdom centers. Overnight forays of large war parties were practically impossible for logistical reasons in chiefdom societies on a regular basis. A two-hour walking distance seems to be a reasonable estimate for a half - day walking trip. It was assumed that leaders could coerce populations by threats at this distance to aggregate economic goods (e.g., maize) at chiefdom centers.

One settlement systems had coverage distances that were only greater than at most a tenth of what could be randomly generated. In the northern section of the study area during the Late Dallas/Mouse Creek phase (1450 to 1600 A.D.) the maximal coverage distance of the settlements was no greater than ten percent of the settlement systems that could be randomly generated. There is considerable overlap of coverage areas in this temporal periods (8,000 hectares). Centers in this temporal period were being located in less-than-ideal areas to maximize the acreage of land controlled.

During the Early Hiwassee Island phase (1000 to 1200 A.D.), Late Hiwassee Island phase (1200 to 1300 A.D.), Early Dallas phase (1300 to 1400 A.D.), Middle Dallas phase (1400 to 1500 A.D.), and in the southern section of the study area during the Late Dallas/Mouse Creek temporal phase (1500 to 1600 A.D.), chiefdoms appeared to be attempting to maximize their control of the area. Each temporal period's coverage is greater than 78 percent of the randomly generated centers. The purpose behind such positioning may possibly be an attempt to maximize their control of bottomland regions where the majority of the population and rich agricultural soils were located.

4.4.2 Objective-function Weight for Agricultural Productivity

Agriculture was the main economic activity in Mississippian culture prehistoric populations. Administrators in elaborate tribute ceremonies controlled the excesses of production. Areas outside their control probably did not have to contribute to various chief's demands. Emphasizing the values of agricultural productivity (w_1= 1) and ignoring the impact of hierarchical level (w_2= 0), thus allowing the administrative facilities to be placed at any site, would illustrate whether the administrative sites were selected to maximize the control of the agricultural resources.

To run the model, the same fifty randomly generated sets of centers for each time period and the 2-hour walking distance were used. Site type was ignored for this model and the agricultural productivity was the only value used. The cumulative aggregation of 50 randomly generated agricultural productivities for each Mississippian phase possessed a normal distribution. Minor differences among the different time periods can probably be attributed to the number of sites identified during each phase.

The agricultural productivity that could be controlled by chiefdoms was not completely maximized in all temporal periods. Chiefly centers in the in the northern section of the study area during the Late Dallas/Mouse Creek phase (1450 to 1600 A.D.) controlled far less agricultural surplus than expected if they wished to maximize their resource base. The temporal period chiefdom centers were capable of encompassing more agricultural productivity than about 35 percent of randomly chosen sets of chiefdom centers. Other temporal periods were capable of encompassing the agricultural productivity of at least 50 percent to 89 percent of the randomly generated coverage sets.

4.4.3 Objective-function Weight for Site Type

Given the relatively uniform nature of agriculturally productive soils in the river valleys of the study area, it might be more useful to determine to what degree efficiency in control the population was achieved for administrative centers. Weighting the administrative centers heavily ($w_2 = 1$) while ignoring agricultural productivity ($w_1 = 0$) would show the degree to which efficiency in the location of important administrative centers had primacy in maximizing control of the population.

The same fifty randomly generated sets of centers for each time period and the 2-hour walking distance were used in this location-allocation model. Aggregated together, the fifty randomly generated sites were normally distributed for each settlement system. Differences between the different time periods can be attributed to the number of sites identified during each phase.

The Early Hiwassee Island phase (1200 to 1300 A.D.) chiefdom settlement system was the only settlement system that did not control more sites than half of the randomly generated settlement systems. The other temporal periods, including both areas of the late Dallas/Mouse Creek phase (1450 to 1600 A.D.), succeeded in sufficiently covering other sites better than the average of the randomly generated settlement systems. If in fact the sites in this study represent the actual population of the areas during each time period, the chiefdom centers could be located to take advantage of native population labor.

It must be emphasized that the determinant for representing the actual population was based simply on the ordinal value given to that site on the hierarchical scale (i.e. 1,2,3). Anything larger than a hamlet (level 1) was automatically covered in the model. Additional information would be needed from the archaeological remains at each site to get a more accurate representation of the population at each site. These determinants that have been used in other settlement system analyses include, but are not limited to, site size, number of burials, and number of houses. Future research may wish to generate solutions based on interval and ratio data rather than the ordinal 2 - and 3 - stage hierarchical data used here.

4.4.4 Using Both Objective Function Weights

The last model that was run uses both the variables possibly used by chiefdom political units to determine chiefdom center locations. Both the economic variable (agricultural productivity) and the population variable (site type) were assumed to contribute equally to the solutions in these model runs. The weighted values are used to equalize each variable so that they have the same relative value. The weighted value for agricultural productivity was given a weighted value of ($w_1 = 0.00169$) developed by dividing 1 by the mean of the agricultural productivity values. The weighted value for the population variable (w_2) remained at 1. Using the weighted value of .00169 for agricultural productivity, agricultural productivity values varied from 0 to 1.8 for all sites with Mississippian period components. These agricultural productivity values countervailed site type values that ranged on an ordinal scale of 1 to 3.

Mississippian phase settlement systems that were hypothesized to manifest a chiefdom structure all showed that when both objectives were used together (i.e., maximizing agricultural productivity and coverage from elite sites), they played a considerable part in the choice of chiefdom centers. The temporal phases that were hypothesized as having a weak or no chiefdom political organization: Early Hiwassee (1200 to 1300 A.D.); and the northern section of the study area during the Late Dallas/ Mouse Creek (1450 to 1600 A.D.) showed that the objectives were less important in choosing settlement locations.

The models run using both variables concurrently at countervailing rates showed considerable promise in demonstrating that chiefdom centers were located so as to take advantage of at least two major considerations for settlement siting. The agricultural productivity and population were probably only two of the many variables used to pick a place of residence for the chiefly elite. Trade routes to other areas, mineral resources such as salt springs, and distributions of game animals for protein and hides are some of the other variables that could be incorporated into future models of chiefly settlement location.

Chapter 5. Discussion

The working hypothesis of this thesis was that central place principles should be at work in any agricultural society that possessed a social hierarchy. To test this hypothesis, a location-allocation model was formulated to simulate a maximal covering location problem in five Mississippian periods from a group of known settlement locations. The cultures during the Mississippian phase (900-1600 A.D.) in the upper Tennessee River valley were postulated to be hierarchically stratified (i.e. capable of exhibiting central place principles). In almost all time periods during the Mississippian cultural phase the working hypothesis was found to be true, the culture's chiefdom centers were placed within the settlement systems so as to maximize their control of both the population and resources. In two time periods where the working hypothesis was found to be false: Early Hiawassee Island phase (1000-1200 A.D.); and in the northern part of the study area with a Mouse Creek cultural phase components (1450-1600 A.D.), the chiefdom settlements were not located in the most ideal locations to control the valley. The archaeological remains support the thesis's findings by indicating that there was probably no or very weak chiefdom political systems present during those phases.

The settlement system found during the Early Hiwassee Island time period (1000-1200 A.D.) was found to exhibit some central place tendencies but not as clearly as those of later time periods. The efficiency of the actual settlement system hierarchy was found to be slightly greater than arbitrary hierarchical arrangements that were randomly generated in the model run as measured by the coverage area. The efficiency of the actual settlement system hierarchy was found to be slightly less than arbitrary hierarchical arrangements that were randomly generated in the model run as measured by the: 1) agricultural produce covered 2) population covered; and 3) agricultural production combined with population covered by elite centers. Archeologists have speculated that chiefdom political systems were gradually developing during this time period in the study area. The location-allocation models run for this time period reinforce the theory of an emerging, and probably weak, chiefdom political organization. These models show that the chiefly centers could be situated in better locations.

The Late Hiwassee Island time period (1200 - 1300 A.D.) was speculated to consist of many small chiefdoms. By 1200 A.D., elite materials are found in significant quantities at gravesites indicating a clearly defined social hierarchy. Based on the archaeological theories, the settlement system of elite centers during this time period should be hypothetically situated in locations to take advantage of the population and resources of the valley. The actual settlement system should perform better than the majority of randomly generated settlement system. The actual settlement system during the Late Hiwassee Island time period did performed as good as or better in all the model runs than half of the randomly generated settlement systems of sites. Based on this comparison, it is likely that a chiefdom political system was thus probably operating in the study area.

Following the Hiwassee Island phase (1000- 1300 A.D.) the Dallas phase (1300-1600 AD) cultures display all classic characteristics of the Mississippian cultural traits (e.g., platform mounds, walled towns, distinctive social classes). Sullivan (2001) found that individual chiefdoms, as indicated by mound sites, lasted at most one hundred years based on before giving way to new chiefdoms located in other parts of the river valley. Three separate Dallas phase settlement systems: Early Dallas phase (1300-1400 A.D.);

Middle Dallas phase (1400-1500 A.D.) and; the southern part of the study area with Late Dallas phase (1500-1600 A.D.) components were compared with randomly generated settlement systems to determine the chiefdom center's effectiveness in controlling the population. Each of the settlement systems performed better than the majority of randomly generated settlement systems in each model run. Based on this comparison, it is likely that a chiefdom political system was thus probably operating in the study area in each of the Dallas phase settlement systems.

As early as 1450 AD, the northern portion of the study area began to slip back into a tribal level of political organization, as indicated by the absence of archaeological material typical of chiefdom political systems (e.g., platform mounds, elite burials, SECC motifs). The southern portion however still retained indications of chiefly political systems. This may be a reflection of better trading opportunities reflected in smaller distances between southern centers and trading partners in chiefdom areas of northern Georgia and northern Alabama. The settlement system in the northern part of the study area, consisting of palisade villages and small hamlet centers, was poorly situated to control the population and resources of the surrounding hamlet sites. The southern part of the study area with Mouse Creek phase (1450-1600 A.D.) components were compared with randomly generated settlement systems to determine high level center's effectiveness in controlling the population and resources of the valley. The settlement system performed better than the majority of randomly generated settlement systems in two of the three model runs. Based on this comparison, it is likely that a chiefdom political system was probably not operating in the study area in the Mouse Creek phase .

Compared with the random covering models run, the actual settlement system only proved better than about half of the randomly generated model runs. In the southern portion of the study area the models that were run indicated that the chiefly centers were situated purposely to control both the populations and the resources of the area.

My thesis has attempted to offer an answer to the following questions about the Mississippian culture in the upper Tennessee River Valley: What kind of effect did administrative/economic roles of settlements play in the prehistoric chiefdom societies of the upper Tennessee River valley? More specifically, do the finding of this thesis reinforce many of the contentions of archaeologists about the nature of Mississippian culture as a society?

As indicated by the results of the thesis, the elite leaders of the Mississippian time period in the study area seemed to be knowingly situating themselves in areas that controlled the population and resources from at least 1200 to 1450 A.D. The southern portion of the study area may have been under control of chiefdom societies up until the mid 16th century as indicated by early accounts of Spanish explorers. The less-than-ideal coverage of Early Hiwassee Island (1000-1200 A.D.) and Mouse Creek (1450-1600 A.D.) temporal period settlement systems is probably a reflection of a tribal political system or very weak chiefdom political system.

This study highlights the usefulness of geographic theory and techniques applied to the discipline of archaeology. The thesis's usefulness in understanding the political systems at work in study area may be called into question once a reexamination of the archaeological materials is completed. A reexamination would be useful in developing a chronology for many of the smaller sites that lack a chronological reference. Soil type, the environmental component of the model used to predict Native American corn yields at different sites could have also been more accurate if pre-TVA reservoir information could be obtained for newly flooded regions. The population variable used in this study was very simple compared with other covering models run on archaeological settlement systems. Bell and Church (1987) used burial population data to estimate population sizes at each site rather than a simple hierarchical level used in this study. The important point to consider with this study is that many new insights can be gained from it to be used by archaeologists in formulating new hypotheses and reaffirming past ones about premodern cultures.

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Vita

Jonathan Witcoski was born in Walton, New York on April 18, 1982. The first few years of his life were spent along the shores of Somerset Lake, New York. After six years, his family moved to Conyngham, Pennsylvania where he spent the majority of his childhood. He graduated from Hazleton Area High School in May 2000. In 2004, he obtained a B.A. from Penn State in Anthropology and Geography with a minor in Geographic Information Sciences. After graduation he enrolled in the Master's program at the University of Tennessee. His Master of Science degree in Geography was awarded in August of 2007. Jonathan is optimistic about the future of geographic information sciences as a career and is hopeful he can find a job that could combine his love of geography and archaeology.