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A COMPARISON OF SHOVEL TESTING AND SURFACE COLLECTION AS ARCHAEOLOGICAL SITE DISCOVERY METHODS: A CASE STUDY USING MISSISSIPPIAN FARMSTEADS

A Thesis presented in partial fulfillment of requirements for the degree of Master of Arts in the Department of Sociology and Anthropology The University of Mississippi

By

CAMERON SMITH HOWELL

May 2016

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ABSTRACT

Shovel testing and controlled surface collection are common methods of archaeological site investigation that are generally approved by state and federal agencies as well as the academic community for cultural resource management projects and research. While both techniques are equally utilized, little research has been conducted on how equivalent these techniques are in terms of their efficacy for finding site. This thesis seeks to find a way to compare these techniques by creating Mathematical Models to describe how well the methods behave when tested on known datasets generated from Mississippian period farmsteads. The predicted performance can then be compared to real world results of investigations. A discussion then follows on the implications for treating the investigation techniques as equivalent and recommendations are made to adjust for survey efficacy bias in future research designs.

DEDICATION

For my parents Harold and Harriet Howell and especially my son, Rowan Howell.

ACKNOWLEDGEMENTS

It has been a long, arduous journey, but I have finally made it. I could not have done it without the help of a number of people and institutions. Dr. Jay Johnson and my committee members Robbie Ethridge and Matthew Murray have shown extreme patience and a continued willingness to work with me, which was essential to me being able to finish and not having to start all over again. I would likely still be working on it in the next lifetime, if that were the case. To them I owe a big debt of thanks for helping push this through.

Thanks also go to the numerous people who provided reports as well as the state historic preservation offices in Mississippi and Georgia. Mark Williams allowed me to quickly dive through their nascent site database and pull out reports. Janet Rafferty and Evan Peacock provided reports which greatly helped to add to the database for Mississippi, as did Jay Johnson from his own surveys in the area. I am thankful for the fieldwork done by graduate students at Alabama whose work provided almost all of the information on the Black Warrior River Valley.

An underlying goal of this thesis was to learn statistical techniques and geographic modeling. I had the benefit of great teachers who helped me achieve this goal through their patient instruction: my father Harold Howell for ideas on how to model geometrically the surface collection model, Dr. Henrique Momme for spatial analysis, Jay Johnson for basic statistical reasoning, and the University of South Carolina's Drs. John Grego and Brian Habing for more intricate statistical understanding.

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Along the way I had a great deal of involvement from a number of helpful ears and oftentimes bewildered readers who provided editorial commentary and positive feedback which makes all the difference for creating the energy necessary to finish this kind of task: Leoma Gilley for editorial comments on organizing life and the thesis, Linda Christensen for positive reinforcement and life outlook, my mother Harriet Howell for help on graphically illustrating the Mathematical Models, and Rachel Black for editorial feedback.

Finally, the energy and unwavering belief in me by my family and friends made all the difference, and I count myself as being especially blessed and privileged to have had their love and support.

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1 INTRODUCTION

On all vital existential questions, human beings have biases more deep set than they can begin to comprehend. The task of philosophers is not to work up fanciful idealistic rhetoric designed to appeal to hypothetical disinterested-bourgeois bipeds, but to get to know what the actual or extant preconceptions and worldviews of human beings really are, and WHY they ultimately are such as they are. It may be interesting ad hominem how and why humans might happen to presume themselves to be impartial listeners. But the truly challenging question is Nietzsche's: just how the hell did such a species ever imagine that it might want to know what "the truth" is, in the first place? Why would we presume ourselves to be at all INTERESTED in "the truth"? -Kenneth Smith

The past 150 years of professional archaeology in the United States has produced a vast body of knowledge about the archaeological record. During that time, methodologies have greatly changed as have the interests of the general public and professional community. What we know of the archaeological record is directly tied to how we investigate it and what kinds of questions we are asking. Sources for our understanding of the archaeological record can come from surveys, excavation, archival, ethnographic, geological, climatological, and remote sensing activities, amongst many possible others. Each of those sources with its own evolving set of methodologies and individual variations can present a challenge when it comes time to weave together a coherent narrative asking what happened here in the past.

Archaeological site discovery techniques are no exception and have thus changed over the years to be able to better answer the kinds of questions and address the research interests of archaeologists. Intrinsically a method of scientific investigation introduces bias into what we can know. For example, if we were examining the cosmos armed only with optical telescopes, we would not be able to observe phenomena which are characterized by infrared or x-ray wavelengths on the electromagnetic spectrum. In a similar way, the methods of site discovery affect the kinds of sites that archaeologists find and therefore dictate what we can know about the archaeological record. It is critical then to understand the instruments we use for site prospection and how equivalent they are regarding discovering different aspects of the archaeological record. The two most prevalent methods of systematic archaeological site prospection are surface collecting and shovel testing. Currently the relationship between the two methods in terms of their relative efficacy remains uncritically examined, so we don't know for sure if they find sites equally well, and if not, how we might adjust for the differences.

In an effort to address these deficiencies, this thesis seeks to understand the relative abilities of shovel testing and surface collection for finding archaeological sites by modeling the detection techniques mathematically. A mathematical model takes an observable phenomenon and tries to describe its behavior with a mathematical formula that draws upon appropriate theorems and proofs to achieve an approximation of the observed behavior. The model should have characteristics of reliability and replicability to make it effective, meaning that it does a good job of modeling the observed phenomenon.

A physical, controlled experiment would be limited in its sample of sites and involve time consuming efforts at replication that are applicable to a small number of specific conditions. In contrast, a mathematical model can sample an entire known population to develop ideas about larger regions and entire classes of sites and conditions. Another benefit of constructing a model is that it allows the parameters to be easily changed that might be much more difficult to do in the real world but be of interest to the creator for making predictions about real world performance under a variety of conditions.

To make it more relevant to tackling archaeological questions, the model created for this thesis will draw upon real world datasets to generate probabilities of detection. The predictions of the model will then be compared to survey data to see how its predictions are borne out by the actual survey data. Comparing the Mathematical Model to survey data will also demonstrate how conditions of the archaeological record affect the quantity of the sites that are found based on their qualities. From that analysis, conclusions may be drawn as to how the methods compare to one another and the implications they have for answering questions archaeologists are asking. Awareness of the differences between methodologies and the quantification of those differences will help reduce some of the biases that resulted from the two methods being treated as equivalent.

The degree of our understanding of the archaeological record is affected as much by the inherent gaps in the record as our attempts to investigate it. The degrees of completeness of that knowledge suffers from temporally fluctuating standards, the recorder's relative level of professionalism, circumstance, and the focus of the research that can be inclusive or exclusive to the record being examined. However this corpus is what archaeologists draw upon to describe the archaeological record. The raw data is then in turn interpreted and presented through a variety of theoretical, statistical, and philosophical frameworks. The degrees to which the differences between disparate techniques or frameworks affect the kind of valid observations and conclusions that can be drawn cannot usually be quantified. The intricate relationships within the microcosm of archaeology create webs of complexity that are difficult to untangle. Instead we all too often conveniently view this often bewildering palimpsest of data and technique as equivalent. To do so, however, invites biases into our interpretations of the archaeological record.

Commonly, bias is used when describing a favoritism for one thing over another. Sources of bias in archaeology originate from three primary sources. The first is the archaeological record itself. The second is how we approach and sample the archaeological record. The third source of archaeological bias is how the information is perceived and interpreted by the observer.

Internal biases to the archaeological record arise from the interaction of culture and the environment. Schiffer (1972) has identified these forces as natural or N-transforms and cultural or C-transforms. The general effect of these internal transforms of the archaeological record is that the record does not contain information on all aspects of any given culture or past activities, some aspects are missing or distorted.

While both archaeological data and methodologies are fraught with potential sources of bias, up until lately we as archaeologists have gotten used to dealing with these issues, largely by ignoring them or resigning ourselves to the idea that there is little we can do about them. The difference now is that archaeology, like most of the world, is being swept up in the data revolution. Archaeological information lends itself well to being turned into bits of data suitable for searching and compiling into databases that can be cross referenced and queried for all sorts of relationships between the data. Open source services like TDAR and DINAA are tapping into the wealth of available data and researchers are predicting a growing number of synthetic interpretations being derived from the digital data (Anderson 2014). Biases from survey methodology that are scalar grow in the magnitude of their impacts when applied to larger areas and regions. The danger is that conclusions drawn from amalgamated datasets will have their biases so magnified that they will no longer describe the past with confidence. The bias in the data should be captured within the metadata and all too often it is not because the problems with bias are poorly recognized.

Metadata is information about the data: how it was collected, what techniques and units of measurement were used, and what exceptions or conditions occurred during the collection of the data. Metadata needs to accompany the information it is associated with because it holds the key to knowing whether datasets are directly comparable to each other, or will require some modifications or transformations to make the datasets equivalent. Without proper metadata documentation, a researcher cannot know how datasets from two different sources compare beyond superficial similarities. For creating or manipulating large datasets, paying attention to the metadata is essential for producing accurate results.

Untangling the many sources of bias that might affect site detection rates would be important to being able to compare site detection methodologies, however this thesis narrows as much as possible the consideration of bias only to the way in which the archaeological record is sampled. This thesis seeks to explore methodological biases which are affecting knowledge of the archaeological record through a quantification of extant data. Of particular interest are those biases which are inherent to survey and site discovery techniques. It is the author's hope that this exploration will generate information which will allow for comparing the effectiveness of various survey methods and allow for an evaluation of these techniques to determine if they are producing the results that we as archaeologists ask of them. Specifically this would address the question of whether these techniques if they are not 100% efficient in discovering all sites within a region of study, do they at least return a representative sample? Can the number of sites that were not found be estimated by the nature of those that were found and the methodology used? To answer these questions, a methodology for determining the efficacy of site discovery techniques would need to be devised.

In approaching the primary question tackled in this thesis, two possible routes of methodology could be considered. The first would be to construct controlled experiments that would measure the rates of discovery through direct experimentation and observation. To do this, prepared surface and subsurface contexts would have to be artificially created, tested and retested in order to determine if results could be replicated. As will be discussed in Chapter 2 of this thesis, there is great interest in understanding the nature of the plowzone and the ratios of artifacts found on the surface as well as debating the pros and cons of shovel testing. Controlled experiments with surface visibility and the relationship of surface artifacts to subsurface deposits have been conducted in several studies (Ammerman and Feldman 1978, Banning et al. 2009, Binford et al. 1970, Odell and Cowan 1987, Redman and Watson 1970). Similarly, shovel test pits have been tried out on known sites in order to understand how replicable the method is and how well it detects sites (McManamon 1981, 1984). Shovel test pit experiments tend to be rarer perhaps due to the difficulty of constructing a robust and replicable experimental program and the high labor costs involved. As was true for other researchers, the complexity and difficulty of conducting a controlled experiment comparing shovel testing directly to surface collecting was prohibitive to proceeding with that option for this thesis.

The second option is to model the behavior of the site discovery methodologies mathematically. The discovery of sites is basically a function of the geometry of transects and the sites themselves combined with probability based on artifact distribution and density. The rigorous sampling nature of archaeological fieldwork lends itself to being modeled mathematically with regular transects and sampling spots. A simple mathematical model can return an idealized version of discovery rates for the two methodologies that would make comparison easy by using the same dataset and conditions to test the models against.

For the archaeological dataset, there are again a couple of options. One option would be to create completely random set of values for site size and artifact density to test predictive models against. This would be a simple and quick solution, however it would also one more step of abstraction away from reality that a mathematical model is already taking. Early attempts at trying to predict shovel testing behavior used artificial datasets of artifact densities (McManamon 1984) and site sizes (Kintigh 1988). Without having real archaeological data to draw upon, it would be unlikely that a random set of values would approximate the nature of archaeological sites in terms of means and modes of artifact densities and site sizes. Instead, using a real archaeological dataset would be preferable, because in addition to better approximating real world data in the abstract, it would make comparison of the results to real world surveys more applicable. This point is a key lament of many of the early studies on the behavior of shovel testing: not enough sites to compare empirically the behavior of the detection technique (for example Shott 1985). In addition, one aspect those early studies did not do, was directly compare the efficacy of shovel test pits to surface collection.

The Mathematical Model of site discovery methodologies would produce predictive results for each site from which averages across the whole dataset could be generated. Each site in the dataset would have a probability for discovery by shovel testing and surface collection. Since most of the variables have been controlled for in this idealized model, the results can be directly compared to each other. Unlike with physical experimentation, changing the parameters of investigation such as transect spacing and shovel test size are easily recalculated by changing a few numbers in the formula for the Mathematical Model. Datasets can also be swapped out or added to and the calculations rerun quickly. The flexibility of a Mathematical Model would

allow it to address many of the questions about bias that archaeologists might have about site discovery techniques which this thesis is concerned.

The datasets for this thesis were drawn from published reports, academic papers and theses, and state site file searches. Mississippian period farmsteads were chosen as the analytical unit for sites in the database because they have quantifiable attributes of small site size and recognizable diagnostic artifact categories that made modeling site artifact density a relative easy matter. Mississippian Farmsteads are also a common occurring site type across the southeastern US and as such have a wide range of applicability to many archaeologists' work. Their prevalence in the available literature meant that assembling a reasonable sample size was possible.

In particular three regions; the Black Prairie of Mississippi and Alabama, The Black Warrior River Valley of north central Alabama, and the Georgia Piedmont had high numbers of Mississippian farmsteads that would allow each of the regions to be compared to each other and demonstrate how different combinations of site size and artifact density creates biases in both the Mathematical Model and the real world data. A better informed conclusion about prehistoric settlement and the best techniques to find this site type could be interpreted from comparing the data.

In order to address the problem of bias and provide greater context to both the problem and the way it will be addressed in this thesis, the following chapters follow this introduction. Chapter 2 is a literature review that focuses on how archaeological sites have been discovered and the way those discovery techniques have shaped the kinds of interpretations and conclusions that can be drawn bias in the archaeological record. Included in that chapter is also a discussion on the governmental codification of methodologies as federal and state agencies attempt to fulfill

their mandates on inventorying and protecting cultural resources. Chapter 3 discusses the origin, nature, and organization of the data that will be used in this study all gathered from surveys and excavations. The reasoning for selecting Mississippian farmsteads as the analytical unit is discussed, the database structure is explained, and the data within the database explored. The three regions that contributed the most farmsteads to the database are also described.

Chapter 4 lays out the methodology used to interpret the data from Chapter 3. The Mathematical Models for shovel testing and surface collection are detailed and their mathematical formula explained. How sites were modeled is explained, along with a discussion of the use of the Poisson distribution for determining probability of successfully finding an artifact diagnostic of a Mississippian farmstead. Significance is also discussed with strategies delineated for how to determine the nature of sites deemed to be significant and thus eligible for nomination to the National Register through the section 106 process of the Historic Preservation Act.

In Chapter 5, results of the application of the Mathematical Model are discussed and compared to the data from real world surveys. Additionally, the different primary survey regions are compared and contrasted through statistical testing. In general the results will show that there is a significant difference between the site discovery methodologies with surface collection having a much higher success rate at finding Mississippian farmsteads. However an exploration of the Mathematical Model data and the real world surveys also show where and how the differences are not so great between surface collection and shovel testing discovery probabilities.

Within the Conclusion chapter, the implications for the biases demonstrated in both the Mathematical Models and real world data are discussed. With the recognition of the inherent bias of discovery methodology some ways to compensate for the differences are proposed. After the references cited, appendices follow with details of the sources used for the data as well as the data in the database

2 LITERATURE REVIEW

Science is but one special and actually rather small part of knowledge, whose truths depend on the social beliefs of the time and the cultural atmosphere in which they are created (Clarke 1979).

The datasets and methodology used in this thesis are rooted within the far reaching sweep of both space and time. The background of the project is made up of three interconnected parts, and these themselves are just smaller pieces within a larger picture. Archaeological methodology and theory closely conditions and is in turn conditioned by cultural interests, legislation, and regulations all of which invite bias into the collection of data. Interpretations of the archaeological record in turn are contoured by the data made available from the production of archaeological knowledge and its methods and objectives. Those derived interpretations can in their own turn influence and affect methods and theories. The interplay between these different aspects creates a complicated system of webs of interdependence which I will out of convenience separate for further discussion. It is important to remember, however, how they fit back together to provide meaning greater than their individual contributions. My discussion of these components will not include all of the possible aspects of archaeology, just those that are pertinent to this thesis, specifically site discovery methodologies, the types of sites of interest, and the social climate, rules, regulations, and laws which encourage or hinder aspects of the two former cases.

The greater Southeast region that includes the study area encompasses a number of physiographic provinces and biologically diverse ecotones. This rich and fertile landscape has encouraged settlement and provided the impetus for cultural development for more than ten thousand years leaving behind an abundant archaeological record which has made the region particularly attractive to archaeologists. The natural boundaries of mountains and rivers also provide some of the political boundaries of the states that occupy the region. More often than not however, the political boundaries are arbitrary and they cut across those physiographic provinces, biomes, and ecotones creating artificial divisions. These divisions come into play as part of the patchy development of archaeology programs that occurs in some states but not in others. The differentiation and territoriality helped to foster closed system approaches to interpreting the archaeological record and led to duplication of effort and difficulties in achieving synthesis. While this is not an insurmountable problem and has been resolved many times in the past, it is important to understand that in the discussion that follows, consistency is not necessarily maintained as far as methodologies, practices, or interests across the region. As information becomes more readily available for exchange through advances in technology some of these divisions will inevitably ease or cease to be of relevance.

2.1 Bias

Mathematically, "bias is the difference between the true value of a parameter and the expectation of the mean for a particular sampling methodology" (Orton 2000:23). More generally, bias as I use it in this thesis, means any process which distorts the interpretation of the subject of scientific inquiry leading to false conclusions that are potentially scalar in magnitude. Since this thesis is concerned with measuring site discovery techniques, there would be intermethodological bias if one method produced false negatives at a different rate for the same kind

of sites as the other method. A false negative in this case would be not finding a site which is there. If unrecognized, that bias for finding sites on an individual site by site basis can be greatly magnified once extrapolated out across a large survey area. The error becomes larger once survey data is applied for regional interpretations.

Biases in their different forms have long been recognized in archaeology as they have for many sciences. These biases can come from a variety of different sources both within the archaeological record itself and in our efforts to understand that record. Internal biases to the archaeological record arise primarily from the interaction of culture and the environment (Schiffer 1972). N-transforms include such forces as decay and rot upon artifact such that typically only the hard durable artifacts survive through time such as arrowheads, metal, pottery, and sometimes bone while softer materials such as cloth, food, flesh, and wood are typically decomposed. Additionally, N-transforms can describe the action of animals on archaeological deposits which creates movement of artifacts, and also the effects of erosion and deposition on a site through geological processes. C-transforms on the other hand are the varying degree to which culture affects the types, variety, frequency, manufacture, curation, and discard of different artifact classes. It can also encompass subsequent reuse of the site by later occupations. In sum, the archaeological record is incomplete, and awareness of exactly what is missing from any particular part is challenging.

Biases that are external to the archaeological record arise from our efforts at trying to understand and interpret said record. The primary source of external bias is the observer who is influenced by his own values (Martin 1979), theoretical framework (Binford 1983), the methodological landscape of tools for inquiry, and even her very existence as an observer (Carter 1974, Nozick 2002). Some of these factors such as the existence and values of the observer can

only be acknowledged as part of the process of gathering data. This is because the data that is gathered has to be of some relevance to the observer and the target audience. Other factors concerning the theoretical framework come into play typically during the initial research design and interpretation phases. Theoretical considerations may directly affect the methodology used in order to engage in data retrieval. Additionally, while methodologies can be subordinated to the idiosyncrasies of individual practitioners, they also inherently have different levels of efficacy for addressing research questions given the constraints of environmental conditions and regulatory requirements. Archaeological method is the primary way in which data is extracted from the archaeological record and thus arguably has the greatest impact on interpretation. It is also consequently the largest or easiest potential source of bias.

How do we go about exploring bias when there are so many possible vectors for them to affect our interpretations? A promising solution is to try and narrow down the field of possible vectors. As can be seen from the above dual definitions of bias, archaeology often navigates between (and engages in) the transformation of qualitative information into quantitative data and vice versa. Given the right controls, biases that are affecting the interpretation of the archaeological record could be identified, isolated, and quantified. This exploration of bias would perhaps bear the greatest fruit in exploring methodological biases. The aforementioned importance when generating raw archaeological data makes methodology a good choice. Additionally, the nature of archaeological methods most readily lends themselves to making quantitative comparisons. The scientifically based Processual archaeology reinforced the need to have research designs and methods which would generate replicable results. Archaeological projects over the interceding years have produced a tremendous amount of information which could be data mined for this quantifiable data.

2.2 History of Archaeological Methods and Theory of Site Discovery

In the southeastern United States, archaeological methodology from the late 1700s through the mid-1800s began as an endeavor to try and unearth the treasures and mysteries of the past starting with Thomas Jefferson's excavation of a mound on his property (Brose 1993:2-3). As more land was cleared for agricultural use by European settlers, mound sites with their easily recognized features were typically the target of antiquarian interest in this period and continue to be important into the present day. Jefferson's work which included detailed notes and observations on stratigraphy was the exception and not the rule (Brose 1993:2-3). Early workers had little to no formal training and picked large obvious sites upon which to excavate usually by placing a pit or "unit" in the top of a mound and proceeding to dig downward. Other methods included trying to tunnel into the larger tunuli from the sides to reach supposed central burial chambers. No paperwork or scientific methodology was employed, as the point was to find the area with the highest potential for elaborate artifacts that could be cheaply and expediently discovered. In some cases, it was for the purpose of collecting skulls from the graves to be used in trying to provide data for early work on races like that of Samuel George Morton's 1839 Crania Americana (MacCurdy 1917:59). The interest in mounds as important historical resources prompted the Smithsonian Foundation to commission Squier and Davis (1848) to survey and map many of the mounds in the Eastern United States.

After the Civil War, resolution of the Mound Builders question and an interest in northern university museums in southern antiquities led to a great expansion of archaeological investigation in the Southeast. Specifically the question of whether the Mound Builders, Native Americans, or proto-Mormons built the mounds resulted in money being spent by Congress to task the Bureau of American Ethnology with finding out (Brose 1993:5). The Division of Mound

Exploration was formed and under its second director, Cyrus Thomas, conducted extensive surveys and excavations of mounds throughout the greater Southeast. Thomas employed local agents to search for the most promising mound sites, using word of mouth, local knowledge, or newspaper articles to find sites that had often been targeted by earlier relic hunting. These agents would secure rights to excavate on the site and in some case conduct the excavations themselves and send the results back to Washington (Thomas 1894 and e.g. Jeter 1990). In some cases, there was direct communication between relic hunters and those at the Smithsonian through selfreporting on interesting finds that were published in the Bureau's Annual Bulletin. In other cases, Thomas employed his own local knowledge for site selection (Williams 2002:66). These methods for site discovery and selection by Thomas would continue to be used by subsequent investigators into the 1930's for example C. B. Moore (Wardle 1956) and M. R. Harrington (Harrington 1922).

The primary focus was still on burials and their accompanying grave goods to try and answer the question as to who had built the mounds. To uncover burials, excavations employing semi-skilled labor were conducted comprising the opening of large squares on the tops of mounds and the excavations of trenches (Thomas 1894). Field notes, maps, and profiles also began to be drawn though stratigraphic placement or exact provenience was only rarely noted for most items. In the end, Thomas (1894) presented the case for the Native Americans as the architects and builders of the mounds and the matter was largely settled.

Alongside Thomas's work for the Smithsonian, were some independently wealthy archaeologists such as Gen. Gates Thruston who worked mainly in the Nashville Basin region of Middle Tennessee (Thruston 1890) and Clarence B. Moore who conducted extensive excavations into mounds across the Southeast wherever he could reach with his steamboat The Gopher

(Wardle 1956). There was also competition with contractors working for various museums and foundations such as E. O. Dunning for the Peabody Museums of Yale and Harvard (MacCurdy 1917:59) and Mark R. Harrington for the Heye Foundation's Museum of the Native American (Harrington 1922). The work of these various actors was considerable in scope but variable in quality. Dunning for instance left no notes or records other than the letters accompanying the artifacts to the Peabody Museum (MacCurdy 1917). Moore, going by way of riverboat to reach mounds and village sites all over the Southeast, took detailed notes and published his findings in well-illustrated monographs (Aten and Milanich 2003). Harrington on the other hand followed after Moore and imitated his methods as well as also digging on some of the same sites in the hopes of finding similar artifacts for his benefactors (Harrington 1922).

It was also during this time that culture history was beginning to take shape and divisions and successions of people began to be discerned within the archaeological record. Thruston (1890) saw comparisons between Indians of the Southwest and those of the Nashville Basin and surrounding areas and contrasted those with the northeastern Indian tribes based on the artifact assemblages and ethnographic accounts. William H. Holmes (1903) initiated a comparative approach using various pottery types from across the Eastern United States to try and tie prehistoric pottery to known historical Native American groups. Harrington tried to connect what he was seeing in the archaeological record with the Cherokees who had traditionally claimed much of the range of territory in which he operated in. Specifically he looked at linking the burial practices of prehistoric groups, identifying a "round grave" culture that was earlier than the later Cherokee group and who he interpreted as maybe having been a separate peoples (Harrington 1922:166-171). Harrington's and to a lesser extent Thruston's and Holmes' analysis techniques would later be identified with the Direct Historical Approach which tied known

ethnographic data to the unknown archaeological data (Steward 1942). Relative cultural chronologies were now starting to be built, but were still largely based on intuition due to uncontrolled, poorly documented excavations which did not follow the stratigraphic approach (Lyon 1996:55).

The culture history paradigm would become fully developed with the advent of the New Deal's answer to unemployment and under development. The construction of dams and reservoirs would inundate numerous archaeological sites and the opportunity to both employ thousands of laborers in scientific endeavors as well as recover important information about America's past before it was destroyed proved to be an attractive option (Lyon 1996). It was during this time that archaeology in the Southeast moved from being an avocational or part time professional pursuit to a profession with full academic credentials (Lyon 1996:52). Most of the archaeologists who were retained to supervise these projects had training in anthropology and sometimes archaeology. Archaeological field schools offered through the University of Chicago provided training in some of the newer techniques being developed in the southwest and it is at this time that the stratigraphic approach comes into common usage (Lyon 1996:61). Site selection was still largely based on using local informant to identify the richest most promising sites which were also typically those with mounds on them. Sites were also chosen to try and identify different potential cultures within a given region though this was often more haphazard than systematic in nature.

Field techniques used large unskilled and semi-skilled labor pools (Lyon 1996:63) to excavate large areas including completely excavating mounds. Large block and long trenches were excavated into the village areas to determine their layout and activities (Lewis and Kneberg 1946). Burials, burial morphology, and grave goods continued to be an important focus of the

work as these often produced the more spectacular finds. Documenting change over time had previously been determined by the often subjective opinion of the excavators with limited rigorous attempts at control to make comparisons. However new techniques developed in the Southwest concerning stratigraphy and especially stratigraphic controls were seen as essential to developing cultural chronologies (Willey and Sabloff 1974). Stratified sites in the Southeast proved to be more elusive but mounds were plentiful. Careful excavation using arbitrary levels provided the data to determine characteristics that would be identified as the hallmarks of cultural stages (Phillips and Willey 1953). While many of the archaeologists had some formal training, these kinds of large scale excavations were new to everyone and a steep learning curve was often encountered (Lyon 1996). For instance, in trying to decide the best way to excavate a mound, Webb and later Lewis and Kneberg, initially excavated mounds in vertical slices (Lewis and Lewis 1994). This method allowed for multiple detailed top to bottom profile drawings but was problematic for horizontal control making reconstruction and documentation of the structures and building episodes difficult as in the case of the Hixon Mound (n.d personal communication Lynne Sullivan).

The large scale of the excavations produced an almost over abundance of data and new techniques had to be developed to interpret and analyze what had been found. The Midwestern Taxonomic Method was developed to both try to handle the large volume of data by producing regular categories and trait lists that lent themselves to cross site comparisons and to also remove the restrictions placed on analysis by the Direct Historical Approach (Lyon 1996:60). The pursuit of culture history also saw the introduction of statistical techniques to try to tie together the extensive trait lists that were being developed from the excavated material. These trait lists could then be employed to try and reconstruct the culture history of the areas under study with the most

attention paid to the larger charismatic elements such as burials, structures, pottery, and lithic tools as key areas of affinity. Due to a lack of stratigraphy on sites to make cross site comparisons and establish relative dating, surface collections were employed to tie sites together and to create a ceramic seriation through frequency distributions (Ford 1936, 1938).

Surface collection, while it had been used by advocates and amateurs for centuries, was formalized and brought into the archaeological literature as a method of site discovery by W. G. Clarke in 1892 (Banning 2002:3). More rigorous methods would be further devised and utilized by archaeologists working in the Lower Mississippi Valley. Here the absence of large reservoir projects which focused on highly obtrusive mound sites within the area of impact meant that numerous small scale surveys and excavations were conducted instead (Johnson 2002: 185-187). These smaller scale surveys included many surface collections and it is from these that Ford (1936) developed a ceramic chronology for Mississippi and Louisiana. Surveys with an emphasis on developing chronologies culminated with Phillips et al's1951 monograph on the Yazoo River Basin and Eastern Arkansas (Johnson 2002:186-187).

The beginning of World War II would see the end of most of the New Deal projects and a general slowing down of archaeological research. The frantic work of the 1930's settled down with many of the prominent archaeologists taking positions at universities often close to the areas where they had conducted archaeological excavations. In some cases, the archaeologists started archaeology programs at the universities and began to write up and synthesize their work. The results of some of these syntheses were more of a functionalist theoretical base rather than one strictly of culture history (Faulkner 2002:176). During this time the conjunctive approach would be put forth by Taylor in 1948 encouraging a more holistic approach to site excavation and an interest in examining everything and excavating as much as possible to be better able to

understand the site (Trigger 2008). While the conjunctive methodology would not take hold in the Southeast, the 1950's strong positivist cultural values would lay the foundations for the "New Archaeology" of the 1960's and a reinvention and interpretation of the conjunctive approach. The invention of radiocarbon dating in 1950 started an ongoing trend of incorporating the hard sciences into answering archaeology's soft science questions. The next step would be to turn the soft science of archaeology into a hard science itself.

During the 1950's continued work on developing dams and irrigation projects threatened numerous archaeological sites. Through a program instituted by the National Park Service, small teams of archaeologists contracted from local universities engaged in survey, excavation and mitigation of archaeological sites. This program became the beginning of salvage archaeology. The techniques learned from the 1930's were refined albeit on a smaller scale. Sites were still discovered by surface reconnaissance and local informants. The interest had increased however in the presence and understanding of a greater range of archaeological sites both large and small in order to reconstruct settlement patterns (Willey 1953).

With the advent of more positivist cultural norms the introduction of New Archaeology in the 1960's brought with it a corresponding increase in interest in how to generate scientific results by improved methodology. Flotation of soil samples to retain carbonized plant remains (Struever 1968), water screening to recover micro artifacts from 1/16th inch screens, and a heavy use of predictive modeling and statistical theory to be able to reach scientifically valid conclusions about what people did and how they behaved in the past (Redman 1973). In particular, Binford argued that the object of study should not be site specific, but should be that of entire regions (Binford 1964). To accomplish this Binford realized the general impossibility of 100% survey for a particular area given the amount of time and money costs which would be

typically prohibitive (the Mexico Basin study being an exception). Instead, Binford suggested that a probabilistic survey that would discover and observe a proportionate example of the range in types of sites present in the region would be an acceptable substitute. Binford included different types of sampling strategies that could be used at different levels of analysis and addressed some of the problems faced with trying to generate statistical samples from the archaeological record (1964:427-434).

Not coincidentally, the title of Binford's 1964 article was "A Consideration of Archaeological Research Design" and this reinforces that what was needed were systematic, clearly defined studies to address specifically detailed questions about the past. A research design is now a key component to all archaeological work conducted in the United States and maintains an understanding that what is being accomplished is done so in a scientific manner. Specifically this was through a reinforcement of the idea of statistics and statistical sampling as scientific in nature. Statistically valid sampling strategies could be used to help address the questions of adaptation, cultural, and natural processes that the New Archaeology was interested in answering. This required a finer grained study of past occupation and use of the landscape: its distribution of features, habitations, and activity areas by earlier peoples. Documentation and collection from sites both large and small, permanent and seasonal was thus required and necessitated a shift away from the collection of artifacts only from large sites that were used to create seriations for culture history (Wobst 1983:44).

Conceptually, statistical analysis of the archaeological record was a perfectly valid use of the Mathematical Models. However, it may be helpful to point out that there are differences between what is sampled and the original behaviors that Processual archaeology was trying to identify and describe. The live population consists of sets or ranges of activities and interactions
that in sum constitute their culture which is what archaeologists are trying to understand. That living culture leaves behind a portion of itself that becomes the archaeological record, which is subject to cultural transforms (C-transforms) during creation or post-depositionally by activities such as plowing or intrusive digging by later and perhaps unrelated peoples and cultures (Schiffer 1972). N-transforms are those cause by natural forces such as erosion, burrowing of animals large and small, decomposition, and other taphonomic processes which further modify the archaeological record (Schiffer 1972). Archaeologists then are taking a sample from the archaeological record, so it is in fact a sample of a sample. This means that predictions that we make from archaeological samples have more to do with the shape and distribution of the archaeological record than they necessarily do with the original population (Orton 2000).

Theoretical problems in trying to address the issues that Processualism attempted to address brought up more inconsistencies within archaeology as a discipline. These problems needed to be addressed especially for the employment and conceptualization of sampling strategies. The basic unit of analysis for sampling needed to be identified, in other words what were archaeologists exactly trying to find within their sampling regimen? For Binford (1964) and many others this was the region, but what constituted a region? A region was conceived of consisting of an archaeological record which could be sampled by discovering its constituent sites. The question of what constituted a site was then problematic, as were questions of what and how were non sites to be addressed and conceptualized. Formal definitions were often vague in the literature and are necessarily exclusive which can lead to criticism by exception. General agreement on terms and units of measure are necessary to maintain cohesion within a discipline and allow information to be comparative outside of itself. These are elementary scientific principles and so became important under the Processualist paradigm.

Both region and site definition would suffer from trying to assign boundaries to something that would have to be in at least some cases artificially or arbitrarily bounded. Regions could be defined as those with topographic or cultural cohesion however the scale of which can be completely arbitrary and based more on project parameters rather than on any necessarily real divisions (Orton 2000:67). The size and scale of regions is variable which can make comparison between surveys of different regions problematic on a one to one basis. Other points of commonality must be followed to allow comparison at least statistically. Next, the questions of what constituted a site would not be resolved easily as this too was recognized as a largely arbitrary decision. Definitions on site typically include the understanding that they represent discrete loci of human activity. However how those look in the archaeological record is problematic as the edges of "discrete" are often times blurred over time. Over time, sites came to be defined more along the lines of certain artifact densities, or their change in densities from one area to another (Orton 2000:67-68). This came about largely as a response to cultural resource management laws in the United States which are discussed below.

Sampling up until this point had largely relied upon the visibility of artifacts on the surface and the resulting surface collection. Controlled surface collecting techniques were developed to plot in the locations either exactly or within pre-designated units of varying sizes in order to generate density maps. The density maps and the distributions contained within could then be used to assess site history and use by identifying activity areas and temporal changes based on diagnostic artifacts. While this sufficed for a time during the 1960's and early 1970's, questions began to arise about how representative was what could be seen on the surface compared to what was in the ground (Orton 2000:58). In other words, did what was visible at any given time on the surface provide a reliable, representative sample of the site's population?

Into the 1980's questions about the reliability of the plowzone for maintaining the relative integrity of sites as far as boundaries and locations was questioned. Several controlled seeded artifact studies were conducted to see how artifacts are moved, how the shape of sites could be changed, and how much was visible on the surface (Ammerman 1981, 1985, Cowan and Odell 1990, Odell and Cowan 1987). From those studies, the numbers of artifacts present on the surface was more consistently in a range from 5-6% of the total artifacts within the plowzone (Ammerman 1985, Odell and Cowan 1987). Other research on archaeological sites showed that there is some cause to think that the number of artifacts on the surface from one plowing episode to the next can be highly variable (Frink 1984, Verhoeven 1991). The nature of the artifacts, the soil conditions, and the experience of the collector all has an impact on recovery rates (Banning, et al. 2006).

In addition, some computer simulations of the effects of tillage on artifact size and distribution were also produced (Boismier 1997, Van der Welde 1987, and Yorston, Gaffney, and Reynolds 1990). Those studies concluded that there is some degree of loss of resolution of the amount of clustering of artifacts on a site when it is subjected to plowing. Other results were more mixed as far as artifact dispersal was concerned (Ammerman 1985, and Van der Velde 1987). A kind of plowing equilibrium was posited to suggest that after a certain amount of plowing, the size of the artifacts and dispersion of the original artifact patterns would cease to change significantly with each episode of plowing (Lewarch and O'Brien 1981) was not supported by the simulations nor by limited controlled experiments (Cowan and Odell 1990, Orton 2000:63).

Another problem of how to address the archaeological record within a region arose with the recognition that many areas suffered from a lack of visibility (Lovis 1976). Visibility is the

extent to which an observer can detect the presence of archaeological material (Schiffer et al. 1978). The lack of visibility in a region necessitated the inclusion of new techniques for increasing archaeological visibility through subsurface testing. Amongst these, test pitting, shovel test pitting, auguring, and coring were debated from the late 1970's through to the mid 1990's (Chartkoff 1978, Howell 1993, Krakker et al. 1983, Lightfoot 1986, 1989, Lovis 1976, McManamon 1981, 1984, Nance 1979, 1981, Nance and Ball 1986, Orton 2000:71, Shott 1985, 1989, Stone 1981). In addition to discovering sites, the utility of shovel test pits for determining site boundaries through delineation (Chartkoff 1978) and examining intra site variation and clustering (Lightfoot 1986, Nance 1981, Rootenberg 1964) was studied. Survey transect placement and configuration were examined and manipulated for optimum site intersection probabilities (Kintigh 1988, Krakker et al. 1983).

While the participants in the debate about shovel test pits and its employment in probabilistic sampling differed on a number of details, on one issue they were in general agreement: shovel test pits were a poor method of site discovery (Nance and Ball 1986, Shott 1989). Specifically the researchers predicted that shovel test pits had a difficult time finding small, low density, highly clustered sites and sometimes larger low density sites (McManamon 1981, 1984, Nance and Ball 1986, Shott 1985, 1989). It was felt that the shortcomings of shovel test pits could be overcome by tailoring the probabilistic sampling design to the kinds of sites being sought or anticipated in the area to be surveyed (Krakker et al. 1983, McManamon 1984). The problem was that at the time of their debate, the available sample sizes was low and so most of the debate centered on theoretical discussions and assumed aspects of sites such as site size and artifact density. The lack of robust regional samples to draw from meant that some of the researchers were hesitant to draw definitive conclusions.

Instead, the researchers typically hedged their bets by recommending a multi-prong approach to survey in low visibility areas such as intentionally plowing areas ahead of survey, relying on auguring, or mechanical deep testing in order to find buried sites. Some even predicted that because of its problems detecting sites that shovel testing would be abandoned as a technique for probabilistic sampling (Shott 1989). In the end, shovel test pitting emerged as the preferred method of subsurface testing due to a combination of factors including ease of implementation, relative reliability, and cost (Kintigh 1988, McManamon 1984:261, Orton 2000:71-72).

In more recent years, but in truth having a long history, the use of remote sensing has increased in popularity and effectiveness (Johnson 2006). Methods such as soil resistivity, magnetometer, and ground penetrating radar would also allow subsurface visibility. However they operate on a level above artifact and are useful in determining the presence of subsurface features. While potentially highly accurate, remote sensing techniques are typically not used as a method of site discovery due to their relative high cost. As with shovel test pits, the cost was a consideration that was to figure prominently with the advent of cultural resource management legislation and the need to balance the achieving of goals of site identification and preservation had to be achieved within the realities of limited budgets and time constraints.

2.3 Regulation and Development of Cultural Resource Management

In the brief history outlined above, the close interaction between archaeology in the United States and the Federal government is evident, with most archaeological work being financed as part of the responsibilities entailed in a mandate for stewardship of natural and historical resources. Governmental responsibility would increase over time since the New Deal era, not in scope but in more consistent and wide spread application. In 1935 the Historic Sites

Act was passed providing for the preservation of buildings, artifacts, sites, and antiquities which were of national significance. Preservation of historic and prehistoric sites was made a national policy under the philosophy that it was for the 'inspiration and benefit of the people' (Jameson 2004:27). The National Park Service would be the lead agency and assume responsibility for managing and preserving sites as well as acquiring some under certain circumstances (National Center for Cultural Resources 2006). The National Park Service would continue to be the lead agency in cooperation with the Smithsonian and the Army Corps of Engineers through the river basin projects of the 1940's into the 1960's. TVA managed its own work through large scale reservoir projects into the mid 1970's. This is the beginning of use of the term salvage archaeology which would evolve into cultural resource management as a part of the preserving ethic that was growing in American culture in the 1960's (Jameson 2004:29).

The key piece of legislation in creating cultural resource management as a professional field and as a fully developed program of archaeological investigation and preservation was the passage of the National Historic Preservation Act (NHPA) in 1966. NHPA provided the framework for assessing site significance and mandating their protection or mitigation if under federal jurisdiction. It created the National Register of Historic Places and the President's Council on Historic Preservation which would develop the rules and standards by which sites were assessed and the how, why, and ways in which archaeological work was to be performed. That framework would be further elaborated upon by other laws which supported NHPA such as Executive Order 11593 which enforced standards set by the controlling agency and the Department of Transportation Act of 1966 which included all federal projects to be subjected to the same rules. The subsequent Archaeological and Historic Preservation Act further enforced the rules that all federally funded projects were subject to the same rules and that funding had to

be provided up to 1% of the total cost of the project for data recovery efforts (Jameson 2004: 30-31). With assured adequate funding and the continuous nature of federal spending on a range of different projects which potentially impacted the archaeological record, cultural resource management became a viable business enterprise.

The implementation of the NHPA on the federal level led to the passing of legislation creating similar agencies on the state level to coordinate with the federal government. State historic preservation offices were created to provide the mid-level management both for managing the states own cultural resources, but also to coordinate with the federal government. The states were allowed a great deal of latitude in setting their own standards for archaeological work, rules for enforcement, and regulations that needed to be followed. The individual states maintain lists of qualified archaeological contractors and make sure that the archaeological work conducted in the state meets the minimum requirements as well as enforcing the laws which require archaeological work to be conducted. State agencies also act as the primary go between for the submission of applications of sites to the National Register of Historic Places. Eligibility or potential eligibility to meet the National Register's minimum requirements is a key determining factor in deciding the next step to take. It is also a goal in and of itself, and is based on the concept of significance.

Significance in archaeological terminology, at least in the United States, is not related to statistical significance but rather to an arbitrary designation created by the National Historic Preservation Act in 1966. Significance is a qualitative assessment of the value that the site holds towards contributing to knowledge and understanding of the past and represents a threshold which must be crossed to be eligible to be included on the National Register of Historic Properties. Most prehistoric archaeological sites are considered eligible for the national register

if they meet the requirements of criterion D which states that they have the potential to yield important knowledge of the past (36 CFR 60.4) and which have integrity (typically meaning intact undisturbed deposits), although that also means they should qualify under criterion A as well for association with important patterns of events (King 2012).

King (2012:91-92) points out that in discussions of eligibility for a site, the question of integrity and significance are best addressed by those it is significant to, which in this case are typically archaeologists. As such, regulatory significance holds no true relevance to the archaeological record, but it does create an arbitrary lens by which cultural resource managers must view it. What it does hold is some idea of the notion of the relative value of the data potentially contained by a site for addressing questions of interest to the archaeological community. Theoretically the relative value of this information would decline as greater numbers of similar sites with similar significance were discovered and nominated. The idea of a relative amount of data again perpetuates the bias towards large, artifact dense sites that hold the greatest volume of information.

However, this is not always the information that archaeologists seek. If we are to understand the relationships of a people on a regional level then significance of a site should take on more of the how much is the site likely to shed new information and how much is going to be redundant. There should be a closer approximation between what would be a significantly significant sample of the types of site in a region for a given time period and those that are nominated as eligible. Where there are disparities entire aspects of human behavior and relationships with the world are ignored because it does not meet arbitrary thresholds or do not have adequate research designs incorporating those types of sites in relevant research questions. The idea of under representation of certain types of sites in the record has recently been

addressed by Peacock (2008), Cain (2012), and Chartkoff (1995) with regard to small lithic scatters.

Significance as a cultural value which we place on the archaeological record has direct bearing both in how we define what we are looking for and the methods which would be acceptable to achieve those goals. We as a discipline seem to continue to conflate the necessities of government regulation with the limits of what we are interested in as scientists. Hearkening back to the description of what constituted a site, is the relative density of material more crucial than its presence or absence? A single artifact in a shovel test does not constitute a site in most states though it may have been the direct result of human activity. Instead a minimum number of artifacts per unit sampled has to be achieved in order for the area to be recorded as a site (typically 3 within a certain radius). Sites also need to have boundaries, since as Wobst (1983) pointed out managing them from a government point of view requires definition.

Additionally, the sampling strategies specified by the states are geared towards finding sites that are more likely to meet the requirements for eligibility. This is accomplished by specifying maximum intervals for survey transects and the size of shovel test pits. Both of these factors can greatly reduce the chance of finding smaller, less artifactually dense sites. These sites are generally regarded as having a lesser chance of being potentially eligible for the national register. Further reasoning behind ignoring this 'noise' is that additional work and effort is required in their identification which directly translates into higher costs both in time and money, resulting in a perceived minimal amount of return in the form of new and conclusive information.

Whether intentional or not, the state specified spacing of transects and the size of shovel tests does bias the sampling methodology and these vary from state to state. Table 2.1 shows the

different requirements for surveying from states across the study region. There is a great deal of variability and it is interesting to note a couple of different factors. First amidst this variability some states are very different in what they require as compared to most other states. For instance, Florida is adamant about conducting 50cm by 50cm shovel test pits while the majority of states in the survey area require only a 30cm by 30cm shovel test pit. The reasoning Florida offers is that the smaller shovel test pits have been shown to consistently miss sites which Florida deems important enough to want to discover. Other states like Tennessee simply expect that professional archaeologists within the state will know what is an adequate transect spacing and use their best judgment to discover sites. This gives the state a great deal of flexibility in their requirements depending upon how much work they think is necessary on a particular area.

The differences in transect distance may be a reflection of the expectations and general knowledge about site size and shape found in the archaeological record in that state. If the shape of the archaeological record is known, then sampling strategies can be designed so that they can capture that shape. As an example, if sites in an area are all round and 30 meters in diameter or larger then with perfect visibility either with surface collecting or shovel testing, all sites will be found using 30 meter transects (Sundstrom 1993). Unfortunately what we know about the archaeological record is based on previous work, which merely sampled the record. This would just continue to perpetuate the bias (Wobst 1983).

These arbitrary constructs and regulations have some serious and poorly understood implications. From the original population which created the archaeological record, to the cultural and natural forces which act upon the record, to the archaeologist who can explore only part of the remaining record we have thus a sample of a sample. Further, in some cases like the decision of whether to call a single flake a site or not, this means a sample of a sample, of a

sample, for three layers at least. In the case of transect size past discovery of sites dictates the spacing of transects, thus ensuring similar results. This biases the sample of the archaeological record to no longer reflect the archaeological population, just a representative sample of the portion in which our culture is currently interested or can afford to be interested in. The current but changing interests of our culture is a valid point to make in relation both to archaeology and state requirements for surveying. Cultural interests can and do change over time. In some cases this reflects refinement of technique or in addressing deficiencies. State requirements tend to be conservative in nature as reflected by information compiled on the Council of Texas Archaeologists website which lists the date of publication for state survey methodologies across the United States. Most of those listed are in the mid to late 1990's which corresponds roughly to the end of the fierce debate over the adequacy of shovel testing. In recent inquiries, four of the states in the study area have been found to have recently or are in the process of updating their methodology requirements.

Archaeological method and theory has the biases of historicity favoring the identification and excavation of large sites, burials, elaborate and exotic material culture, with a focus on the elites. Data generated from biased and subjective methodologies necessarily skew the conclusions that can be generated. The effect may be great or it may be small, but it has a measurable effect that can be determined and should be understood. Problems continue to occur when seemingly small errors made at the field level are magnified when constructing the larger picture and conducting regional synthesis. For instance, if a settlement model is trying to be developed for an area and the smallest unit that is identified as isolated households constitute sites which are smaller than the transect distances being used for a survey then they will be under represented in the known archaeological record and consequently in the settlement hierarchy as

well. Deficiencies such as this can be the result of bias occurring along the path of twists and turns detailed above, and these can be identified by using the very variety in standards amongst the states along with examination of a larger regional level to determine variations in the statistical significance of particular types of sites. In this study, we will be looking at the smallest unit of habitation with permanent structures and facilities during the Mississippian period, the so called farmstead to determine if and how those biases are present and how they have affected our interpretation of the archaeological record.

Table	2-1	State	Survey	Rec	quirement	ts
			~		1	

State	STP Interval (m)	STP Radial Interval (m)	SC transect Interval (m)	Screen Size	STP Size (m)	STP Depth (m)	Adopted	Source:
Alabama	30	5-10	NS	1/4"	0.3	NS	1996, rev 2002	Alabama (2006)
Arkansas	20		20	1/4"	0.3	0.5	2010	Arkansas Archaeological Survey (2003)
Florida	25	10	NS	1/4"	0.5	1	2002	Florida (2001)
Georgia	30	10	30	1/4"	0.3	0.8	post 2000	Georgia SHPO 2010
Illinois	15	5	5	1/4"	0.4	Sterile	1996	(Illinois State Historic Preservation Office n. d.)
Kentucky	20		20	TS	0.3		1991, rev 2001	(Sanders 2006)
Louisiana	30	10-15	NS	1/4"	0.3	0.5	unknown	Louisiana Office of Cultural Development 2016
Mississippi	30	5-10	15-30	1/4"	0.3	Sterile	2001	(Sims 2001)
Missouri	15	5	5	1/2"	0.25	Sterile	unknown	Missouri (2010)
North Carolina								no data
South Carolina	30		30	1/4"	0.3	0.8	2005	(South Carolina Prof Council Arch. 2005)
Tennessee	NS	NS	NS	1/4"	NS	NS	rev 2009	Tennessee (2009)
Virginia	15	NS	Complete	1/4"	0.381	Sterile	2009	Virginia (2011)

Notes: STP= Shovel Test Pit, SC = Surface Collection, NS = Not Specified

3 DATA

3.1 Mississippian Farmsteads

The unit of measure used in this thesis for examining biases inherent to archaeological site detection methods is the Mississippian period farmstead. A combination of personal interest in and experience and familiarity with this type of sites by the author contributed to their selection. In the interest of full disclosure, it is also the opinion of the author that farmsteads, especially in certain areas, are under-represented in our knowledge of the archaeological record. Questions about 'why this is so?', or even more basic, 'is this a valid observation?' compelled the author to try and look for answers. At the same time, the author is fully cognizant of the need to be as open minded about the results as possible and putting personal biases aside in the execution of this thesis. While there are many other types of sites which could have been chosen to try and illuminate possible differences between detection methods, the Mississippian period farmstead was chosen due to its many advantages and the importance that this class of site plays in interpretation of the archaeological record.

First, Mississippian farmsteads are relatively abundant in the archaeological literature, occurring in varying densities across the Southeastern United States. The farmstead's relative abundance in the literature may be masked somewhat because as a formal type of site they have been poorly and variously defined. Within Mississippian typology and hierarchy nomenclature they have in addition to farmsteads (Knight and Solis 1983) been variously named or referred to as hut clusters (Mehrer and Collins 1995), households (Smith, B. 1978, 1995),

homesteads (Davis 1990), and rural communities (Myer 2002). The purpose of this thesis is not to arrive at a new term, rather to recognize that while the term farmstead has persisted in common usage, there has been some dissatisfaction with the term and alternatives have been proposed (Myer 2002). Disagreement over the term farmstead usually centers around the implied functional meaning, i.e. that farming was the primary function of the site (Mistovich 1995:177, Myer 2002:22) when expanded research into these small scale sites showed them to also possibly serve as a centers of skilled craft production (Prentice 1985), meeting grounds (Maxham (2000), centers of salt production (Muller 1997) and seasonal procurement stations (Lorenz 1996, Riordan 1975). The second typical objection is that farmstead is appropriately used to describe a western European concept of settlement, one which in North America is more tied to the settlement of the west with free land offered to those who would settle it and make certain agricultural improvements. This kind of connotative meaning is consequently not appropriately attached to prehistoric sites. While these objections are duly noted, the term farmstead continues to be used in the professional literature (Beck 2003, Brown 2008: 372, Hogue 2007, Pauketat 1997) though occasionally the term will appear in quotation qualifiers.

At least a working definition of farmstead is needed in order to proceed with the discussion. In this thesis, there will be both a qualitative and a quantitative definition that is applicable, with the pertinent definition dependent upon the context. The qualitative definition of farmstead used in this thesis is the minimal unit of a culturally created settlement system consisting of the cohabitation of one or more people possibly representing a singular nuclear to extended family group who have constructed permanent housing, facilities, and activity areas. Additionally, it is perceived but not measured that farmsteads are small, highly clustered sites of

relatively short occupational duration. Functional aspects of the activities or primary focus of the habitation are not considered here. The quantitative definition will be discussed below in the section describing the database.

The second factor arguing for the use of farmsteads as the analytical unit is that these small scale sites help to form a key piece of our understanding of a variety of aspects of Mississippian culture. Mississippian culture is defined as a hierarchical based system academically modeled on a Polynesian chiefdom (Peebles and Kus 1977). While recent scholarship has focused on exploring more of the variety and differences that this adaptable culture has manifested rather than the similarities (Pauketat 2007), farmsteads continue to play an integral role in our understanding of that hierarchy and the local variations. This is so due to two main factors: farmsteads can serve as the greater social system in miniature and as a key indicator of adaptation to the social and natural environment.

As described in the definition of farmsteads, these sites are the basal unit of a culture which still retains all of the elements of that culture. As an individual household, these sites represent an opportunity to explore the distribution of and functional use of space, activity areas, gender roles, subsistence, as well as material culture. All of these characteristics are guided and shaped by the inhabitant's cultural identity. While some (Mehrer and Collins 1995) have looked at households as a direct microcosm of the larger culture which in turn influences the larger as it is in turn ruled, others have warned against functionalist interpretations of households and their roles (Pauketat 1997). But either way, which vector of influence is occurring would have to be determined on a case by case basis. The idea is that social change can best be understood by looking at a culture's community pattern as a whole rather than by only examining the larger sites.

The presence or absence of farmsteads on the landscape can be indicative of what sorts of natural and cultural forces are at work on a society. In the hierarchical Mississippian society model, there are four primary patterns or models of settlement system (adapted from Myers 2002). The first is characterized by nucleated villages with no farmsteads which the Dallas phase of east Tennessee is an example (Polhemus 1987). The second consists of single mound centers with surrounding farmsteads which Morse and Morse (1996) describe as occurring in northeastern Arkansas. Blitz (1993) also describes this type of settlement for the Tombigbee Valley. The third model consists of a paramount chiefdom with multiple single mound centers and supporting farmsteads beneath it as has been seen at Cahokia in the American bottom (Emerson 1997). The fourth pattern is typically associated with both the beginning and the end of the Mississippian period and consists of dispersed farmsteads with little to no indication of more complex hierarchies involving mound groups or larger towns.

Under idealized circumstances, Bruce Smith (1978) theorized that Mississippian households would be dispersed around the countryside to provide maximum access to resources. In reality, a great deal of variation in settlement pattern occurs due to both natural circumstances of physiography as well as historically contingent cultural events. The appearance or absence of farmsteads has been used as a barometer of the external stresses facing a Mississippian society (Green and Munson1978). For instance, occurrences of low numbers of farmsteads are characteristic of settlement patterns with nucleated villages which have been perceived as one where the inhabitants are under a fair amount of stress from violence. It is too dangerous to live outside of areas which offer a high degree of collective defense (Bense 1994), so villages and towns are usually fortified and the expectation is that mortuary populations will show a high

incidence rate of inter group violent trauma. That assumption of higher trauma levels is not always borne out by excavation data (Smith, M. 2003).

Conversely, the appearance of farmsteads, such as in the case of the second model, is seen as an indication of relative peace with the population somewhat dispersed and not in a high defensive situation. But take as an example the Kent phase consisting of farmsteads and villages with no mound hierarchy apparent and which is contemporaneous with the Parkin phase consisting of fortified mound and fortified village sites with no farmsteads (House 1996:147-148). It is known from historical accounts of the Spanish entrada by De Soto that both of these groups were in a near constant state of warfare with each other (Hudson 1997).

The dispersion of towns and mound groups into farmsteads and coalescent communities (Kowalewski 2006) during the late Mississippian to Proto-historic periods is seen as a result of the destruction of the traditional Mississippian culture and its hierarchical system of obligations and control. Themes for how this occurs have been recently discussed (Ethridge and Shuck-Hall 2009) and this settlement pattern is often seen as transitional before the reestablishment of towns necessitated by the need for protection during the slaving and warfare of the early historic period. This seems to be the case for the Cherokee during the Middle Qualla where individual farmsteads are common and which then see a contraction into downs at the end of the phase and continuing into the Late Qualla (Greene 1996, Marcoux 2010). However, the Black Prairie region of Mississippi indicates a move to a more dispersed settlement pattern with many small farmsteads, few larger towns, and no mound centers earlier in the Late Mississippian. Johnson et al. (1984) speculated that this was a result of the pursuit of game resources into more marginal farmland, but others believe that the trend began much earlier in the Mississippian (Eastman 1996) and was more diversified in its economic base (Peacock and Melsheimer 2003).

Farmsteads are also important for increasing our understanding of social change and offer opportunities to examine material culture change in ways that larger sites cannot always provide. The short term occupation of farmsteads means that they inhabit narrow chronological ranges which can help to generate tighter chronologies for important artifact markers (for example see Shumate et al. 2005). Farmsteads usually have the added advantage of not having mixed components which can result from long term occupation of sites which can obscure efforts to try and create tight chronologies leading to greater confidence of association between artifacts and activity areas.

Another way in which Mississippian period farmsteads can contribute to our understanding of the Mississippian period is as a possible mechanism for the transmission and spread of Mississippian culture. Three models are currently being debated, the first and oldest theory is that migration occurs typically from large mound centers out into the hinterlands where the migrants found other large mound centers. Such a scenario is proposed by Jenkins and Krause (2009) in drawing a connection from Cahokia to Shiloh, and finally to Moundville. The second one being the Polity Fission-Fusion model proposed by Blitz (1999) where basic units of a society aggregate into a cohesive greater whole which exists in a defined space before internal pressures cause the basic units to reassert themselves and the whole disperses into constituent parts. These basic units are bearers of social identity and though they help to preserve it, they also are subject to change as well (Blitz and Lorenz 2006). The fissioning process is the way in which Mississippian culture makes its way into new territory and into contact with Woodland culture practitioners. The third model is the adaptation of the Kopytoff's (1987) Internal Frontier Model which explained the spread of communities in central Africa to suit the particulars of the southeastern United States (Blitz and Lorenz 2002). Farmsteads were the leading cultural edge of

the Mississippian world and were pushed further and further into territories until they were sufficiently far enough away to necessitate the founding of a new regional center (Blitz and Lorenz 2002). To greater or lesser degrees farmsteads in all of these models figure as an intermediary role between Mississippian and non-Mississippian societies and other Mississippian polities. The dynamic interactions between these groups should be preserved at least in part in the archaeological record and that will give archaeologists insight into cultural change.

The third factor in favor of using farmsteads as the analytical unit for measuring bias is their small size and typically brief occupation will challenge discovery methodologies and highlights the difference in efficacy between those methodologies. These last criteria are key, because in order for biases to be exposed, significant differences need to exist between the archaeological record and the known archaeological record. The harder it is for discovery methodologies to find farmsteads, the less represented they will be in what we know of the archaeological record. If farmsteads are under-represented in the known archaeological record, then many of the conclusions which hinge upon their presence or absence will be similarly incorrect. Accurately identifying farmsteads in the archaeological record is essential to our understanding of the Mississippian period.

3.2 Database

To examine questions of bias on what is known of archaeological record regarding Mississippian farmsteads, a large amount of data on farmsteads needed to be collected. The sources of this data would be a thorough, comprehensive review of the available literature on farmsteads to determine the original sources of the data and anecdotal references from professionals who were contacted by the author for information. Both of these sources would serve as jumping off points for searches of the state sites files in the survey area. Rosy

expectations as to what sort of data could be garnered from the state site files, proved to be overly optimistic. This was primarily due to the nature of the data that was being queried and the various developmental stages of different state's site files. For instance, "farmstead" is not a category that could be queried, nor were recovery techniques utilized or methodologies. Additionally, while the nature of the electronic format of the state site files databases varied from excel spreadsheets to true databases, most included only data which was recorded on the site card. Unfortunately, and rather universally, there are numerous deficiencies of data especially with the older recorded sites. Georgia and Alabama both have some of the more sophisticated state site files, with online query capability and some reports that have been scanned and are available in electronic format. However, as Mark Williams of the Georgia State Site files told me, the questions I wanted to ask the site files could be accomplished electronically maybe in ten years, so for now I would have to go through the records one at a time.

Before that could happen however, a concise definition of farmstead needed to be established. Reviewing the literature for just such a definition proved to be difficult. In particular since this thesis would make an attempt to mathematically compare various strategies, measurable attributes would be favored over functional or other nominal descriptors which can be quite varied. Most state site files do not exert conformity of the data or types of data entered for various fields which makes the parsing out of even ordinal data difficult.

A decision had to be made on how farmsteads would be determined based off of the data that is available. Farmsteads could be parsed from other settlement types based off of size and the density of artifacts found. Green and Munson (1978) set the dividing line between hamlets and farmsteads at 0.25 ha., while Davis (1990) employed a density of 1 to 5 artifacts to fist sites into the homestead (farmstead) category. Originally I had decided to use sites which were less

than 0.5 hectares in areal extent and upon discovery yielded less than 50 diagnostic sherds from the Mississippian period (Lorenz 1997). However, this standard could not be maintained due to a variety of factors connected with both data collection and the way data was stored and presented. Where data was available this standard was upheld, however it was expanded in many cases to include instances where the reporter identified the site as a farmstead, the site was identified as farmstead in a publication, or the review of the site card and/or report provided other indications such as a single burned house which indicated that the site was a farmstead.

Large multi-component sites also presented a problem along two vectors. The first is that in many cases if the site was surface collected the distribution of artifacts within the site was not recorded or reported. A farmstead located within a larger site would then not qualify due to areal extent though the sherd count might still fall within the specified range due to a lack of spatial resolution of artifact distribution. The second problem presented by larger often multicomponent sites is whether the visible artifact distribution is the result of single large scale occupations or by intensive reuse of the site with small scale habitations, a caveat which has been recognized by archaeologists (Orton 2000, Wandsnider 1998). In either case, if the available information was available, and justification for inclusion in the sample was present, the site was added. Attempts were made then to be as inclusive as possible as to what constituted a farmstead, while at the same time not re-interpreting the established archaeological record.

The collected sample consists of 483 Mississippian Period farmsteads from sites across the Southeast. In order to contain the data and provide the maximum flexibility for making comparisons within the data, a relational database was created within Microsoft Access. Figure 3.1 shows the structure and relationships within the database. Table 3.1 is the design view of the Site Table and is provided as an example of the types of data that was collected and how it was

stored in the database. Similar information for the rest of the database can be found in the appendix. The goal of the initial stage of data collection was to capture with both nominal and metrical information that could be utilized to describe farmsteads as a class. The uncertainty as to what would be important defining characteristics of both the class and which factors play the most significant role in site discovery meant that a wide battery of attributes were recorded for each site ranging from site dimensions, plow zone depth, temporal affiliation, method of discovery, primary citation, as well as Phase I, II, and III methods and results. The database also contains a second layer of information above the site level which details the surveys which discovered the sites. As mentioned before, information is not always complete for all examples and so depending upon the attributes being queried only a portion of the total number of records may be returned.



Figure 3.1 Database Structure

Name	Туре	Size	
	Site ID Number	Long Integer	4
	Site Number	Text	255
	Site Name	Text	255
	State	Text	255
	County	Text	255
	UTM Zone	Long Integer	4
	UTM Easting	Long Integer	4
	UTM Northing	Long Integer	4
	Latitude	Text	255
	Longitude	Text	255
	Physiographic Province	Text	255
	Stage Identified	Text	255
	Beginning Time Frame	Long Integer	4
	Ending Time Frame	Long Integer	4
	Phase Name	Long Integer	4
	Site area (m2)	Long Integer	4
	Distance to Water	Long Integer	4
	Soil Type	Text	255
	Plow Zone Depth	Double	8
	Other Components Present	Yes/No	1
	Number of Structures	Long Integer	4
	Burned?	Yes/No	1
	Rebuilding Episodes	Long Integer	4
	Associated Pits	Long Integer	4
	National Register Eligible	Text	255

Table 3.1 Design view of the Site table from the Mississippian Farmstead Database

Basic information on the makeup of the sites in the database can be found on Table 3.2. Figures 3.2 through 3.5 show the geographic distribution of sites based on temporal affiliation. While an attempt was made to be comprehensive across the Southeast, time constraints and relative ease of access to information favored some states over others. Right away three states Alabama, Georgia, and Mississippi can be seen to have many more sites than the other states containing 304 out of the total of 483 sites. Interestingly, the farmsteads in each of these states are concentrated within a particular area within that state which corresponds to a physiographic region. Figure 3.6 shows the concentration of farmsteads within three specific regions: the Piedmont of Georgia and to a lesser extent South Carolina, the Black River Warrior Valley in Alabama, and the Black Prairie in Mississippi and Alabama.

Table 3.2 Database	metrics			
Sample Total: 483		Sites with Excavation Data:		
States Represented:		Phase I Data:	440	
Alabama	76	Phase II Data:	70	
Arkansas	1	Phase III Data:	26	
Georgia	141			
Illinois	5	Time Periods Represented:		
Mississippi	229	General Mississippian	900-1600	226
North Carolina	1	Early Mississippian	900-1200	38
South Carolina	6	Middle Mississippian	1200-1400	33
Tennessee	24	Late Mississippian	1400-1550	116
Total	483	Protohistoric	1550-1650	70



Figure 3.2 Spatial distribution of Mississippian farmsteads in the database



Figure 3.3 Early Mississippian Farmsteads



Figure 3.4 Middle Mississippian Farmsteads



Figure 3.5 Late Mississippian Farmsteads



Figure 3.6 Protohistoric Farmsteads

3.3 Major Database Regions

3.3.1 Piedmont

The Piedmont region consists of the weathered remains of the flanks of the Appalachian Mountains, bordered by the Atlantic Coastal Plain to the south and east and the afore mentioned mountains to the north. The topography is characterized by steep hills rising to about 2800 feet amsl closer to the mountains with more gently rolling hills cresting at around 400 feet amsl at the juncture with the coastal plain (Hodler and Schretter 1986). The soils of the piedmont typically consist of a thick red clay loam of the Davidson series which is the result of the intensive weathering of the underlying metamorphic rock (Payne 1976) which is usually considered by archaeologists to be a subsoil. Overlaying this is the Cecil series of sandy loams which though abundant with stones is moderately productive (Elliott 1990) and is generally the cultural material bearing soil zone. Farming practices and the removal of the original oak and hardwood forest have resulted in the erosion of most of the top soil leading to the abandonment of the area for most types of farming (Trimble 2008). Pine forests have established themselves in the thin soils (Cowell 1998) and significant portions of the Georgia Piedmont are included in the system of National Forests.

The area has a rich archaeological record that has been sampled by amateurs, reservoir construction mitigation projects, cultural resource management, and academic interests. The areas most intensively surveyed are those associated with government owned land such as in the National Forests and around the reservoirs due to federal legislation governing the inventorying of cultural resources and assessing the impact of clear cutting and development on those resources.

Methodologically, both shovel testing and surface collection have been used in the region. As the amount of land under cultivation is relatively minor, surface collection relies on locating disturbed areas of soil which are common in areas subjected to clear cutting. The average plowzone or topsoil depth for sites in the database from this region is 17.5 cm. The relatively thin soils are also helpful in making shovel testing relatively quick and improving visibility for surface collection. The presence of Mississippian period farmsteads in the region was recognized relatively early on, and they are seen as an abundant cultural feature of the landscape. Current estimates place the possible number of farmsteads to be more 10,000 sites in the Oconee Valley (Kowalewski and Hatch 1991). The relative ease of discovery and the fairly predictable location of Mississippian farmsteads in the region (Hatch 1995) have encouraged the use of probabilistic surveying strategies with examination primarily of only those areas where experience has shown there to be a high likelihood of a site.

3.3.2 Black Warrior River Valley

Rather than being a formally defined physiographic region, the Black Warrior River Valley as used in this thesis is the immediate vicinity around the site of Moundville in Tuscaloosa County, Alabama. The county and some of the surrounding area has been the scene of a number of intensive efforts to try to identify the contemporaneous settlement pattern around the Moundville site in order to better understand the settlement system (Bozeman 1982, Hammerstedt 2000, 2001, Meyrs 2002a, 2002b, 2003, and Maxham 2004). Located within the Gulf Coastal plain, the area typically has lower relief than that of the Piedmont. Three distinct divisions are made within the zone: floodplain, terrace, and fall line hills. The floodplain of the river can be 6-7 km wide, with fertile alluvial soils, swampy areas, and lower terraces which are prone to flooding (Johnson, K. 1981). Soil with archaeological components includes a variety of silt and sandy

loam series such as Ellisville, Choccolocco, Dundee, and Cahaba. Some of these soils extend into the other divisions as well (Hammerstedt 2000). The terrace zone consists of moderately fertile and drained soils located on the upper terraces above the floodplain (Johnson, K. 1981). Last, there are the fall line hills with the highest elevations and poor soils, which bracket the floodplain and terraces (Johnson, K. 1981).

The data collected from this region typically comes from the academically oriented surveys usually under the umbrella of the Black Warrior River Valley Survey in contrast to the more cultural resource management focus of the Piedmont. Attempts were made to try to sample each of the three internal regions in a systematic manner. For the most part, surface collection was employed as the method of site discovery, as most areas were under cultivation. However the upper terraces and fall line hills contained some areas in forest or pasture which were subsequently shovel tested. The results of the Black Warrior River Valley Survey were mixed with the general conclusion that the survey had not managed to locate a proportional sample of the available sites and in particular the smaller sites such as Mississippian farmsteads.

One of the primary reasons for this conclusion was that upon revisits to known sites, the relative amount of diagnostic ceramics available on the surface varied widely and in most case seemed to significantly drop over time. Meyr's (2003) attributed this to the decomposition of the shell tempered ceramics as a result of being subjected to repeated plowing episodes. Shell tempering is the majority tempering agent found in both the Black Warrior River Valley and the Black Prairie, however in the Piedmont, the major tempering agent is grit or sand. Since grit does not decompose like shell tempering does, the idea is that grit tempered wares would be more durable against natural transforms (acids in water) and cultural transforms (intensity of plowing) leading to increased survivability and therefore increased chance of detection within the

archaeological record. The choice of tempering and its subsequent relative survivability as a diagnostic artifact is a cultural based factor that can produce differences in detection regimens and should be compensated for if direct comparisons between areas are to be attempted. Information is not available at this time for other contributing factors such as average plowzone depth since most of the sites were not shovel tested.

3.3.3 Black Prairie

The Black Prairie of Mississippi and Alabama is a crescent shaped physiographic region extending from the northeast corner of Mississippi into the mid-west of Alabama. It is characterized by broad, flat bottoms with silty soils underlain by chalk deposits and sandy ridges which rise above the bottom lands (Johnson et al. 1991). The ridges tend to be forested while the chalky lowlands are prairie (Johnson et al. 1991). The antiquity of these land cover types is under debate (Peacock and Melsheimer 2003). Soils are rich and heavy with clays making screening difficult and time consuming (Johnson et al. 1991).

Archaeologically, the area has been sampled by a variety of different methods and has had a more mixed impetus for survey. Major reservoirs do not exist in the area though the construction of the Tenn-Tom waterway impacted the area on the east side resulting in a few sites found within the region (Jenkins 1986). The Tombigbee National Forest lies just outside of the physiographic area in the North Hills region and has been extensively surveyed (Triplett 2008) such that it might provide an interesting comparison for future studies. Cultural resource management efforts concerning road and small dam construction (Johnson et al 1984) have occurred as well as academic pursuits through field schools run by Mississippi State (Rafferty and Peacock 2008). Both surface collection and shovel testing have been applied to the area. However, a great deal of flexibility has been applied to research designs owing to the differences

in ground cover and the difficulty of the soils to be screened (Johnson et al. 1991). The average plowzone depth for sites in this sample was 15.9 cm, so it is slightly shallower than the Piedmont region.

These varied approaches have resulted in a debate over the meaning of the data and the implications for how and when the region was settled in prehistoric times (see Johnson et al 1984, 1991, McNutt 2009, Rafferty 1996, Rafferty and Peacock 2008, 2009). This thesis will not address that debate directly as it beyond the goals of the research questions. However, it is hoped that the information generated herein will help the participants in the debate to rethink the nature of the data and possibly come to a more comprehensive and accurate conclusion.

3.4 Analytical Units

Each of these regions has its own unique physiographic and environmental characteristics, however they do share at least one aspect in common: they have all been the subject of intensive archaeological study. In many cases, the primary goal was the discovery of Mississippian period farmsteads. The large numbers of farmsteads found in each region makes each of these regions a good candidate for examining the intra- and inter- regional variability of Mississippian farmsteads as a class and to also test the efficacy of various discovery method regimens. The relatively large samples from each region make the possibility of statistical comparison more viable. Additionally, one of the goals was to try to generate data which could be compared with fewer biases caused by both cultural and natural factors. Within each of the three regions the physiographic region is the same thereby controlling for differences in geology, soil structure, climate, and access to water. Possible cultural biases are also controlled along two vectors. First prehistorically, the relatively small size of each of the study regions precludes a great deal of cultural diversity. The people living within each area were most likely closely

related culturally to each other with similar adaptive strategies, hierarchical organization, use of space, and disposal patterns. The reactions to stimulus both natural and cultural would be fairly consistent over the breadth of the area. The second vector involves post depositional cultural activities. Following the use and abandonment of the farmsteads, the greatest cultural transforms came with the arrival of European agricultural and urbanization practices that modify the landscape with increased speed and impact on archaeological deposits beyond what was likely to occur naturally. Intensive farming and especially plowing, silvaculture, and development in the form of roads, dams, and cities have all had an effect on what remains intact in the archaeological record. The relative amount of impact is different however between each region but can be assumed to be fairly homogenous within that region.

Understanding how these regional histories can affect our knowledge of the archaeological record within that region can then be used to make inter-regional comparisons. To do this we will need to have as comprehensive knowledge of the Mississippian farmstead as a unit of study as possible. Since we are not interested in the functional aspects of how these sites operated in a direct way, we can measure variability between sites based purely on the amount of diagnostic artifacts recovered, their patterning, and their relative visibility to various site prospection methodologies. This might allow the effects of differences between regions to be highlighted and even lead to explanations as to those differences. For instance, though both the Black Warrior River Valley and the Black Prairie's inhabitants used primarily shell tempering which can be subsequently broken down by weathering and farming practices, we might expect the Black Prairie region to have sites that are relatively denser with shell tempered sherds due to the less intensive nature of agricultural activities in the area as compared to the Black Warrior River Valley.

Using site as the basic unit of measurement is not without its theoretical problems. There has been considerable interest in the last two decades in examining the concept of site and its relative validity (Thomas, D.H. 1975). In particular, there is the Selectionist theoretical camp which advocates the removal of sites as a unit of measurement scaled above assemblage and instead focus on artifacts and their attributes on an individual level as a basic unit of study due to common use of classification (Dunnell 1992, Dunnell and Dancey 1983). The purpose of this thesis is not to argue the point over the validity of site as an analytical unit. The continued use of site here is based upon three factors. The first is that the data that is used in this thesis was generated from site based data, such as site reports, state site files, and published syntheses. Conversion from this one established unit to the smaller analytical unit of the artifact would be difficult and result in a significant loss of data. As an illustration, the attempt to gather information and to generate site specific densities based on recovered diagnostic artifacts proved to be difficult due to a general lack of information. Important items such as locations of collection units, stps, surface scatters, and their contents as well as links between phase I and subsequent work made it difficult to impossible to be able to generate comprehensive artifact maps. Often data was lumped together and reported collectively as a site, without differentiation or specifics for the artifacts recovered. More recent work is generally better about reporting these specifics, but they are still linked together as part of a coherent closed system of the site.

The second point for continuing to use site as the analytical unit is that this thesis is examining the detection of farmsteads. However, they could be defined, they are, on a basic level, a collection of activities. The goal then is to be able to evaluate discovery methods which can identify those activities and successfully deduce that they are the result of a collective pattern of associated activities. That those activities create artifacts is essential to the success of most
discovery techniques, however activity exists on a level above the individual artifact. Most discovery methods are very poor at detecting any particular artifact, and instead rely upon focused activities to generate the densities necessary to achieve a reasonable chance of detection. With this idea then we can link the discovery of a single diagnostic artifact, say a sherd, with the collective activities of the site which constitute the definition of a farmstead. The likelihood of recovering an artifact from a completely random, non-systematic, and/or unrelated event is very small compared to recovering an artifact from a consistent regular activity.

The third point is closely tied to the second and to basic sampling theory. In order to see the clusters which are the result of activities, an appropriately sized unit has to be employed. If everything is examined at the artifact level, clustering which would denote activities is lost and so does not contribute to organizational understanding nor the recognition of activity areas. A higher level of inclusive analysis is needed which, for all intents and purposes, is the same as the categorization of artifact clusters into sites. If we are interested in the characteristics of these activity areas, how they are distributed across the landscape, how they are patterned internally, and how that patterning affects detection methods, then site is a more appropriate unit of measure than the individual artifact.

Pursuant to this, sites consisting of a single Mississippian farmstead will continue to be used in this thesis as the basal level of analysis. While the database contains information on sites from across the southeast, the focus of the thesis will be three regions: Piedmont, Black Warrior River Valley, and the Black Prairie. Sufficient data exists within each of these regions to try to derive information that can address the questions this thesis seeks to answer. To investigate the characteristics of Mississippian period farmsteads and prepare for inter and intra-regional

comparisons, appropriate methodologies will need to be developed and implemented and which will be detailed in the next chapter.

4 METHODOLOGY

The purpose of various site discovery techniques is to try and return a representative sample of the range of sites which exist within any given study area. While there had been considerable debate in the 1970's through early 1990's on the relative merits of shovel testing and the plowzone as an archaeological resource, surface collecting and subsurface collection have not been directly compared with each other (see chapter 2 for details). To expose the underlying bias that exists within our archaeological methods and which consequently finds its way into our knowledge of the archaeological record, the relative efficiency of different discovery methods can be evaluated based on the information stored within the database. In principal this is a relatively straight forward comparison between different techniques. The results may show which techniques perform better under certain conditions over others. It is also hoped that if there are inherent biases, for instance continued reliance on inefficient techniques which leads to under representation of these small scale sites, that they can be identified and that the magnitude can be understood and possibly compensated for when evaluating survey results.

However, while on one hand a simple known data comparison can provide results from the real world, developing a Mathematical Model would be ideal for understanding more of the dynamics involved. In order to evaluate for possible biases, I will pursue a two prong approach where real world and Mathematical Models will be developed separately and then see how they compare. The results can then be evaluated to determine if site discovery methods are viable techniques for generating information that continues to meet our expectations for determining the presence or absence of significant sites and a representative sample of all sites significant or not.

4.1 Real World Data Model

Data recorded from surveys and contained within the farmstead database can be evaluated for the relative amount of efficiency each technique exhibits for discovering Mississippian farmsteads. Initially results from all sources can be compared. Then to eliminate biases due to regional, physiographic, cultural, and to a lesser extent temporal differences, each of the three regions: Piedmont, Black Warrior River Valley, and Black Prairie will be evaluated. The results can be statistically compared to each other to determine if any differences are statistically significant.

Perhaps the best approach would have been to develop a multivariate model to try and account for a number of variables which might and probably do play a role in farmstead visibility. However, while the database does contain many fields which may have an effect on visibility such as plow zone depth, soil types, the presence of burned structures, and multiple components, this information was not available in a consistent enough manner to be able to constitute a significant subset of the database population. Instead a simplified averaging for the different field methodologies was compiled using the following formula:

For each survey the amount of area surveyed is normalized then totaled for each technique:

(Total surveyed area / number of farmsteads recorded)* the number of farmsteads found in that survey with a particular technique

Then the area is totaled for each technique then divided by the total number of farmsteads found with that technique to get a normalized efficiency rating of hectares surveyed per farmstead:

Sum of total surveyed area for a particular technique determined above / sum of farmsteads discovered

This method will generate numbers both overall and parsed down to the three study areas. Statistical significance can be ascertained by utilizing a chi square test comparing observed values with expected values. A determination that there are significant differences between site detection techniques will further validate the need to try and understand why those differences are present. Significant differences between the efficiency of various discovery techniques might be a source of bias both between and within a region. For instance, the nearly exclusive use of shovel testing in one region, compared to surface collection in another may be shown to have an effect on the numbers of Mississippian farmsteads which are estimated to be present.

Some potential problems with the above technique is that it only utilizes survey data from surveys which found at least one Mississippian farmstead. To get a better idea of the actual number of Mississippian farmsteads which were present in a region, then all surveys should be included and the equation modified to accommodate that. As it is, the model assumes complete accuracy in accessing areas were no farmsteads were present, and thus only measures efficiency for areas which have farmsteads. This can create some problems on its own with this assumption as there is a good chance that in certain areas, the farmsteads may have been missed entirely. The purpose of this equation then is solely to compare the relative efficiency between various discovery techniques and not to estimate actual populations of sites in the different regions. Estimation of a null set or negative results for surveys when there are in fact positive available

targets is perhaps best explained and explored through an abstract Mathematical Model rather than the potential vagaries associated with the real world data.

4.2 Mathematical Model

By developing a mathematical model of the different techniques, significant differences might be explained. The Mathematical Model will be developed utilizing the data contained within the database along two separate lines. The first is through a coarse modeling of different sites based on densities reported during the initial discovery or phase I. The second line is through modeling based on data from those sites which have undergone more intensive testing, typically designated phase II and III. The idea is to try and arrive at an estimation of the probability of each technique encountering and successfully recognizing that a site is present.

For the purposes of the Mathematical Model, only two techniques: shovel testing and surface collection will be examined. The different conditions of these types of discovery techniques: opportunistic, systematic, and stratified probabilistic will not be modeled. The relative effect that these variations have on the efficiency of discovery techniques should be addressed in the previous section. Instead this model will determine the basic probability of a site being discovered by a particular detection technique. There are some testing parameters which will be utilized to help directly compare techniques, such as transect spacing and shovel test pit size. These will be initially set to the industry standard for the three regions of interest: 30 meter transects and .3 by .3 m shovel test pits. As part of the analysis, the parameters can be easily modified to explore the effect that enlarging or decreasing the spacing of the transects or shovel test pit size may have on discovery probability.

The Mathematical Modeling is all based on the recovery of diagnostic artifacts. Site areas can and usually do contain more non-diagnostic artifacts than diagnostic ones. However, our

ability to know if the site is possibly a Mississippian period farmstead is based off of the presence of at least one diagnostic artifact as non-diagnostic artifacts may or may not be associated with the Mississippian farmstead component. This means that the techniques detailed below are not modeling the site in its entirety, only the presence, distribution, and the probability of discovering a diagnostic artifact.

The development of Mathematical Models to try and describe the behavior of archaeological prospection techniques is not new. Starting with the idea of probabilistic sampling of areas and regions for sites, the employment of statistics was an integral part of planning understanding the results of survey work. Interest in mathematical models was especially keen during the debate over subsurface sampling strategies and their efficacy during probabilistic survey (see Chapter 2). A couple of methods were discussed for estimating the likelihood of finding sites. The first proposed using a Poisson distribution as the basis for predicting finding sites (Krakker et al. 1983, Stone 1981). Others disagreed, saying that sites were too clustered and that a negative binomial distribution was more appropriate (Nance 1981, 1983, Nance and Ball 1986). On either side of the debate, artifact densities used to plug into the formulae developed were arbitrary in nature or derived from small sample sets. The negative binomial distribution also requires a measure of clustering, which lacking empirical evidence, also had to be estimated.

The Mathematical Model developed in this thesis builds on the modeling tradition for survey interactions with the archaeological record. The parameters of sites used in earlier site detection models such as site size, artifact density, and clustering in general had to be estimated, because surveyed and excavated sites samples were small. Where real sites were available, the results were mixed with a wide range in site size and artifact density (for example Krakker et al. (1983) n=13), Nance and Ball (1986) n=18, Shott (1985) n=19). Access to a database of

Mississippian farmsteads provides a robust sample of sites that overcomes many of the shortcomings of the earlier models.

4.2.1 Site Detection

A model takes an observable phenomenon which can be quite nuanced and complex and seeks to break it down into its primary and essential components. The Mathematical Model developed for this thesis abstracts both archaeological sites and the detection techniques used to find them. Archaeological sites are essentially collections of artifacts that are spatially related to each other that result from human behavior. To model an archaeological site the essential aspects are the size of the site and the numbers of artifacts present that can be expressed as a density per unit of measure within the boundaries of the site. Systematic site discovery techniques are essentially parallel straight lines that are observing for artifacts either continuously or at set intervals. The Mathematical Model is attempting to calculate the chance of one or more of those lines intersecting a site and assessing the results once so encountered.

In the real world, archaeological sites are complex with no two exactly the same. The shape of sites can vary widely based as much off of the natural environment and processes as from human activity and agency. The resulting distribution of artifacts creates a unique signature for each site if it could be exactly measured and recovered in its entirety. Site detection techniques are not that precise and so the information available to be entered into the database is already an approximation of the reality that was in the ground. The basic information recorded in Phase I reports which comprise the majority of sources of data for the database do not lend themselves to determining artifact concentrations. Nor should it, since a phase I survey is testing for presence/absence of cultural remains and providing some idea of their possible integrity and relative abundance.

A site that was surface collected does not typically have each of the artifacts piece plotted, as there simply isn't the time nor the equipment with the precision available to make it worthwhile. Shovel testing, even with delineation occurring on a cruciform pattern, samples only a very small portion of the site. When abstracting the artifact density for a site, given the sources of the data, intra-site patterning is not possible. All that can be said is the number of artifacts recovered within a certain site area derived from using a certain technique of discovery. This information is enough to generate an estimate of the artifact density for the site and also fits the definition of a Poisson distribution.

A Poisson distribution allows for the probability of certain events occurring within a fixed interval where each event is independent of the other (Haight 1967). So it predicts how often events occur based off of the average that those events happen, such as the number of hits a website might receive in a day. For the Mathematical Model, the event we are concerned with is the success at detecting a diagnostic artifact which is based off the rate or in this case, the density of artifacts on a given site. Each success is independent of another, as artifact presence or absence is not dependent on each other. In this way, archaeological sites are abstracted from potentially very complex three dimensional phenomena down to a continuous artifact density across a fixed area. To use the Poisson distribution first it has to be determined if it is appropriate to use it given the data available.

The Poisson distribution is an appropriate model if the following assumptions are true.

K is the number of times an event occurs in an interval and K can take values 0, 1,
 ...

- 2. The occurrence of one event does not affect the probability that a second event will occur. That is, events occur independently.
- 3. The rate at which events occur is constant. The rate cannot be higher in some intervals and lower in other intervals.
- 4. Two events cannot occur at exactly the same instant.
- 5. The probability of an event in an interval is proportional to the length of the interval.

If these conditions are true, then K is a Poisson random variable, and the distribution of K is a Poisson distribution (adapted and simplified from Koopman 1950, Haight 1967).

Applied to the Mathematical Model, we find that:

- K in the Mathematical Model is successfully finding a diagnostic artifact on a site.
 We are interested in K where K > 0, so all successes.
- Finding an artifact does not determine whether we will find another artifact and so they are independent events.
- 3. The rate is the artifact density and due to the source of the data there is no clustering, therefore, the artifact density is constant across the whole site area.
- 4. Events are determined by the intersection of the site by a transect and the sampling each transect conducts. They cannot happen simultaneously in the same place and each event is sampled only once.
- 5. The interval is each point sampled by a transect within the site. The number of intervals is dependent on the size of the site or the proximity of the transects, such

that the probability is proportionally affected. A larger site size leads to potentially a greater number of intervals while a wider transect spacing could lead to fewer.

In conclusion, based on the way this thesis is modeling archaeological sites and measuring the success at finding artifacts, the Poisson distribution is appropriate.

The probability mass function formula for the Poisson distribution looks like this:

$$P(k \text{ events in interval}) = \frac{\lambda^k e^{-\lambda}}{k!}$$

Where:

 λ is the average number of events per interval e is the natural log 2.71828... k takes values 0, 1, 2, ... k! is the factorial of $k = k \times (k - 1) \times (k - 2) \times ... \times 2 \times 1$

Within the Mathematical Model the variables used are:

k is the number of successes at finding a diagnostic artifact. Since we are interested in knowing what the probability is for all successes greater than 0, the model first solves for k=0 and then subtracts that from 1.

 λ is the artifact density for the site and is calculated as either the surface artifact density or the shovel test artifact density as appropriate to the model being used.

When solved for k=0 the equation looks like this:

$$P(0)=\frac{\lambda^0 e^{-\lambda}}{0!}$$

Simplified down to this:

$$P(0)=\frac{1e^{-\lambda}}{1}$$

The P(0) is then subtracted from 1 to get the probability of all successes.

As mentioned earlier, there is some debate about using the Poisson distribution for estimating a positive intersection. Nance (1981, 1983) and Nance and Ball (1986) advocate using a negative binomial distribution instead of the Poisson distribution as it would more accurately represent the clustered nature of archaeological sites. The Mathematical Model will use a Poisson distribution for two primary reasons. The first, as noted previously, is that data on clustering is not available for sites which were primarily observed only at the phase I level. Secondly, as Shott (1989) discussed and supported by Krakker et al. (1983), the effect that clustering has on site detection is relatively small compared to the primary factor of artifact density. An opportunity to examine the clustered nature of Mississippian farmstead artifact distributions will be presented in a later section.

4.2.2 Site Metrics: Size and Density

The two primary metrics captured from the database of Mississippian farmsteads and used for mathematically modeling probabilities of intersection and discovery are site are and site artifact density. Site size is drawn directly from the reported size of the site with as little calculation as possible unless the reporting was poor. The actual shape of the site is not pertinent because all site shapes have been simplified to circles for ease of modeling intersection geometrically. While this does add an extra level of abstraction to the Mathematical Model, a circular shape is not too far removed from the real world. Banning (2002) has observed that sites

tend to be oval in shape with the long axis oriented towards the direction of plowing. Other computer simulations have predicted the shape to be circular and oriented towards down slopes (Boismeir 1997). As a result, the Mathematical Model represents a best case scenario, since the narrower a shape is compared to its width increases the chance the shape is missed by a transect (Banning 2002:99). It would be possible to model the sites more accurately with an equation that takes into account a site's actual shape, however only site area and not actual dimensions were recorded in the database.

Within the database of Mississippian farmsteads is enough information to generate artifact densities for a significant portion of the sites. Artifact densities can be computed regardless of the original discovery method by making use of a few simple formulae. Better data recording and more formal strategies for delineating sites provide sufficient data now, that was lacking in some earlier studies (for example Shott 1985) to calculate site artifact densities. Additionally, a better understanding of the relationship between the surface and the underlying plowzone allows us to estimate the number of artifacts present (Odell and Cowan 1987).

The methods for calculating site artifact density by discovery method are presented on Table 4.1. The constant 0.056 is the average number of artifacts found on the surface at any given time based off of studies by Ammerman (1985) and Odell and Cowan (1987). Note that α_e is the total number of shovel tests excavated within the site area whether positive or negative.

Discovery Method	λ: Surface	λ: Subsurface
	Diagnostics per meter ²	Diagnostics per meter ²
Shovel testing	$\frac{\mathrm{d}}{a_e}(0.056)$	$\frac{\mathrm{d}}{a_e}$
Surface Collecting	$\frac{\mathrm{d}}{\mathrm{a}}$	$\frac{\mathrm{d}}{a(0.056)}$

Table 4.1 Determining site artifact density

Where: d = number of diagnostics recovered

 $a = site area (m^2)$

 a_e = total area of shovel tests excavated within the site area

Once the surface or sub surface artifact density has been determined, the numbers are plugged into a formula that calculates first the intersection of a site by a transect and then multiplies that by the probability of events for a Poisson distribution. The result if less than 1 is the percentage chance that the site is encountered and that at least one diagnostic artifact was recovered. If the result is greater than 1 (100% chance) then the number is the average number of diagnostic artifacts that should be recovered from the intersection and discovery of the site. Due to the differences in the way shovel testing and surface collection detect artifacts, a separate model has to be developed for each.

4.2.3 Surface Collection Model

To calculate the probability of site discovery by surface collection the procedure is as follows. For sites initially discovered by surface collection the number of diagnostic artifacts found on the surface was divided by the surface area of the site to derive an average density per square meter. A transect is not a line with no width however, the surface collector is in effect a sensor with a swath width of detection. The Law of Definite Detection applies (Koopman 1980) such that all available artifacts will be detected within this arbitrary swath. No studies have been conducted that this researcher has knowledge of to dictate ideal swath width, so it is set arbitrarily at 2 meters, or 1 meter to either side of the surface collector (but see Banning et al. 2006). The transects are parallel rectangles with which we are trying to intersect the area of a site. The model calculates the maximum area of intersection for the site, with a transect intersecting the site through the middle of the circle. The chance of detecting the site is a function of the amount of area sampled and the density of artifacts found on the surface as predicted by a Poisson distribution. Figure 4.1 graphically illustrates the formula below:



Figure 4.1Area of Intersection by Surface Collection

If
$$D \leq 2t$$
, then $A = s^*D$

If D ≤ 4t, then A = s*D +
$$(4\sqrt{(D/2)^2 - t^2})$$
s

If D > 4t but
$$\leq$$
 6t then A = s*D + $(4\sqrt{(D/2)^2 - t^2})s + (4\sqrt{(D/2)^2 - 2t^2})s$

Where D= site diameter, t = transect interval, s = detector swath width, A = area intersected

Next that number is plugged into a modified Poisson distribution to determine the overall likelihood of site discovery or a non-zero finding within the site area:

Where λ = surface artifact density and A = area intersected

An assumption with the surface collection density is that after initial discovery, the surface of the site was completely walked over and 100% of the diagnostic artifacts on the surface were recovered. This is a big and perhaps in some cases erroneous assumption. However specifics such as this detail were not always recorded and more importantly the percent of surface visibility which is a subjective measure was usually not recorded either. In actuality, surface density was likely higher than was reported which consequently should make the site more visible. The actual effect on the efficiency of surface collection can be measured by taking percentages of artifact density to reflect different levels of visibility prior to being calculated with the Poisson distribution:

P(≠0)= 1- e^{-λAv}

where **v**= visibility (0.9, 0.8, 0.7...)

4.2.4 Shovel Testing Model

To calculate the probability of site discovery by shovel testing, the procedure is as follows:

Shovel testing involves the use of transects like surface collecting, however in addition to the spacing between transects, the other important factor is the interval between shovel tests. Once the sub-surface site density has been determined using procedures similar to those mentioned for surface collecting, the chance of a transect(s) intersecting the site multiplied by the chance for the result of an stp to not be zero (meaning at least one positive shovel test with at least one diagnostic artifact) from a Poisson distribution. The procedure is detailed in the following:



Figure 4.2 Mathematical Model of the average number of intersections of a site by shovel testing Average number of intersections (after Banning 2002:97):

$$M(i) = \frac{\Pi r^2}{t^2}$$

Where r is the site's radius and t is the interval of the transect and stp spacing.

This model assumes circular site shape and constrains the model to only considering regularly spaced shovel tests with transect spacing and intervals having to be equal. Figure 4.2 illustrates the model.

To determine the probability of detection, the Poisson distribution of the subsurface artifact density is calculated and then multiplied by the average number of intersections. Total chance of detection with a non-zero or positive shovel test is:

$$P(\neq \theta) = (1 - e^{-\lambda}) * \mathbf{M}(\mathbf{i})$$

Where λ = sub-surface artifact density and M(i) = average number of intersections by stps.

The results will show that all sites in the database regardless of discovery procedure can then be compared to see which method discovers more sites under ideal circumstances. Additionally, the results will be further broken down to examine trends within the different regions of interest. Field testing has shown that there can be quite a bit of variation in the amounts of artifacts which may be present on the surface at any given time (Verhoeven 1991). The mathematical variance is not available from the information used here as that would require each site to be visited multiple times, however the mathematical values can be compared to the real world values for each site to determine relative scarcity. How close to being accurate this model is can be further checked by modeling individual sites for which greater amounts of data are available from more intensive explorations.

4.3 Site Modeling

Data from sites which have undergone more intensive investigations such as cultural resource management instigated phase II and phase III as well as academic based field schools can be used to create more detailed maps of sites that can then be subjected to the above mentioned Mathematical Models of site detection. In order for a site to be modeled, it must have detailed information on the locations of shovel test pits, test units, controlled surface collections, or other methods of total recovery of diagnostic artifacts. Again, non-diagnostic artifacts are not a part of modeling the site. The data is converted into an interpolated surface using ArcMap from which average density is determined for both total artifacts and artifacts on the surface. The

Mathematical Models for shovel testing and surface collection are then applied and the probabilities of detection determined. The procedure is as follows:

X-Y coordinates are generated for each provenience on a site and the diagnostic artifacts are normalized for the area of the investigating unit. Test units and controlled surface collection units are referenced to their southwest corner and two sets of densities are necessary for total artifact density and for surface density. The coordinate data and diagnostic artifact density is loaded into ArcMap where the interpolated surface is produced using the Kriging algorithm. The spherical model is the default model setting and the number of lags will be adjusted to try and achieve best fit. The output of the interpolated surface to a raster will have a cell size of .3m for shovel test pit model and 1.0m for surface collection. The cell size represents the typical size of shovel tests in the study regions. The site boundaries will be determined by the best fit made of a circular to oval boundary overlying the .1 artifact density contour line. The interpolated surface raster will be clipped to the site boundary. Site dimensions, average density, and standard deviation will be recorded for each site modeled.

With the data thus generated, the same procedures for determining discovery probabilities for shovel testing and surface collection using the methods outlined above for initial survey can be applied to this more detailed dataset. Comparisons can then be made between the different probabilities generated from initial survey data and from more intensive investigation. Differences may help to highlight how much variation is present between the two samples with the assumption that in most cases the greater amounts of data from the more intensive explorations should be more accurate. This might help to produce a range of variation that can be used to estimate density ranges for sites where there is only the initial discovery data.

There are some caveats, notes, and conditions involved with the model's setup. For instance, shovel test pits are modeled as squares, .3 meters on a side though in the field they are often dug as circular pits with a .3-meter diameter. Also, in some cases dummy zero density points will need to be added to the map to give the site some shape and to fill in gaps left by incomplete data collection. The sites will become mathematical constructs and are no longer bounded by natural physical barriers or manmade limits of time for excavation or right of way boundaries. An additional benefit to generating densities this way is that it allows the calculation of the standard deviation which can then be used to examine the relative amount of clustering on the site.

4.4 Testing Significance

The previous sections help to generate a more accurate picture of what we know about how Mississippian farmsteads were discovered and also more about how they are structured and how those internal structures affect discovery probabilities. To address the issue of significance, the goal is to try and understand how much of the archaeological record is being sampled by these techniques. First, statistically speaking, are the results we can derive from the database a representative sample and can the undiscovered portion be estimated. Secondly, are these techniques providing the data necessary to make informed decisions about more subjective aspects of significance?

Between the different regions, histograms can be generated of the artifact density utilized for some of the previously mentioned measures of site visibility. The bin sizes can be standardized to be able to compare the ranges and typical kinds of densities present. Statistical comparisons can then be made between the different regions of interest to determine how similar they are to each other. This can be accomplished by applying the Central Limit Theorem with the

total database sample acting as the original population and each region of interest treated as a different draw from that population. The means and variance for each region can be generated and the expected compared to the observed with probabilities being derived for the likelihood they are derived from the same population.

By utilizing the database sample as the original population it does not include that portion of the archaeological record which was missed by the inefficiency of the different discovery techniques. Preliminarily, it might be assumed that site discovery techniques are skewed to favor larger denser sites and that smaller lower density sites will be underrepresented. While this may be true, the true relationship in terms of the ratio between high density sites and lower density sites is unknown and further complicated by the added element of size. With the added understanding of what the relative chances of site discovery generated previously, the unknown site populations can be estimated for different size and density ranges.

Significance can be addressed by examining the relationship between initial density and eligibility for nomination to the National Register of Historic Places. Again this might be examined as what are the probabilities that this sample was drawn at random from database population. This approach assumes that significant sites as a sample of the original population will be normally distributed around the mean of the population. This though can only be assumed if there is a relationship between site densities and the likely eligibility of a site for the National Register of Historic Places. A profile or characteristics of this population can then be generated for what significant sites likely look like at the initial survey level.

Taking the data from the expanded population by including the previously undiscovered portion and the profile of what typically constitutes significant sites, an estimate can then be proposed for the missing likely significant sites. Based on the number generated for this

category, the relative success of these site discovery techniques can be evaluated. Additionally, if the purpose of sampling is to produce a random sample which is statistically valid from which to create a pool which will be further investigate so that the total range of sites is evaluate and not just those that fit into the expected range for significant sites. Both aspects of significance can be addressed with the data which being generated.

5 RESULTS

All models are wrong, but some are useful.

-George E. P. Box

The data returned good results from the methodologies applied to it. Some methods were more successful than others though even the failures proved instructive. The complexity of the subject matter and the research questions did prove to be difficult in confidently addressing all possible issues. Nevertheless, meaningful results were obtained in both the real world and the Mathematical Modeling of different site discovery techniques.

Given the complicated nature of the information possibilities, an overview of the chapter is necessary. There are two basic questions that each have a series of related sub-questions. First is 'what questions are we asking the database?'

- 1. Is there a difference between methodologies observable in the Real World data?
- 2. Does the Mathematical Model predict that there will be differences?
- 3. Are there differences between the studied regions?
- 4. Can we compare the Real World data results to those from the Mathematical Model?

The results of asking those questions of the database are then subjected to statistical tests to determine if the differences are significant and therefore more likely to be real and important differences.

The second major constituent to this analysis is a discussion section where now that the data is understandable, what can it tell us, and what can we apply that knowledge towards?

- 1. Does discovery methodology affect archaeological constructions of significance and management?
- 2. If there are differences between methodologies, what can be done to bring them into parity?
- 3. What is the optimal discovery method and parameters for each Region?
- 4. Do the inherent limitations of the Mathematical Model greatly affect the outcomes it can predict?

There is a real danger of overwhelming complexity in trying to answer all of these questions in one chapter. However, the goal of this thesis is to investigate sources of bias, and then once identified, how to correct for it. A goal which will necessarily involve a fair amount of belabored checking and cross checking. The concluding chapter will summarize the results and provide succinct answers to the above posited questions.

5.1 Real World Modeling Results

Survey and farmstead information contained in the database was analyzed to produce a comparison of the different survey and site discovery strategies. The relative efficiencies of different survey methodologies and techniques could be extracted and compared both overall and on a regional basis. To make comparisons some assumptions about the data is necessary. First, it

is assumed that outliers are minimized or averaged out by having a large enough sample of surveys. Second, it does not account for farmsteads that were present, but not discovered. Some surveys were not included because they did not definitively find any Mississippian farmsteads. These results were tabulated and a two proportion Z test was applied to the resulting ratios. Tables 5.1 and 5.2 show the results both for the total sample of all farmsteads located and broken down by region. As can be seen there are some significant differences between regions and within the overall results.

The Real World Modeling indicates that for the total sample, surface collecting is 3.7:1 more efficient than shovel test pits at finding farmsteads when both methods are conducted in a systematic manner. Interestingly when the stratified probabilistic methodology is employed, the efficiencies are nearly the same with shovel testing being slightly better at 72 hectares per farmstead versus 75.3 for surface collection. Opportunistic surface collection is abysmally inefficient and rightfully is not currently an acceptable manner of conducting surveys either in CRM or academia. Further analysis of the Real World Model data will not consider the opportunistic approach and will instead compare results of stratified probabilistic surveying and systematic surveying approaches. Also, due to a lack of data on shovel testing in the Black Warrior River Valley, the Real World Model data for the region will not be subjected to statistical significance between approaches. More data almost certainly is available on the subject, and future projects may incorporate that data as an ongoing study.

			All Surveyed Areas	
Survey Methodology	Detection Technique	Farmsteads Located	Surveyed Area (Ha)	Survey Efficiency (Ha per
				Farmstead)
Opportunistic	Surface Collection	61	35704.91	585.33
Stratified Probabilistic	Surface Collection	57	4292.69	75.31
Systematic	Surface Collection	191	7346.62	38.46
Opportunistic	Shovel Test Pits	6	176.58	29.43
Stratified Probabilistic	Shovel Test Pits	14	1008.75	72.05
Systematic	Shovel Test Pits	25	3589.58	143.58
	Totals	354	52119.125	

Table 5.1 Comparison of surveys contributing to the database

Table 5.2 Comparison of regional survey results

		Blac	k Prairie Reg	ion	Pie	edmont Regi	on	Black War	rior River Val	lley Region
Survey	Detection	Farmsteads	Surveyed	Survey	Farmsteads	Surveyed	Survey	Farmsteads	Surveyed	Survey
Methodology	Technique	Located	Area (Ha)	Efficiency	Located	Area (Ha)	Efficiency	Located	Area (Ha)	Efficiency
				Ha per			(Ha per			(Ha per
				Farmstead			Farmstead)			Farmstead)
Opportunistic	Surface	9	264.87	29.43	38	32749.00	861.82	1	74.74	74.74
	Collection									
Stratified	Surface	10	1407.98	140.8	41	2165.00	52.80	N/A	N/A	N/A
Probabilistic	Collection									
Systematic	Surface	79	4631.53	58.63	33	761.00	23.06	44	392	8.91
	Collection									
Opportunistic	Shovel	5	147.15	29.43	N/A	N/A	N/A	N/A	N/A	N/A
	Test Pits									
Stratified	Shovel	5	471.69	94.34	8	432.00	54.00	N/A	N/A	N/A
Probabilistic	Test Pits									
Systematic	Shovel	4	3065.13	766.28	21	524.45	24.97	N/A	N/A	N/A
	Test Pits									
	Totals	112	9988.35		141	36631.45		45	466.74	

To try and understand whether the differences between methodologies at the total sample and regional level are significant, a statistical test was prepared. Initially, a Chi-square test for independence was constructed to look at the values involved such as efficiency and methodology. However, while a Chi-square test can handle nominal, ordinal and other data types, it does not handle proportional data. The only way that the different methodologies can be compared since they sampled different areas of different sizes, is by a comparison of the efficiency ratio. This number is a normalized proportion of either hectares surveyed per farmstead located or the number of farmsteads located per hectare. A proportional Z test is more appropriate in this situation and will return more robust data since a confidence interval can be ascribed to the test.

The two proportion Z test works by comparing the proportion of one sample to the proportion of another sample drawn from the same population. In this case the archaeological record is the population from which samples were drawn in one case via shovel testing and in the other by surface collection. The test assumes that there is a normal distribution present which in this case means efficiency of finding sites in the archaeological record. The efficiency would be influenced by a range of different factors, but in this instance the most compelling condition for a normal distribution is the assumption that the relative detectability of farmsteads ranges from almost impossible to guaranteed and the distribution of that measure would be normal. However, as we shall see with the analysis of the Mathematical Model there are problems with even this assumption. Concern for this is tempered by the Central Limits Theorem which states that a normal distribution will result from the means of independent random variables which are sufficiently numerous and which each have normally distributed means and variance (Rice 2006). If there is one thing the archaeological record has, it is a large number of independent

variables affecting the visibility of cultural remains. Consequently, the assumption of a normal distribution in computing Z scores is a standard procedure and it has been shown that the robustness of the test makes it applicable to non-normal distributions as well (Lin and Mudholkar 1980).

Specific conditions for a proportional Z test are that sampling is conducted by simple random sampling, the results of the sampling can either be a success or a failure for each point, there are at least 10 successes and 10 failures (although 5 of each may be sufficient), and the population size is at least 10 times the size of the sample (Rice 2006). With one exception, the Real World Model data matches or exceeds these minimums though some explanation is necessary. The finding of a farmstead is treated as a success so that there are more than five successes in each category with the exception of systematic shovel tests in the Black Prairie Region which had only 4 successes. While this may throw the accuracy of the test results off, it does not seem to have grossly affected the outcome such that it does not make sense. On the contrary the results are in line with those generated from the total sample. The test is set up as follows:

- Samples: Proportion 1 (p1) are shovel test pit efficiency and Proportion 2 (p2) are surface collection efficiency
- The Null Hypothesis (H0) is that the two proportions are equal while the alternate hypothesis (HA) is that the two proportions are not equal.
- The level of significance assigned is .05 (α) representing a 95% confidence interval.
- The test is two tailed and if the Z score represented by 2P is less than .05, then the H0 Null Hypothesis is rejected and the two proportions are not statistically similar and that a significant difference exists between them.
- If the Null Hypothesis is not rejected, then the two proportions are not significantly different. A significant difference between the proportions means that the method employed does affect the results.

The results of the statistical test support the basic observations made of the Real World Model data (Table 5.3). From the total sample, stratified probabilistic methods were not significantly different while there was a significant difference between the systematic methodologies. Those results were repeated in the tests of the Black Prairie region but not those of the Piedmont. For the Piedmont, the two proportion Z test could not reject the null hypothesis (2p of .952 and .772) and showed no significant differences between methodologies for either stratified probabilistic or systematic approaches. Why there is a difference between methods and between regions will be addressed after the Mathematical Model has been examined.

Sample Region	Method	Surface Colle	ection		Shovel Test F	Pits		Z Score com	putation		
		Farmsteads	Hectares	Farmsteads/hectare	Farmsteads	Hectares	Farmsteads/hectare	р	Standard	Z score	2P
		located	Surveyed		located	Surveyed			Error		
Total	Stratified	57	4292.69	0.013	14	1008.75	0.014	0.013	0.004	0.149	0.881
Sample	Probabilistic										
	Systematic	191	7346.62	0.026	25	3589.58	0.007	0.020	0.003	-6.717	near 0
Piedmont	Stratified Probabilistic	41	2165	0.019	8	432	0.019	0.019	0.007	-0.058	0.952
	Systematic	33	761	0.043	21	524.45	0.040	0.042	0.011	-0.292	0.772
Black Prairie	Stratified Probabilistic	10	1407.98	0.007	5	471.69	0.011	0.008	0.005	0.739	0.459
	Systematic	79	4631.53	0.017	4	3065.13	0.001	0.011	0.002	-6.550	near 0

Table 5.3 Two proportion Z Test comparing shovel testing to surface collection methodologies using Real World data

5.2 Mathematical Model Results

The results of the Mathematical Model have produced a table of data from the 247 sites that could be modeled using the techniques described in the Methodology chapter. Each site has five data points derived from survey information that will be carefully scrutinized here: site area, surface artifact density, subsurface artifact density, surface collection probability, and shovel testing probability. Given the similar nature of artifact density either above or below surface, only one, surface artifact density is utilized in the more in depth analyses that follow. It should be clarified that the Mathematical Model corresponds to the systematic methodology used in site detection and that all data discussed below was generated by using thirty meter transects for both stp and surface collection methodologies. The stratified probabilistic approach could not be easily modeled by the author; however, the Real World Model data provides some insights into what they might look like which will be discussed in the analysis portion of this chapter which follows.

A first look at the data comes from generating descriptive statistics of the results from the Mathematical Modeling of the site data. Table 5.4 shows the mean, standard deviation, min and max for each of the four recorded or modeled variables. Right away the means for stp probability when compared to the probability of detection using surface collection shows a roughly 6:1 ratio favoring surface collection as the more efficient technique. While this is an interesting figure, it would be instructive to know why there are such marked differences and what sorts of significant relationships exist within the data. Also of interest and relevance to this thesis are the dynamics which are present at the regional level and which will be discussed in a following section.

Descriptive Stats	Mean	Std Dev	Min	Max
N = 247				
stp Probability	0.0865	0.2022	0.0013	1.0000
Surface Collection				
Probability	0.5111	0.3457	0.0425	1.0000
Artifacts per m ²	0.9822	3.2894	0.0034	35.7576
Site Size	2545.63	2029.22	50	8450

Table 5.4 Descriptive statistics for the entire available dataset

We can look a bit more deeply into the detection probabilities of stps and surface collection by running a couple of statistical tests. The goal of running these tests is to explore the accuracy and the precision of the two detection techniques. Accuracy in this case is the mean of each detection probability, while the precision or repeatability of accuracy is related to the standard deviation. The first of these is the F test which measures the similarity of the variance between two samples. Ostensibly, both samples are drawn from the same population, so a significant difference in the samples' variances would indicate that there are significant differences in the sampling methodologies. The null hypothesis H0 is $\sigma 22 = \sigma 12$ and the HA that $\sigma 22 \neq \sigma 12$. The confidence interval is $\alpha = 0.05$ (.025 for the two tailed test) and I am asking both a two tailed question and a one tailed question. The first is 'are the variances significantly different between detection methods?' The second question and a single tailed test is 'is the precision of surface collection better than stps?' The latter would seem to be contra-indicated by the smaller standard deviation of stp detection so determining if there is a significant difference would be useful. Table 5.5 shows the result of an F test for the variance between the detection abilities of surface collection and stps.

	Two Taile	d Test	Single Tailed Test		
	Probability of	Probability of	Probability of	Probability of	
	Surface Collection	STP Detection	Surface Collection	STP Detection	
	Detection		Detection		
Mean	0.511137	0.086537	0.086537	0.511137	
Variance	0.11948	0.040894	0.040894	0.11948	
Observations	247	247	247	247	
Df	246	246	246	246	
F	2.921714		0.342265		
P(F<=f) one-	1.1E-16		1.11E-16		
tail					
F Critical one-	1.284675		0.810463		
tail					
P(F<=f) two-	2.2E-16				
tail					

Table 5.5 F-test two sample for variance of detection probabilities of surface collection and stps

The results show that the H0 is rejected in first case as the Fcritical value is less than the Fcalculated value nor is at all likely and regardless irrelevant that the Fcalculated will be larger since the p value is not exceeded for two-tail test $(2.2 \times 10^{-16}) < \alpha (0.025)$. The single tailed test however has a different result in that the null hypothesis is not rejected as the Fcritical (0.81) is larger than the Fcalculated (0.34) and the p number is chance that a value could have occurred greater than the Fcalculated value which in this case is very small at 1.11×10^{-16} . We can then be strongly confident that surface collection does not offer better precision for discovering Mississippian farmsteads but it does offer greater accuracy. The variances between the two sampling strategies shows a significant difference which is the result of the sampling strategy themselves, thus surface collection and shovel testing have the same precision, but surface collection has significantly greater accuracy.

To further test of the differences between surface collection and stps in the Mathematical Model a t-Test of two sample means was conducted to determine if the averages generated by the two methods are likely to have originated from the same population. Since we know that the two samples originate from the same population of the archaeological record and are in fact the same samples just tested by different methodologies, the t-test will demonstrate whether the two methodologies have produced a detection probability which is statistically similar or different. The preceding use of the F-test established that there are unequal variances between the two methodologies. The appropriate t-Test is one that takes into account unequal variances caused by the sampling strategies. The H0 is $\mu=\mu0$ while the alternate hypothesis HA $\mu\neq\mu0$. The threshold value for rejecting the H0 is $\alpha=0.1$ for a two-tail test. Table 5.6 shows the results of the t-test.

1						
t-Test: Two-Sample Assuming Unequal Variances						
	Prob of Surface Det	Prob of STP Det				
Mean	0.511137	0.086537				
Variance	0.11948	0.040894				
Observations	247	247				
Hypothesized Mean Difference	0					
Df	397					
t Stat	16.66335					
P(T<=t) one-tail	6E-48					
t Critical one-tail	1.648701					
P(T<=t) two-tail	1.2E-47					
t Critical two-tail	1.965957					

Table 5.6 T-test for significance of differences between the probability of detection by surface collection and stps in the entire dataset

The t-test result shows that the H0 is rejected: the Tcritical is considerably less than the Tcalculated (1.97< 16.66) and the probability of two-tail (1.2 X10-47) < α (0.1) is well below the alpha threshold. This indicates that there is a very significant difference between the probabilities of detection generated by the two detection methodologies and they are extremely unlikely to have been generated by two strategies that produce equal probabilities. Based on the higher

probability for detection by surface collection, that method seems to be superior and produce results that are markedly different than shovel test pits.

For the other basic statistic on site area and artifact density the kinds of statistical tests used above would not shed additional data on the nature of the data set. Those parameters are important components to the Mathematical Model but are not interesting in and of themselves without some context. Instead, an integrated avenue of inquiry is to explore the data of each of the four recorded or modeled variables. Histograms of the probabilities for stp and surface collection site detection, site area (m2), and surface artifact density are shown in Figures 5.1 through 5.4. Visual examination of the histograms shows that the data is not really even close to being normally distributed. All display some amount of being skewed to the left or towards minimal values. For example, artifact density is extremely skewed left with roughly half (53%) of sites having more than the first bin's 0.005 artifacts per square meter. The lack of variables that have a normal distribution will have an effect on the kinds of statistics that can be utilized on the data and how the results should be interpreted.

Figures 5.1 and 5.2 show rather clearly the disparity between the two detection techniques. The largest frequencies for stp detection are skewed right with 73% of the sites (n=180) having a 10% or less frequency of detection. For surface collection the same number of sites have a 83% chance of discovery or less. The numbers for surface collection detection probabilities are more evenly spaced but with higher frequencies of greater detection and a spike at 100% detection. Consequently, sites having a 10% chance of detection or less make up only 12.6% (n=31) for surface collection.

Site area in general shows a falling away from the left skew trend, with larger frequencies on the smaller end of the spectrum of 50 to 8000 m2. A brief uptick occurs in the 4000 and 5000

m2 range however it is unclear if this represents a clear break in the histogram. If such clear breaks do exist, they might denote differences in Mississippian period farmsteads. Such differences could be regionally or culturally specific or could be functional in nature. It is beyond the scope of this work to speculate on the nature of that debate other than to comment that there is probably greater complexity in the record than we have been able to determine.



Figure 5.1 Histogram of stp probabilities


Figure 5.2Histogram of Surface Collection Probability



Figure 5.3Histogram of Surface Artifact Density



Figure 5.4 Histogram of site size

To what degree though are the different modeled and recorded data dependent on each other? Understanding that dynamic would be helpful to know. For instance, if site detection probability was most dependent on site size then detection strategies would be adjusted to take advantage of this knowledge. Figures 5.5 through 5.9 show bivariate plots of the different components compared to each other and each also includes a correlation table. Correlation is scaled between -1 and 1 with 1 being perfectly correlated, -1 a negative correlation, and 0 meaning no correlation exists. The relationship between the stp detection probabilities and stp artifact density shows the highest correlation at 0.75 and also the steepest slope on the charts. Since the correlation does not equal 1, stp detection probability increases at a faster rate than increases in stp artifact density with the slope line intersecting the 100% probability at around the 1.7 artifacts per shovel test pit. An example of a near 0 or almost no correlation result is

represented by Figure 5.9 showing the random scattering of points and a nearly flat line with a correlation of 0.099 that exists between surface collection probability and site size.

Of interest to this author, is what relationship exists between the probability of detection and site size and artifact density. The probability of detection by stp is much more contingent upon artifact density than it is with site size as the correlation is only mild at 0.25 (Figure 5.6). However, it would seem that stp probability is much more sensitive and correlated to the two main measures included in the Mathematical Model when compared to surface collection probability. Site area as previously discussed shows almost no correlation to surface collection detection probabilities at 0.099 for surface collection. Artifact density has a mild to moderate correlation of .38 for surface collection and so like stp detection, the density of artifacts on a site has the most correlation of two variables. The density of artifacts on a site certainly affects stp detection more than surface collection which could account for some of the differences in overall detection probabilities given the previously discussed skewed lower artifact density nature of the data set.

However, it is likely that the most significant variable which affects artifact detection is the method employed. As evidence, there is some correlation between the surface collection probabilities and stp detection at 0.54 with surface detection probability increasing at a faster rate than stp detection. This results in the slope of the correlation line crossing the 100% chance of detection for surface collection while near 60% for stp detection. The numbers by themselves do not tell the whole story and as such the veracity of which method is better needs to be further explored by looking at the dynamics from the three different regions of interest.



Correlation	STP Prob	Surface Collection Prob
STP Probability	1	
Surface Collection Probability	0.541728	1

Figure 5.5 Correlation between stp and surface collection probabilities



	Site area	Probability
Correlation	(m2)	STP
Site area (m2)	1	
Probability STP	0.251088	1

Figure 5.6 Correlation between site area and stp probability



Correlation	Probability STP	STP Artifact Density
Probability STP	1	
STP Artifact Density	0.751362	1

Figure 5.7 Correlation of artifact density to stp probability



Correlation	Site area (m2)	Probability Surface Coll
Site area (m2)	1	
Probability		
Surface Coll	0.099336	1

Figure 5.8 Correlation of site size to surface collection probability



Correlation	Probability Surface Coll	Surface Artifact Density
Probability		
Surface Coll	1	
Surface Artifact		
Density	0.382071	1

Figure 5.9 Correlation of surface artifact density to surface collection probability

5.3 Regional Differences and Implications based on the Mathematical Model

Basic Descriptive statistics were generated for sites in the three regions: Black Prairie, Piedmont, and Black Warrior River Valley in a fashion similar to what was discussed above for the total sample (Table 5.7). Just based on the simple statistics produced by the Mathematical Model for each of the regions, there are some obvious differences. The probability of detection by stps in the Piedmont is much higher at 20.82% compared to 2.99% and 1.58% for the Black Prairie and Black Warrior River Valley. For surface collection the Black Warrior River Valley and Black Prairie are again closely matched 40% and 47% respectively while the Piedmont again has a much higher rate of success at 64.47%. Understanding why there are such differences is contingent on the influence of site size and artifact density on the probability results. From the earlier correlation determinations, site size plays little role in determining detection by either stps or SC, with correlations of .25 and .099 respectively, while artifact density is more correlated at 0.75 and 0.38 respectively. So in comparing the regions we can see that the effects of artifact density which is very high at 2.3044 in the Piedmont contributes more significantly to site detection probabilities when compared to the BWRV which has an artifact density of 0.2267 and the Black Prairie with 0.3896. The limited effects of site size on detection probabilities are apparent by comparing the Black Prairie which has roughly twice the average site size as the Black Warrior River Valley but has only minor increased chances of detection. The slightly higher artifact density of the Black Prairie sites contributes much more than does site size.

The relationship between the detection values is almost certainly more complex than represented here and is undoubtedly also contingent upon the size of the standard deviations that are present from one data set to the other. All of the BWRV standard deviations are smaller than the other two regions while the Piedmont has the largest. This indicates that the BWRV is a more homogenous sample that has less variability than the other regions. The Piedmont region since it has the largest variability including a huge standard deviation in artifact density may indicate that there is more complexity in the nature of these small scale sites and how they are utilized or the duration of occupation as compared to the other regions. Exactly what those differences are cannot be addressed in this study, however one clear conclusion that can be drawn is the there are significant differences between detection probabilities due to differential artifact density between the regions.

Regions		Mean	Std Dev	Min	Max
Black Prairie	STP Probability	0.0299	0.0422	0.0013	0.1993
N= 101	Surface Collection	0.4703	0.3457	0.0425	1.00
	Probability				
	Artifact Density	0.3896	1.0284	0.0034	8.96
	Site Size	2605.47	1903.04	50	8000
Black Warrior	STP Probability	0.0158	0.0180	0.0019	0.0884
River Valley					
N=45	Surface Collection	0.4011	0.2467	0.0455	0.9936
	Probability				
	Artifact Density	0.2267	0.3390	0.0079	1.8519
	Site Size	1583.40	1451.45	56	6500
Piedmont	STP Probability	0.2082	0.3143	0.0019	1.00
N=76	Surface Collection	0.6447	0.3467	0.0525	1.00
	Probability				
	Artifact Density	2.3044	5.5472	0.0051	35.7576
	Site Size	3177.17	2348.76	200	8450

Table 5.7 Regional descriptive statistics

An examination of the results called for t-tests to be conducted to examine if there are significant differences between probabilities of detection for the different regions. The tests were set up similarly to those previously mentioned for the entire dataset with the H0 is $\mu = \mu 0$ while the alternate hypothesis HA $\mu \neq \mu 0$. The threshold value for rejecting the H0 is $\alpha = 0.1$ for a two-tail test. Tables 5.8 and 5.9 show the results of the two sample t-Test of means assuming unequal variances as established by the earlier F-tests for the probability of detection by stps and Surface Collection respectively. The null hypothesis was rejected in all pairings of the regions for stp detection indicating that for shovel testing there are significant differences for detection probabilities between regions. For surface collection, the null hypothesis could not be rejected between the Black Prairie and the Black Warrior River Valley. The other regional pairings were rejected indicating that there are significant differences in surface collection detection

probabilities between the Black Prairie and the Piedmont and between the Black Warrior River

Valley and the Piedmont.

	Black Prairie	Black	Black Prairie	Piedmont	Black Warrior	Piedmont
		Warrior				
Mean	0.029139	0.016029	0.029139	0.204129	0.016029	0.204129
Variance	0.001745	0.00033	0.001745	0.098826	0.00033	0.098826
Observations	100	44	100	75	44	75
Hypothesized						
Mean						
Difference	0		0		0	
Df	142		76		75	
t Stat	2.625067		-4.789059		-5.167145	
P(T<=t) one-						
tail	0.004806		4.05E-06		9.51E-07	
t Critical one-						
tail	1.655655		1.665151		1.665425	
P(T<=t) two-						
tail	0.009612		.0000081		.0000019	
t Critical two-						
tail	1.976811		1.991673		1.992102	

Table 5.8 t-Test: Two-sample assuming unequal variances for mean stp probability by region

Table 5.9 t-Test: Two-sample assuming unequal variances for mean surface collection probability by region

	Black Prairie	Black	Black Prairie	Piedmont	Piedmont	Black	
		Warrior				Warrior	
Mean	0.465174	0.405859	0.465174	0.639921	0.405859	0.639921	
Variance	0.118053	0.061224	0.118053	0.120117	0.061224	0.120117	
Observations	100	44	100	75	44	75	
Hypothesized							
Mean							
Difference	0		0		0		
Df	112		159		112		
t Stat	1.169575		-3.313021		-4.278347		
P(T<=t) one-							
tail	0.122328		0.000571		.0000199		
t Critical one-							
tail	1.658573		1.654494		1.658573		
P(T<=t) two-							
tail	0.244655		0.001143		.0000398		
t Critical two-	1.981372						
tail			1.974996		1.981372		

One interpretation of the results of this is that the Piedmont has significantly different detection probabilities regardless of the methodology. The Black Prairie and the Black Warrior River Valley are more similar to each other than they are to the Black Prairie. Stp probabilities were significantly different, so the two regions are not exactly the same. The key to the differences lies largely with the higher artifact density found at Piedmont sites. As established earlier, site size has little bearing on detection probabilities so even though Piedmont sites are twice as large as those in the Black Warrior River Valley; it is the magnitude of ten disparity in artifact density which drives the differences between the two regions. The implications are that even seemingly subtle differences in aspects of sites between regions can lead to significantly different results from surveys, even those that employ the same methodology. Knowing where they are similar and where they are different are essential for any effort that seeks to make comparisons and draw conclusions based on the results of work done across regions. By and large quantifying differences is not practiced when comparing regions and thus direct comparisons cannot be made and be reliable. To make direct comparisons, adjustments would have to be made to make results comparable.

5.4 Comparing the Real World Model to the Mathematical Model

The goal of conducting this analysis was to identify the ways in which bias is introduced into our knowledge of the archaeological record through the site discovery method and to seek ways to establish how to be able to make comparisons between different datasets. In the process of trying to accomplish both of these tasks real world data from surveys was compared and a Mathematical Model was constructed to approach the questions from a more abstract direction. There are certainly differences between the two modes of discovery examined: surface collection

and shovel test pits; however how to quantify the differences remains difficult. The sources of the data and the nature of archaeological fieldwork contains many variables making it difficult to control for numerous complicating and confounding factors.

In the first instance, there is a significant difference with regards to the probability of success at discovering small scale sites such as Mississippian farmsteads. The results of the Mathematical Model predict that surface collection has roughly six times the rate of success as stps at discovering sites that are drawn from the sample used to create the model. While this would seem to be strong reasoning to favor conducting surface collection over stps, how well does the Mathematical Model's prediction compare to the real world data?

With the prediction that surface collection is roughly six times as likely to identify a given site based on the Mathematical Model, we would expect this to be reflected in the efficiency presented in the Real World Data. A comparison of the overall database and a break down by region for the efficiency reported in the real world data and the Mathematical Model by discovery method is presented in Table 5.10. Direct comparisons between the two models can be made because the reported efficiencies in the table for the real world data are only selected from systematic surveys which are the kind modeled by the Mathematical Model. The ratio of the efficiency from one model compared to the other controls for the differences in units of measure.

	Entire DB		Black Prairie		Piedmont		Black Warrior	
Discovery	Survey	Math	Survey	Math	Survey	Math	Survey	Math
Technique	Efficiency	Prediction	Efficiency	Prediction	Efficiency	Prediction	Efficiency	Prediction
Surface	38.46	0.5111	58.63	0.4703	23.06	0.6447	8.91	0.4011
STP	143.58	.0865	766.28	0.0299	24.97	0.2082	N/A	0.0158
Ratio	3.73:1	5.9:1	13.07:1	15.73:1	1.08:1	3.1:1	N/A	25.39:1
Surface:STP								

Table 5.10 Comparison of the observed versus the predicted for systematic methodology

The table shows some interesting results which have to be interpreted within the context of the categories which they originate. First, in general the real world data confirms the greater efficacy of surface collection over that of stps. The efficiency of surface collection is almost 4:1 more efficient than stps for the real world data using the entire database and 13:1 for the Black Prairie region. The Piedmont region surveys show however that stps and surface collection are roughly equivalent and not at all close to the 3.1:1 ratio predicted by the Mathematical Model. The lack of stp survey data from the Black Warrior River Valley again prevent an estimation in this category, however given some of the similarities concerning artifact density and probability detections discussed earlier, we might expect that results for the BWRV would be in line with those of the Black Prairie where real world ratios were relatively close to the predicted efficiencies.

Secondly, the Mathematical Model consistently overestimates the relative efficiency of surface collection detection versus stps compared to the real world data. Interestingly, the overestimation is also consistently 2 over the real world data ratio. The variation of the real world data away from the predicted values by the Mathematical Model can at least be partially explained by the conditions which created the real world data. Surface collection is primarily affected by visibility. The ability to see the ground surface and exposed artifacts can be greatly affected by all kinds of field conditions ranging from leaf litter, to weather conditions, dried out soil, and the type of surface exposure such as plowed field or erosion features. The database assumes 100% visibility and 100% detection of all artifacts within the transects, a kind of perfection which is unrealistic in the real world. Consequently, surface collection efficiency in the real world should always underperform the Mathematical Model's prediction. While surface

visibility is often recorded on site forms, this figure is more of a qualitative number and not a quantitative measure, making it difficult to compensate for in the database.

Limited surface visibility can be estimated within the Mathematical Model by decreasing proportionally the area examined within the transects. So for example 50% ground visibility reduces the area input into the model also by 50%. When the entire data set is run at 50% visibility, the overall average detection of sites by surface collection decreases from 0.5111 to 0.3887, a 24% decrease in overall efficiency. Interestingly when this 50% coverage figure is compared to the overall stp average, the ratio of 3.9577:1 comes out much closer to the real world data's 3.73:1 ratio of efficiency.

In addition to being a difficult variable to quantify, visibility at the state regulatory level also differs from state to state. Most state archaeological guidelines make a distinction between good and poor visibility. Good visibility of surfaces usually means that fewer or no shovel tests are needed to supplement the surface examination. However what percentage of visibility constitutes good and what is poor varies between states. Some states such as Mississippi do not quantify what is good visibility leaving it to the archaeologist's discretion. Other states such as Georgia and Missouri use 25% as the difference between good and bad, while South Carolina designates 50% or greater as what constitutes good visibility.

A second issue with the assumptions of the Mathematical Model is that in real world conditions there is not 100% recovery or recognition of artifacts on the surface. Banning in 2009 conducted a number of surface collection experiments and found that within 4 meters of the transect, participants identified 63% of the surface artifacts in plowed fields. The percentage of artifacts identified can be modeled in the database by proportionally decreasing the surface artifact density. The Mathematical Model can recalculate the overall efficiency using Banning's

results by changing the transect width size and the artifact density and arrive at an overall average of 76.8% for surface collection. That greatly increases the predicted efficiency of surface collection from the 51.11% figure used in most of the calculations in this thesis. The default two meter transect used in the Mathematical Model may be too conservative for real world conditions but the results more closely matched those of the Real World Data. Undoubtedly a combination of less than perfect recovery and obscured surfaces reduce the efficiency of surface collecting. The inherent qualitative nature of the visibility variable can introduce bias into survey results from a number of vectors but in general with proper recording, the biases can be compensated for in the Mathematical Model to approximate the real world results.

Differences in field methodologies, technique, and regulatory stipulations can affect results from shovel testing as well. For stps the size and regularity of the test pit will affect the chances of discovery. Consider that in the Mathematical Model, the stp is standardized to be a perfect 30 cm by 30 cm square, which projected as a cube and taking the average plowzone depth for all sites within the database of 18 cm the resulting cube has a volume of 0.0162 m3. If the stp were round, with a 30 cm diameter and again the 18 cm depth the result is a volume of 0.0127 m3 or 78.5% of the square shovel test. Additionally, if the stp is not a perfect cylinder but is instead conical in cross section which is an effect of using a pointed shovel, the resulting volume is a third that of the cylinder at 0.00423 m3 or 26.1% of the volume of the idealized square shovel test. Admittedly the latter case is unlikely given the standards by which archaeologists are supposed to adhere to and based on the author's experience that the tendency of the stp shape is cylindrical near the surface with the bottom 5 cm tapering in to a point given standard shovel dimensions, but it perhaps can serve as a worst case scenario. How much though

do these differences with the idealized stp tested volume affect the overall probability of detection?

Detection probabilities for cylindrical test pits and conical test pits can be computed by the Mathematical Model by adjusting the size of the stp sample size by the percentage differences in the volume sampled from 0.09 m2 for square stps to 0.07065 m2 and 0.02349 m2 respectively. The results are that detection probabilities are reduced drastically. The overall detection probability for stps is 8.65% for the idealized 30 cm square test pit. If the test pits are 30 cm cylinders the overall probability of detection drops to 7.55% and if the test pits are conical the probability of detection drops further to 3.85%. A one percentage point difference in overall detection probabilities are for stps the modification to employ square test pits would seem to be prudent. Changes in both stp size and stp spacing along transects can be used to greatly increase the detection value of this discovery technique and will be discussed in detail in a later section.

One of the interesting results from the comparison of the Real World data and the Mathematical Model is how poorly shovel detection efficiency is predicted (with the exception of the Piedmont) and in the case of the Black Prairie verified. Although the Black Warrior River Valley sample did not include systematic stp samples, the Mathematical Model predicts that these would also have an extremely low efficiency compared to surface collecting. One explanation for the situation of the Black Warrior River Valley and the Black Prairie is that since the majority of the Mississippian farmsteads were found using the surface collection methodology, the resulting range of sites reflect the range of what is likely to be found when this method is used exclusively. Since surface collection has greater chance of discovery of small and less dense sites, we see that reflected in the metrics for the BWRV such that artifact density and site size are much lower than the other two regions.

Figure 5.10 shows the distribution of surface artifact density by discovery method for sites in the database. While the scale of the data is modified, the range of densities found by surface collection more closely approximates a normal distribution while sites found by stps are skewed to the higher densities and do not appear to be a normal distribution. The differences in the averages are also telling with stps 6.705 compared to surface collections 0.338. There is a clear tendency for stps to find on average larger and denser artifact bearing sites than surface collection, which means many sites are likely being missed by using that method. Since both the Black Prairie and the BWRV regional data is composed of sites found mostly or exclusively by surface collection, this might explain the lower artifact densities and smaller site size for these regions when compared to the Piedmont which had a more even mix of stp versus surface collected sites. As more surveys involving stps are conducted, the additional data may bring the regions site characteristics closer together.

Even so, differences between the sampling strategy which created the data for the regions does not explain all of the variability which exists between them. Instead, there are almost certainly interdependent factors such as environment, weather, soil types, and cultural practices which affect duration of site occupation, material culture practices and consequently artifact distributions and density which account for the differences.

Both cultural and natural transformations may be at work to create the differences in the artifact densities and site sizes between the three regions. There are more obvious forces at work affecting artifact densities than site size. A primary factor in the difference in artifact densities may be artifact survival. The pottery used and created by Native Americans in the Black Warrior

River Valley and the Black Prairie was typically tempered with crushed mussel shell. In the Piedmont, sand and grit tempering was favored. Shell temper can be leached from pottery by acidic soil conditions, while sand and grit is relatively stable. Leached shell tempered pottery can lose 20-30% of its mass, leaving voids behind which compromises the structural strength of the pottery. Consequently, the pottery becomes more fragile and friable, such that when mechanical stress is applied to it, such as through plowing, it more easily breaks into smaller and smaller pieces. Sand and grit tempered pottery is likely more resistant to the mechanical effects of plowing and agricultural practices.

As described in Chapter 3, the Black Warrior River Valley and the Black Prairie are both largely still under cultivation. The fields may be plowed two or more times a year. In contrast, while subjected to intensive agricultural practices for the first couple hundred years, the Piedmont has for the last century been largely in silvaculture. Most of the land was probably not subjected to mechanized plowing like the Black Warrior River Valley and the Black Prairie has been. Animal drawn plows may induce less stress on plowzone artifacts than mechanized plowing (Dunnell and Simek 1995). The combination of temper selection and land use practices contribute to the more rapid mechanical breaking down of the primary diagnostic artifacts found in the Black Warrior River Valley and Black Prairie compared to the Piedmont. These are more likely factors for lower artifact density than cultural practices that would reduce the number of diagnostic artifacts such as reduced usage of ceramic vessels.



Figure 5.10 Distribution of surface artifact densities per m^2 by discovery method

5.5 Results Discussion

In the previous section, the data was explored in detail and the results of the Mathematical Model compared with the Real World data in order to gain a better understanding of the nature of the data available and how useful it might be towards answering questions. This thesis is specifically concerned about bias in our understanding of the archaeological record due to the methods of data recovery employed. The focus is on small scale sites Mississippian Farmstead sites and we now have assembled a large enough body of information that we can estimate characteristics of farmsteads as a population based off of the sample. By understanding how surface collection and shovel test pit methods differ from each other, quantifying that difference,

and applying it to estimated populations, we can see the effects on archaeological constructions of significance, calculate optimizing strategies for stps to make them equivalent to surface collections, attempt to normalize data from different regions to make their results comparable, and more fully explore and understand the limits of the Mathematical Model for interpreting the archaeological record.

5.6 Effects of Survey Bias on Discovery of Significant/National Register Eligible Sites

Within the dataset were sites that were determined to be eligible for inclusion on the National Register. There are perhaps many more that are or could potentially be eligible, however of the 247 sites used in the Mathematical Model, only 18 were considered eligible, 51 were determined to be not eligible, and 178 were unknown. The large numbers of unknowns is a result of lack of eligibility reporting in state site files, especially for sites recorded in the 1970s and 1980s. The result is unfortunately too small a sample of eligible sites to do too much work with, but some useful observations can be made, even if the data cannot be mined too deeply. Regionally, 5 sites from the Black Prairie, 9 sites from the Piedmont, and 4 sites from other regions were considered eligible. No sites in this small data subset were known from the Black Warrior River Valley and the limited data precludes a deeper examination into regional differences of site characteristics of significance at this time. Instead, eligible sites are grouped together for further analysis. Table 5.11 shows the descriptive statistics for the 18 eligible sites which can then be compared to the non-eligible sites (n=229) to see whether the smaller eligible subset is representative of the larger group or not (Table 5.12).

There do appear to be differences in the means and standard deviations of site artifact density and probability of detection by both methods with the Eligible sites having higher average means and standard deviations. Something could be said then that in general Eligible sites appear to have higher artifact densities than non-eligible sites, however before coming to that conclusion and weighing its consequences it is important to know whether the differences seen in Table 5.12 represent a statistically significant differences between the samples. An F-Test to determine whether equal variance was present between the two samples was conducted followed by a t-Test of the two samples. The null hypothesis stated that there is no significant difference between the samples, meaning that they likely could have both been drawn from the same population (ie the archaeological record) and that they do not vary significantly from each other at least as far as their mean and standard deviation dictates. The P threshold value for both the F-test and the t-Test was 0.05.

Table 5.13 shows the results of these two statistical tests. The F-test conducted on each variable: site size, density of surface artifacts, probability of detection by surface collection and probability of detection by stps showed that site size and probability of detection by surface collection could assume equal variance while the other two could not assume equal variance. The results of the t-Tests show that there is no significant differences (at a p=0.05) between the means of the tested variables. This implies that the sites which were considered archaeologically significant were likely to have been drawn from the same sample as the non-eligible sites and are affected the same way as non-eligible sites by the method of site discovery. The larger standard deviations of the Eligible sites further support this conclusion since that indicates there are broad ranges between sites and that the sites are not clustered along one axis of probability as shown in the histogram of sites Figure 5.11.

While not completely convincing considering the small sample size of the Eligible sites, the tests indicate that both Eligible and Non-eligible sites are likely to be roughly the same in terms of the variables measured by this study. Equivalence would indicate that Eligible sites are being discovered at the same rate as Non-eligible sites and that neither one of them is over or under represented in the known archaeological record. In other words, site size and site density do not seem to be indicators by themselves of whether a site is likely to be considered Eligible for the National Register and thus also be more likely to be found. No bias in the discovery differentials between Eligible and Non-eligible sites would hold true as long as there are no other compounding factors which favor the discovery of one site type over the other.

While on the face of things, the lack of bias for the discovery of one type over another would be a good thing, it should be recognized that it also means that the limitations of the two site discovery methods examined in this paper also apply to the discovery of significant sites as well. The implication is that tacit expectations of being able to identify all Eligible sites in a survey area though not all archaeological sites is a false assumption based on the characteristics and dynamics of the surface collection and stp site discovery methods. The relative tolerance or acceptable expected rate of site discovery can be quantified and the implications for significant sites not discovered based on the discovery methods employed could be utilized by the archaeologist in considering the importance and potential significance of archaeological sites which were discovered within a survey area.

In addition, it is interesting to note that if the variances were considered to be equal both the surface artifact density and the detection by stps would show a significant difference between Eligible and Non-eligible sites, the fact that they are not equal may be influenced by the size (Non-eligible n=229 and Eligible n=18) of the samples involved as the assumption of non-equal variance reduces the degrees of freedom dramatically which corresponds to a higher resulting P value. Whether the results are greatly affected by the small sample size of Eligible sites has not

been determined, however it could be addressed with additional statistical investigation or

increased sample size.

Descriptive Statistic	Site Size (M ²)	Surface Artifact Density	Surface Collection Probability	STP Probability
Mean	2542.889	0.27693	0.623494	0.257873
Standard Error	603.6907	0.125974	0.093488	0.090233
Median	1154	0.04025	0.758226	0.036951
Mode	100	#N/A	1	0.00185
Standard	2561.243			
Deviation		0.534464	0.396635	0.382826
Sample Variance	6559964	0.285651	0.15732	0.146555
Kurtosis	-0.68419	5.063804	-1.92902	-0.11129
Skewness	0.85529	2.31419	-0.23411	1.276394
Range	7925	1.930724	0.930055	0.99815
Minimum	75	0.000185	0.069945	0.00185
Maximum	8000	1.930909	1	1
Sum	45772	4.984732	11.22289	4.641712

Table 5.11 Descriptive statistics for eligible sites

Table 5.12 Comparison of eligible and non-eligible site descriptive statistics

	Me	an	Std	Dev	Ν	/lin		Max
	Non- Eligible	Eligible	Non- Eligible	Eligible	Non- Eligible	Eligible	Non- Eligible	Eligible
STP Probability	0.0731	0.3391	0.1752	0.3828	0.00128	0.00185	.9996	1
Surface Collection Probability	0.5023	0.5998	0.3407	0.3967	0.04251	0.06995	1	1
Surface Artifact Density	0.03544	0.2752	0.09207	0.5345	0.000217	0.000185	0.7333	1.9309
Site Size	2545.85	2542.89	1988.39	2561.24	50	75	8450	8000

Table 5.13 F test for variance and t-Test comparing eligible and non-eligible sites

Statistical Test	Site	Surface Artifact	Surface Collection	STP
P= 0.05	Size	Density	Probability	Probability
F Test P value	0.05174	1.3E-53	0.1608	1.12E-08
t-Test: Two Sample	equal	unequal	equal	unequal
Variance Type				
P value (two Tailed)	0.9953	0.07251	0.15466	0.05725



Figure 5.11 Histograms of site artifact density for the entire dataset plotted with eligible for National Register sites

5.7 Methods for Achieving Surface Collection and stp Detection Probability Parity

'Why is surface collection so much more efficient than shovel testing?' is an obvious

question to ask when looking at the conclusions from early sections in this chapter. Both the Real

World results and the Mathematical Model predict that surface collection is simply superior to shovel test pits when it comes to detecting small scale sites. While some of the complex math behind that assumption has been explored, there is a simple way to visualize why this may be so. The average site in the database is 2545 square meters. The Mathematical Model estimates that 113.9 m2 will be examined by a surface collection survey using a standard 30 meter transect with a two-meter detection width. A shovel test survey using the same transect spacing will on average place about 2.8 stps within the site's boundaries. Assuming the average plowzone depth from the database, the soil from those .3m square stps were spread out such that it was half a centimeter deep, it would only cover an area of 7.13 m2. In order for shovel test pit surveys to be comparable to surface collecting, the amount of soil examined has to be increased.

Within the Mathematical Model the transect spacing and the size of the stps can easily be changed, allowing us to increase the amount of soil examined. By changing the interval from a standard 30 meters to 15 meters, the average detection probability of Mississippian farmsteads within the database increases from .0865 to .1769 effectively doubling the chance of success. Increasing the size of the shovel test pit from a 30 cm by 30 cm unit to a 40 cm by 40 cm increases the average detection from .0865 to .1175. A number of combinations of the calculations of average probability of detection are presented on Table 5.14.

	Test Unit Size			
Transect Spacing	30 cm square	40 cm square	50 cm square	1 m square
30 m	0.086537	0.117549	0.147399	0.291396
15 m	0.176876	0.235142	0.291396	0.518505
10 m	0.263612	0.344404	0.416676	0.670354
5 m	0.480339	0.586214	0.670354	0.896471

Table 5.14 Variable transect and stp size detection probabilities

From the chart it is apparent that in order to try and bring stp detection probabilities up to the average detection for surface collection of around 50%, that a great deal more effort needs to be expended to come close. However increasing the size of stps to 1 m squares or decreasing the interval between transects to five meters is cost prohibitive in terms of time and consequently money. Since detection probabilities have to be increased, there is little choice but to examine what the costs would be. Costs for changing the transects can use this formula to estimate the maximum number of stps to cover a given rectangular area:

$$\frac{L}{t} + \left(\frac{L}{t} \times \frac{W}{t}\right)$$

Where L= length of the survey area

W= width of the survey area

t= transect and stp interval

In a hypothetical 100 ha survey block, the number of stps needed to cover the area using 30 m transects would be 1144, while a 10 m transects would require 10,100 stps. To achieve an increase in average detection probabilities from 8.65% to 26.3% requires almost nine times as many stps. Nine times the effort for roughly three times the detection probability does not seem cost effective. A ratio of the relative amount of effort needed for each possibility is presented in Table 5.15. The larger stps were computed as multiples of .3 m stp size and multiplied by the number of stps for the respective transect. The total number of .3 m stp equivalents for each possibility was then divided by the average percentage chance for discovery. The lower the number, the more cost effective the combination is. From the table, the standard 30m transect with .3 m stps turn out to be fairly efficient at finding farmsteads compared to the other

strategies. To try and achieve around a 25% discovery probability, the option include 15 m transects with 40 cm stps and 10 m transects with 30 cm stps. One definite trend the table illustrates is that the higher the probability of discovery is pushed, the more expensive and less efficient the strategies become.

While four of the states in the southeast use the standard 30 m transect with .3 m stp, other states have committed to smaller transect spacing and larger stps in a variety of combinations (see Table 2.1). Getting closer to the 25% detection rate for small sites like Mississippian farmsteads is a more responsible way to manage cultural resources. Indiana and Virginia have adopted a 15 m transect interval with .4 cm stp despite the cost. Surveys are still conducted in those states, so the increased cost is capable of being borne by the system.

	Test Unit Size			
Transect Spacing	30 cm square	40 cm square	50 cm square	1 m square
30 m	132.2	173.1	215.7	436.4
15 m	255.0	341.0	430.0	966.7
10 m	383.1	521.3	673.3	1674.0
5 m	836.9	1219.1	1665.7	4982.5

Table 5.15 Number of standard .3 m square stps divided by the average chance of detection

From the Mathematical Model we can see that trying to bring the detection levels of stps up to that of surface collection would be costly. A 7 to 9-fold increase in effort yields around a 25% average detection rate for stps falling far short of the 50% average for surface collection. As mentioned previously, that detection rate for surface collection is idealized. When taking into account real world conditions that obscure surface visibility, the average detection rate at 50% visibility falls to .3887 and at 25% visibility the detection rate falls to .2846. Since some state survey rules allow for surface collection to be conducted with 25% visibility, roughly equal detection parity may be achieved by decreasing the interval of shovel tests to 10 meters. A 7 to 9-fold increase in labor costs may be prohibitive, but given the low success rate for finding small scale sites using the default methodology, this can hardly be seen as an adequate attempt to identify a representative sample of sites in surveyed areas, let alone come close to providing a reasonably accurate inventory. To reiterate from earlier, eligible sites are found at the same rate as non-eligible sites, meaning that the low density sites are likely being missed by shovel test surveys with unmodified transects and stp sizes.

5.8 Making the Settlement Data Between Regions Comparable

The Piedmont region has the highest detection probabilities of the regions studied and is significantly different with both larger average site sizes and higher artifact densities. Consequently, Mississippian farmsteads are viewed as very abundant in the region and estimated to number in the thousands. But are farmsteads really more abundant in the Piedmont than they are in the other studied regions? As previously discussed, with one exception, there are significant differences for the detection probabilities of farmsteads between the different regions. Since similar effort yields different results, the generated knowledge of settlement patterns between the three regions cannot be directly compared to each other. To make the regions comparable two techniques can be used.

The first technique applies to future work and is a similar approach to the how to make stps as efficient as surface collection. This approach would involve tightening up the interval of stps and surface collection transects. The default detection probabilities are the averages for the Piedmont region: .6447 for surface collection and .2082 for shovel tests. By adjusting the transect spacing as shown on Table 5.16, surface collection probabilities for both the Black Prairie and the Black Warrior River Valley can approach that of the Piedmont by taking on a 10 m transect. The increase in time for a 100 ha survey would be 2.94 times that of just 30 m

transects. The gains in detection probability are relatively small compared to the increased cost, so it may not be worth trying to adopt a tighter surface collection interval.

Table 5.16 Variable regional surface collection probabilities

Transect Spacing							
Region	20 m	15 m	10 m				
Black	0.5122	0.5377	0.5656				
Prairie							
BWRV	0.4699	0.5127	0.5707				

For stp testing regimens in the Black Prairie and the BWRV to approach the probability of the Piedmont, more effort is needed than that of surface collection and the two regions require a different strategy as shown on Table 5.17. The Black Prairie can approach the Piedmont's .2082 probability by decreasing the transect spacing to 10 meters which, as mentioned previously, will cost around nine times as much as the regular 30-meter spacing. The Black Warrior River Valley will have to decrease the spacing to 10 meters and increase the size of the shovel test pits to a 40 cm square. That means the effort to bring the BWRV into parity with the Piedmont will require more than fifteen times as much effort as the default 30-meter testing regimen.

	Black Prairie		BWRV		Black Prairie		BWRV	
Transect	30 cm Square		40 cm Square		50 cm Square		1 m Square	
30 m	0.0299	0.0158	0.0513	0.0277	0.0766	0.0425	0.2260	0.1484
15 m	0.1048	0.0599	0.1654	0.1011	0.2260	0.1484	0.4608	0.4027
10 m	0.1960	0.1242	0.2827	0.1992	0.3581	0.2774	0.6145	0.6090
5 m	0.4006	0.4030	0.5286	0.4931	0.6145	0.6090	0.8663	0.9066

Table 5.17 Variable regional shovel test detection probabilities

The cost to bring surveying techniques into parity with the Piedmont region may be prohibitive and therefore unrealistic. The second technique that may be helpful is one used in wildlife sampling counts where the detector is imperfect.

Where $\hat{\tau}$ = unbiased estimate to the total population :

 $\hat{\tau} = \sum_{i=1}^{\nu} \frac{1}{\pi_i} \sum_{j=1}^{m_i} \frac{y_{ij}}{g_{ij}}$ m_i = number farmsteads found, j = each farmstead

Unbiased estimator of Variance :

$$\operatorname{var}[\hat{\tau}] = \sum_{i=1}^{\nu} \frac{1}{\pi_i} \sum_{j=1}^{m_i} \frac{1-g_{ij}}{g_{ij}} y_{ij}^2$$

(adapted from Thompson and Seber 1996)

Based on the difficulty of finding the farmsteads that were discovered (a function of their ability to be detected based on the Mathematical Model), the formula can be used to estimate the number of farmsteads that were likely present both found and not found. This technique can give the archaeologist an idea of the population of sites that are present within a surveyed area and allow other characteristics such as occupation density to be derived. Once those numbers have been produced select areas within the different regions can be compared to one another.

Actually calculating the numbers of farmsteads present within a parcel and making regional comparisons is beyond the scope of this thesis. Based on some limited testing, the formula is a simplification and can be given to over inflation of numbers of missed sites beyond what is reasonable for the area surveyed. In general, the formula provides more useful estimates from well designed and executed research designs that maximize detection possibilities. The basic formula would benefit from the addition of some Bayesian statistical thinking concerning area of likely habitation and realistic population densities. For instance if the surveyed tract is all swamp and the only high spot had one farmstead on it, it is unlikely that others were present and missed based on the landform coverage. Without that apriori knowledge the formula might predict high numbers of farmsteads present if the single farmstead was relatively unobtrusive artifact density wise. Nonetheless the technique does offer a way to compensate for the low detection probabilities of the Black Prairie and Black Warrior River Valley regions and give some hope that comparable datasets between all the regions may one day be computationally possible.

5.9 Issues, Concerns, and Future Directions Generated by the Use of the Database

As an abstraction, the Mathematical Model will always in some ways be divorced from reality. The goal here is to try and determine if that divergence from reality is crippling to the kinds of information the model can provide. This section is more about trying to establish full disclosure of the remaining issues with the database and the Mathematical Model which utilizes that data. The actual effects are in most cases hard to quantify, but recognition of the limitations helps better inform the user as to the types of questions which may be put to the database and reasonably answered.

5.10 Mathematical Model Reliability

First, while the data is comparing overall methodologies there are some essential parts of the data which are missing that would allow a more fully confident comparison. Of primary importance is the lack of data on specifics for many of the earlier systematic surveys conducted either by shovel testing or by surface collection. Such data as the spacing of transects between observers, size of the shovel test pits, and whether the soil was screened were not always recorded, especially for work done in the 1970's into the 1990's. As can be seen from the

Mathematical Model results discussed earlier, these variables can play a significant role in determining site detection probabilities. As with many things, the output is only as good as the input.

Secondly, while I have indicated that the Mathematical Model should be regarded as a best case scenario, it is quite possible that the results from some surveys represent the worst case scenarios and this data is included in the Real World Model. Worst cases can include errors made in the field such that transects were not followed, shovel tests that are smaller and taper considerably rather than being uniform, surface conditions which were poor for visibility, and soil which was supposed to be screened but got discarded due to poor weather and/or soil conditions. Most of these variables cannot be accounted for in the data, but it can be hoped optimistically though perhaps not realistically that the errors affect the results for both shovel testing and surface collection equally. If this is not particularly reassuring, the fact that the real world data is predicted, though not perfectly, by the Mathematical Model does lend some confidence to the user. Given that this thesis is an exploration of bias, the writer has tried to remain cognizant of the blemishes on the tool he employs to do so.

The Mathematical Model is most certainly an abstraction which likely grossly over simplifies the situation and nature of archaeological sites beyond that which archaeologists find it convenient to parse the archaeological record into sites to begin with. Nevertheless, it would be instructive to know the relative accuracy of the model compared to reality to assess its usefulness in truly understanding the dynamics between archaeological discovery methods and the archaeological record. In the previous comparison between the Real World data and the Mathematical Model, several assumptions of the Mathematical Model were examined to look for explanations for the differences between the two. Surface visibility, surface artifact recovery, and

shovel test shape are controllable variables within the Mathematical Model. The nature of the source of the data was also examined for how it affected prediction rates at the regional level. One more assumption that has not been tested is the utilization of a Poisson distribution for calculating artifact densities. Except under circumstances of extreme plowing, archaeological sites are inherently represented by clusters of artifacts, so it might be useful to know how much real world clustering differs from the Poisson distribution employed by the Mathematical Model. To do that however would necessitate the reconstruction of archaeological sites which have been excavated to examine the distribution and density of artifacts which could then be compared to the numbers generated from initial assessments which were utilized in the Mathematical Model.

Unfortunately, out of the sample of 247 sites which were modeled mathematically, only 9 were subsequently excavated in such a way that a more detailed understanding of the distribution of artifacts and consequently site size and artifact density within the plowzone could be estimated. The reconstruction was accomplished by tallying the artifact totals and locations and placing the data points within ArcGis. The points were then interpolated using the kriging function which created a raster image with the cell size set at .03 meters or the same size as an stp. Site boundaries were determined by the .01 artifact per cell contour line. Descriptive statistics were then computed for the area within the boundary to calculate artifact density. The resulting maps of some of the interpolated sites are included in Appendix B.

The results of the reconstructions with a comparison to the Mathematical Model (where available) are shown in Table 5.18. The sample size of reconstructed sites is too small to conduct an in depth analysis of the results and their comparisons to the Mathematical Model. However, some general trends can be identified, chiefly from the increase in both artifact density and site size which has concomitant impacts on the probability of detection by both surface collection

and stp techniques. The resulting probabilities indicate 100% certainty of discovery by surface collection and also greatly improved chances of discovery by stp with only a few exceptions. To speculate on the meaning, it may be that both discovery methods underperform when it comes to determining the presence of sites (as demonstrated by the Mathematical Model) and that the method of calculating artifact density also under estimates the density of artifacts present on the site. If the latter were true it would cast considerable doubt on the efficacy of the Mathematical Model to make predictions on the performance of the two discovery techniques.

	Sit	e Size	Surface	Artifacts	Surface (Proba	Collection ability	STP Probability	
Site	Phase	Phase	Phase 1	Phase	Phase 1	Phase 2/3	Phase 1	Phase
Number	1	2/3		2/3				2/3
22CH515	500		0.003846		0.130636		0.018348	
22CH814	100							
22CL933	5400	5658.28	0.008667	0.192595	0.9457	1	0.514328	0.867088
22CL944	1500	2866.8	0.027668	0.113984	0.862872	1	0.404598	0.453996
22CL948	600	4856.55	0.007576	0.100592	0.288447	1	0.054041	0.595331
22OK534	1012	3816.99	0.015	0.349934	0.563687	1	0.153518	0.915711
22OK793a		15766.75		0.279241		1		0.999712
22OK793b		6226.36		0.227187		1		0.927163
22OK904		5210.8		0.069496		1		0.488605
22WI865	26400		0.163636		1		0.334627	
40DV446								
9GE1894	6000	8356.4	0.3	0.09489	1	1	0.071397	0.769707
9GE1896	6000	5618.28	0.01	1.29162	0.969861	1	0.581204	0.999999
9GE2178		6590.9		0.410618		1		0.993341
9GE2380	4250	4916.98	0.000556	0.164532	0.134998	1	0.03636	0.776456
9GE2381	8450	18937.63	0.000556	0.138489	0.197003	1	0.054041	0.992224
9PM1414		1396.91		0.706288		1		0.839116
9PM1428	5600	5835.62	0.000222	0.874239	0.071976	1	0.018348	0.999921

Table 5.18 Results of site density reconstruction and comparison to Mathematical Model

There are at least two inherent weaknesses to such a conclusion. The first is the nature of the site discovery process itself from which the Mathematical Model is built and which has to take into consideration all of the factors mentioned earlier about the abstraction that the model encompasses (see Chapter 4). What this means is that the very small portion of the site which is sampled by the discovery method then becomes representative of the whole site within the database. Some sites are thusly defined by a single artifact from a positive shovel test or controlled surface collection grid. Since the relative sample of the site is so small, random chance can have a compounding effect upon the results such that the final results after complete excavation can be vastly different than those reported from the initial discovery.

As an example, a randomly selected site from the database 22OK684 was discovered by surface collection on 30 meter transects and identified by the presence of 3 diagnostic artifacts. The Mathematical Model estimates that the transects intersected 95.77 m2 based on the size of the site at 1800 m2, so the surface collection method sampled 5.3% of the site surface which itself represents only 5.6% of the total artifacts present for a sample of only 0.3% of the artifacts present on the site. A randomly selected site discovered though shovel testing: site 9HB-1-27 was discovered using 30 meter transects recovering 1 diagnostic artifact out of five shovel tests within a site area of 1125 m2. The total area sampled at the phase I level was 0.09 (stp size) X 5 = 0.45 m2 represents of 0.04% of the total site area. In both cases the original percentage of the total site area sampled by the detection techniques was exceedingly small and a small sample size can introduce compounding issues which distort the results away from the reality. Nance (1981), described this situation where relatively rare artifacts can throw off the percentages found on a site where the sample size is low. They can be either grossly under represented or over represented depending on the vagaries of chance in small sample sizes. The small sample size problem applies both within sites and in the sampling of regions, since the scale is not the issue so much as the proportion of the sample to the area being sampled. In this case the rare artifacts are the diagnostic artifacts which identify Mississippian farmsteads. The small sample sizes of the total site by the discovery method allows for some error to be introduced to

individual calculations, however the robustness of the Mathematical Model is supported by the relatively large sample of sites which it has modeled. Undoubtedly there are errors and even egregious ones within the database, however as the sample size increases it tends relegate the gross errors as outliers and assume a more normal distribution, we might expect the same to apply to the modeled sites as more are subjected to intensive excavation.

The second potential flaw with comparing results from more fully excavated sites with the Mathematical Model is in the nature of both the excavation of sites and the way artifact density surface is created as a result of the interpolation function. As mentioned previously, it is typically cost and time prohibitive to completely excavate an archaeological site so archaeologists try to identify the area with the highest potential for information which usually involves those portions of the site perceived to have the highest artifact concentrations. In this way, archaeologists bias the data recovery to include the majority of the artifacts present while spending little to no time investigating areas of low artifact density. As an example, the Monroe site (9PM1428) during Phase I had 93 stps of which 53 were positive yielding 190 diagnostic artifacts or 22.7 artifacts per meter2 tested. During Phase II and III 400 m2 were hand excavated yielding 16,457 diagnostic artifacts or 41.1 artifacts per meter2 excavated thereby almost doubling the artifact density. Excavation unit location criteria was based on the data from the stps and were placed in the areas of highest artifact density (Williams 2006:13).

When these areas of high density are put into ArcGis, the interpolation functions tend to fill in the gaps between the data points with higher values than might otherwise be present, especially if in actuality the artifacts are highly clustered with precipitous declines in artifacts between clusters. Interpolations functions will tend to smooth these out because typically there are fewer low value data points than there are high value ones. The interpolation program does
not guess as to what may or may not be present for a given pixel but rather uses a variety of different neighborhood analysis dependent on the type of interpolation to decide what value to place within a cell of the raster.

These factors may be what contribute to the higher artifact density of the reconstructed sites, however it is difficult to assess exactly how much the nature of archaeological work and the way that the results are then interpolated distort the final numbers. Archaeological sites are by definition recognizable clusters of artifacts that represent past human behaviors. The density of the clusters has to be sufficient for them to be visible on the landscape to archaeological discovery methods. The present Mathematical Model assumes a Poisson distribution where all artifacts are distributed equally across a site such that any one point that is sampled has the same chance of containing a diagnostic artifact as any other. Given the clustered nature of archaeological sites, to employ a more sophisticated method of constructing a Mathematical Model the researcher would have to have a better understanding of the typical dynamics of Mississippian farmstead artifact distributions which can be gained through continued excavation by hand of small excavation units. With greater resolution of the spatial distributions key aspects such as the standard deviation, variance, and mean of the artifact distribution across the site can be used to calculate dispersion or the relative amount of clustering that is occurring and the number of clusters present. By taking into account the relative amount of clustering, more accurate probabilities can be generated for site discovery at the points of intersection by transects. Techniques such as K-means clustering, Expectation-maximization, and Moran's I are all possible future directions by which to improve the model.

Beyond refinement of the probabilities of discovery, an understanding of clustering would aid in site interpretation as well. Clustering of artifacts typically results from activities

being conducted in the same way and place on a site. With a greater understanding of the amount and types of clustering occurring which may allow more confident interpretation on the ways that sites are organized by activities and possibly gender roles. Additionally, differences in activity and disposal patterns might be indicative of differences in site function or possibly ethnicity of the inhabitants when examined at a regional level.

One final note about the Mathematical Model: in discussing the construction of model, it was pointed out that there is a difference between how the Surface Collection and the Shovel Test formulas are measuring probability. The Surface Collection formula is optimized to maximize the intersection of sites based on the assumption that they are perfectly round. The Shovel Test formula on the other hand calculates the average occurrence of stps within the site boundary. The difference between maximized and average undoubtedly does have an effect on detection probabilities and skews things towards surface collection. In order to make them compatible, the Surface Collection formula should be averaged as well. To do so proved to be a significantly difficult undertaking involving the need to run of multiple simulations in a Monte Carlo approach to produce a regression formula that would fix this problem. Time constraints prevent a full exploration of this attempt at correction within these pages, however initial assessments suggest that there is not a very great difference in terms of area sampled between high and low projections for a given site. Making this correction would make the Mathematical Model more robust and should remain a goal for future development.

5.11 Results Summary

This chapter has trodden a torturous path of tests and more tests, statistical and otherwise towards a defined purpose. The Mathematical Model needed to be tested to understand what we can and cannot say about the output from the model and how it relates to the Real World Data. At the beginning of the chapter I stated that a number of questions would be posed to the database and then the implications discussed. The questions, answers, and the main points from the discussion are summarized here:

- Q1: Is there a difference between site detection methodologies observable in the Real World data?
- A1: Yes, there are significant differences, with systematic surface collection research designs proving to be the best technique to use for finding Mississippian Farmsteads by an almost 4 to 1 ratio. Within the Piedmont region, systematic shovel testing comes closest to approximating the efficiency of surface collecting.
- Q2: Does the Mathematical Model predict that there will be differences?
- A2: Yes, there are significant differences between shovel testing and surface collection methodologies. Under optimal circumstances surface collecting out performs shovel testing by a ratio of almost 6 to 1 when both use 30 m transects.
- Q3: Are there differences between the studied regions?
- A3: Yes, there are significant differences between regions in terms of their site size, artifact density, and detection probabilities. Artifact detection is higher in the Piedmont, which contributes the most to the higher detection probabilities for that region. With the

exception of surface collection in the Black Prairie and Black Warrior River Valley, the results of surveys cannot be directly compared.

- Q4: Can we compare the Real World data results to those from the Mathematical Model?
- A4: Yes, the ratios can be compared and demonstrate that the Mathematical Model does make predictions that correspond to real world observations. Better data reporting of real world conditions will increase the precision of the database's predictions making them less optimal and more in line with actual survey conditions.

That understanding provided information for the discussion questions that followed:

- D1: Does discovery methodology affect archaeological constructions of significance and management?
- A1: Yes and no. Tests showed that sites deemed eligible for the National Register of Historic Places were not significantly different than other sites in the database. Eligible sites were not representative of the distribution of sites within the database in terms of size, density, and detection probabilities. Eligible sites are subject to the same problems as other sites; they are no more or less likely to be found than non-eligible sites.
- D2: If there are differences between methodologies, what can be done to bring them into parity?
- A2: To bring shovel testing into parity with potential real world conditions for surface collection at least a fourfold increase in time and effort is required. One method would be to change transect spacing to 10 meters instead of the standard 30-meter interval but maintain stp size. A second method would be to increase stp size to .4 m while still

decreasing the interval to 15 m. Both methods would bring up the average chance of detection to close to 25%.

- D3: What is the optimal discovery method and parameters for each Region?
- A3: Surface collection is the optimal method to employ within each region. The high artifact density and larger site size of Piedmont farmsteads sets the bar for prediction probabilities from the other regions. To make the regions comparable, intervals of both surface collection and shovel test pits would need to be decreased to 10 meters and in the case of the Black Warrior River Valley, the shovel test pit size increased to a 40 centimeter square.
- D4: Do the inherent limitations of the Mathematical Model greatly affect the outcomes it can predict?
- A4: Yes. A great number of assumptions are incorporated into the Mathematical Model which tend to overestimate prediction probabilities. The model is flexible and with careful recording of real world conditions, reality can be better reflected in the output by the model. As is, the model still produces robust predictions that are useful in answering many questions about the real world.

6 CONCLUSION

This thesis demonstrated that there are potentially great differences in efficacy between the two most prominent methods of site discovery techniques employed by archaeologists and mandated by state and federal agencies: shovel testing and surface collecting. When trying to detect sites with limited archaeological visibility, namely those with small areal extent and low artifact density, such as what characterizes Mississippian Period farmsteads, surface collection is typically several times more effective than digging shovel test pits. Variations in the archaeological record across regions need to be understood and quantified in order to better understand the effect local conditions have on archaeological survey results. Without taking into consideration the factors which most greatly affect the ability of these techniques to detect sites, the results of surveys utilizing different techniques and methodologies should not be compared to each other. To do so invites bias into the record and the thinking of archaeologists that can affect interpretation of the archaeological record as well as attempts to preserve and manage it. As long as those biases are not recognized, inter-regional comparisons of settlement patterns are flawed, as are intra-regional comparisons of the results of surveys that employed different discovery methodologies. Using techniques which are poorly suited for discovering the kinds of archaeological resources available call into question as to whether Section 106 and 110 requirements of the Historic Preservation Act have been met.

To arrive at these conclusions, a two-part method was employed: the creation of a database of surveys that encountered Mississippian farmsteads in the southeastern United States, and a Mathematical Model of the two detection techniques. Both of these methods of investigation provided information that could then be compared to the other and helped to better inform conclusions that could be drawn. In addition to the previously mentioned conclusions, the dual approach demonstrates that not only are there significant differences between the site detection techniques but also that the quantifiable differences between them mean that adjustments can be made to help bring them into equivalence. A brief overview of methods and results of the Survey Database and the Mathematical Model follows and concludes with recommendations drawn from the results.

6.1 Overview of Methods

The past thirty years of systematic archaeological survey and fieldwork has created a vast body of knowledge that has largely gone untapped. That knowledge, consisting of survey and studies, limited and full excavations, creative mitigations, and academic endeavors of theses, dissertations, and scholarly papers, is archaeology's Big Data. The existence of this Big Data is known to archaeologists, but is still largely difficult to access as it resides within disparate sources from paper to digital and all steps in between. This thesis shows that such data is useful and worth overcoming the obstacles posed by incomplete reporting and differences in methodologies. Once the data is cleaned and made comparable, large data sets can reveal observable patterns and hypotheses of those observations can be formed that can be subsequently statistically tested. The results can then be used to better inform methods, provide better standards for the collection of data, and open new avenues of inquiry as datasets are made more compatible.

Combing through the available literature and state sites files, data was extracted from surveys that encountered Mississippian period farmsteads. An exhaustive study of all surveys in the southeastern United States was not practical, so most effort concentrated on three regions that had large numbers of surveys and high numbers of farmsteads discovered: the Black Prairie of Mississippi and Alabama, the Black Warrior River valley in Alabama, and the Piedmont of Georgia. The data was entered into a Microsoft Access database to make relational queries easier. In all, 86 surveys and reports encountering 483 farmsteads were recorded. From that information, basic aspects of farmsteads and their discovery could be determined.

The goal was to provide enough data that observations could be made about the discovery techniques, and a hypothesis generated as to which ones are more effective. Differences between regions could also be illustrated with the observational data. By providing a direct way of making comparisons, differences within regions could demonstrate how surveying techniques could generate vastly different results. These observations led to hypotheses about surveying techniques techniques and regional differences that were then statistically tested.

6.2 Overview of Results

Finding a framework to try and encompass as many different surveys as possible proved to be difficult not only because of the different methodologies and variables concerning the implementation of the methodology employed but also because there was a lack of reporting exactly how the surveys were conducted. Enough information was provided or could be interpolated to provide a sizeable sample of Mississippian Farmsteads across the southeast that surveys could be compared and methodologies examined. Of key interest were the observable differences between shovel testing and surface collection strategies. By observation, surface collection is usually the more effective method in terms of efficiency and statistical hypothesis

testing showed that surface collection produces significantly better results compared to shovel test pits regardless of other aspects of survey design.

Further, the two more scientifically rigorous detection strategies: systematic and stratified probabilistic sampling have some interesting patterns. Surface collecting is at least two times as efficient at finding farmsteads via systematic sampling than probabilistic, which would imply that there are many more farmsteads where they are not expected. Interestingly shovel testing shows the opposite pattern, where stratified probabilistic sampling is on average twice as effective as systematic sampling. Exceptions can be found at the regional level. In particular, the Piedmont of Georgia demonstrates that stratified probabilistic sampling is much more effective than systematic while in the Black Prairie, systematic is more effective than stratified probabilistic.

These patterns imply three things: first the probabilistic model for Mississippian farmstead locations in the Black Prairie needs to be re-evaluated as many more sites are found in systematic surveys than where archaeologists think that they are, regardless of methodology. Second, data from the Piedmont suggests that archaeologists are largely correct in knowing where Mississippian farmsteads are located when using shovel test pits. However, given that systematic surface collection finds more sites than probabilistic surface collection, there may be an additional class and location of sites which are largely invisible to shovel testing, but can still be picked up by surface collection. The dynamics of how the two methods differ in terms of their detection probabilities was explored in the Mathematical Model. Third, the non-uniform nature of strategy results indicates that regional differences in the archaeological record play a key role in determining survey success and knowledge of those attributes are important for designing effective survey strategies.

6.3 Recommendations

Understanding sources of bias is an exercise in exploring the metadata of archaeological knowledge. Metadata in this context has multiple meanings. First as archaeological data is digitized and turned into something more like pure data streams, all of this data has to be categorized and turned into searchable quantifiable data (Dreilinger and Howe 1997, Limp 2005). The quantification of archaeological data inherently creates nested trees of information where various aspects of culture are embedded at different levels but this process is key to allowing a digital interface between the data and the archaeological community (McCartney et al. 2000). While most creators of archaeological databases are interested in how to capture the various typologies that have been created prior to being placed in a digital format (Wise and Miller 1997), the quality of the information should be captured as well. In addition to content, authors, titles, dates, categories, and key words (Wise and Miller 1997), archaeological metadata should also include how the data was created, methods used, and reasons why (cf. Gilliland-Swetland 2000). The expanded metadata would preserve the archaeological methodological context of the data along a separate dimension from the context of how the artifacts relate to each other, thereby providing another layer of relationships within a relational database. The difficulties in developing effective metadata standards and strategies, is an example of the complexity of tangled relationships and inter-dependencies that typifies archaeological data. The act of extrication from the ground destroys the original context so archaeologists have an ethical duty to artificially recreate it. The biases that were present at the moment of extraction should be preserved and documented within the data, and identifiable from the metadata.

Secondly, metadata is the underlying subtext to answering questions of how do we know what we know about the archaeological record. From a Processualist point of view this means

the hard facts of what was done, to what rigor, statistical significance, and replicability in order establish a kind of integrity to the data structure itself. That should not be the end of examining the underpinnings of what we know because that will help us to address Post-moderninst interests in understanding the points of interaction between the researcher, the theory, and the limits of science. The transformation of qualitative to quantitative data and back again is this very aspect that this thesis seeks to exploit and explore in the search for the identification of bias. I believe that an exploration of the biases will lead to greater confidence as to what can be comfortably discussed and compared through archaeological data, methods, and inform theory.

Beyond superlatives and higher order theorizing, metadata addresses real world needs in the here and now. Metadata from surveys will help agencies to quantify aspects of survey coverage and assess whether their needs have been met. As standards and preservation directives may change over time, accurate and comprehensive metadata will help in determining if past survey quality is high enough to meet those standards or if areas need to be resurveyed. Uniform meta-data collection would also greatly enhance the ability of researchers to cross jurisdictional borders and conduct more natural, regional comparative work more freely. As with many aspects of digital data collection such as maps, databases, and others, the maintenance and insistence on metadata is essential to good practice.

6.4 Mathematical Model Conclusions

From survey and excavation data, the nature of archaeological sites within a region in terms of their size and artifact density can be quantified which allows the chances of detection by archaeological survey techniques to be modeled. Predictive detection models only work if the researcher has some a priori knowledge of the characteristics of the types of targets trying to be detected. In many cases in archaeological predictive modeling, those characteristics are based on

the intuitive knowledge of the researcher, arbitrary cutoffs of artifact densities which may have little bearing in reality, or confined to very narrow and specific ranges of known sites. As was mentioned in the previous section, stratified probabilistic regimens based on predictive models often fall far short of systematic approaches. This indicates that the models are missing some information that arises from the surveys that are the source of the data. The benefit of the database generated for this project is that those limitations of the data can be quantified and adjusted to compensate for biases and deficiencies. The database and Mathematical Models can be applied on multiple scales from local to regional and is backed up with concrete information quantified from known sites.

In order to test the efficacy of archaeological site discovery techniques a Mathematical Model was constructed for both systematic shovel testing and surface collection. Systematic sampling methods lent themselves to being modeled since the variables could be directly controlled. The probabilities of detection are based on the chances of first intersecting the site based on its size with one or more transects multiplied by the probability of encountering artifacts based on a Poisson distribution of artifact density. The database generated from real world surveys supplied the relevant characteristics of Mississippian farmsteads regarding site size and diagnostic artifact density. This methodology allowed probabilities to be generated for encountering Mississippian farmsteads in abstract space which could then be applied to detection probabilities in the real world for these kinds of sites in general and also broken down into regions.

The results from mathematically modeling detection probabilities confirmed the observations made from real world surveys: surface collection is typically several times more effective for finding Mississippian farmsteads than excavating shovel test pits. In fact, the

Mathematical Model predicted a much greater disparity between the two than was observed in the Real World Database. The reasons for this difference most likely have to do with the idealized nature of the Mathematical Model with assumptions of 100% observation and recovery. When real world conditions were factored into the results such as ground visibility, surface collection prediction efficiency came closer to that observed in the Real World Database.

When the results were considered, it became even clearer that there are differences between the regions which would necessitate differing methodologies and research designs in order to maximize detection of these kinds of archaeological resources. The emphasis should be on site methodology custom designed for the area being surveyed. Given that plowed surfaces are less frequently encountered especially as agricultural practices change and no till sees more widespread implementation, shovel test pits methodologies will have to be improved with closer transects and larger shovel tests to make results more comparable to surface collection.

In conclusion, there are real world differences between regions and between archaeological site detection techniques. Although this thesis demonstrates the limits of techniques, especially the shortfalls of shovel test pits for detecting small scale sites, the outcome of this work should not be seen as a criticism of the techniques themselves, but rather an exploration of the limits of the techniques and what they are likely to reveal about the archaeological record. Where criticism can be leveled is at the state and federal cultural management programs which seem to ignore the published information and studies like this thesis that demonstrate shovel testing and surface collection do not produce equivalent results. As those limits are understood, and amassed data quantified, methodologies can be developed that strike a balance between the needs to identify and manage sites and the increase in costs to more accurately identify what is in the archaeological record.

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LIST OF APPENDICES

APPENDIX A: SURVEY SOURCES

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 - 2003b Test Excavations at the Leah and Zack Site, 9PM1182. Lamar Institute Publication 74, Lamar Institute.
 - 2006a Archaeological Excavations at the Lauren Site, 9PM141. Lamar Institute Publication 121, Lamar Institute.
 - 2006b Archaeological Excavations at the Monroe Site 9PM1428. Lamar Istitute Publication 120, Lamar Institute, Athens, Georgia.
- Willingham, Charles G. and Jack T. Wynn
 - 1985 Cultural Resources Survey of Nichols Exchange Tract, Oglethorpe County, Georgia. Forest Service Report No. 85GA08E02.

Wynn, Jack T.

1993 Cultural Resources Surveys in Compartments 155,170,185 190, and 192: Putnam and Greene Couties, Georgia. USDA Forest Service Report No. 93GA08-04, Gainesville, GA.
APPENDIX B: MODELED EXCAVATED SITES



Figure Appendix B.1 9PM1414 Lauren



Figure Appendix B.2 9PM1428 Monroe Site



Figure Appendix B.3 40DV446 Dorsey Site

VITA

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Educational Background

2016 The University of Mississippi, P.O. Box 1848, University, MS 38677Masters of Arts, AnthropologyM.A. Thesis: "A Comparison of Shovel Testing and Surface Collection as Archaeological SiteDiscovery Methods: A Case Study Using Mississippian Farmsteads."

2005 The University of Tennessee Knoxville, 1331 Circle Park Drive, Knoxville, TN 37996 Bachelor of Arts, Major: Anthropology

Employment Record

ERM, Cultural Services 3300 Breckinridge Blvd, Suite 300, Duluth, GA 30096 Telephone: 678.781.1370; Fax: 678.781.4470 Lab Manager/Archaeologist 1 September 2015 through May 2016

Archaeological Consultants of the Carolinas, Inc. 121 East First Street, Clayton, NC 27520 Telephone: 919.553.9007 Archaeological Crew Chief and Field Technician September 2014 to August 2015

Stone Point Services, llc. 11827 County Road, Tyler, Texas 75706 Telephone: 903.484.4041 Archaeological Contractor August 2014 to August 2015

University of South Carolina: SCIAA 1321 Pendleton St, Columbia, SC 29208 Telephone: 803.777.8170 Research Assistant Etowah artifact analysis September 2014 to August 2015 Graduate Assistant SC Army National Guard McCrady Training Base Environmental Services January 2014 to May 2014

University of South Carolina: Department of Anthropology 1512 Pendleton St #317, Columbia, SC 29208 Telephone: 803.777.6500 Graduate teaching Assistant August 2010- May 2013

University of Mississippi: Department of Geology and Geological Engineering 120A Carrier Hall, University, MS 38677 Telephone: 662.915.7498; Fax: 662.915.5998 Research Assistant August 2008 to December 2009

University of Mississippi: Department of Sociology and Anthropology 565 Lamar Hall, University, MS 38677 Telephone: 662.915.7339; Fax: 662.915.5372 Graduate Assistant August 2008 to December 2009

University of Tennessee: Archaeological Research Laboratory 5723 Middlebrook Pike, Rm 237, Knoxville, TN 37921-5946 Telephone: 865.974.9647; Fax: 865.946.1883 Archaeologist 1/ Crew chief August 1999 to August 2008

Grants and Fellowships:

2013 Archaeological Society of South Carolina graduate student Grant-in Aid award 2010-2014 University of South Carolina Presidential Fellow

Technical Reports: (* denotes primary author)

2012* A Preliminary Report of the 2011 Investigations at 38PN35. Report submitted to the Piedmont Archaeological Studies Team (PAST).

2011 Gonzalez, Jason and Cameron Howell. The 2010 Site Center Mapping Program at Tipan Chen Uitz. In *The Caves Branch Archaeological Survey Project: A Report of the 2010 Field Season*. Edited by Christopher R. Andres and Gabriel D. Wrobel. Belize Archaeological Research and Education Foundation Occasional Report #2, Oxford, MS.

2010* Settlement Survey in the Deep Valley's Peripheral Groups. In *The Caves Branch Archaeological Survey Project: A Report of the 2009 Field Season*. Edited by Christopher R. Andres and Gabriel D. Wrobel. Belize Archaeological Research and Education Foundation Occasional Report #1, Oxford, MS.

2009* Ceramic Analysis in *Phase II Archaeological Evaluation of Site 40KN317, Knox County, Tennessee.* By Stephen Carmody, Archaeological Research Laboratory, University of Tennessee, Knoxville. Report submitted to Knoxville Utilities Board.

2008* Ceramics in Archaeological Investigations of Sites 31SW393, 31SW451. 31SW459, and 31SW460 in the Great Smoky Mountains National Park, Swain County, North Carolina. by Michael Angst, Archaeological Research Laboratory, University of Tennessee submitted to the Great Smoky Mountains National Park.

2005* Ceramics in *Phase II Archaeological Evaluation of Sites 40KN45 and 40KN113 for the Proposed Golf Course at the University of Tennessee, Knoxville Experiment Station, Knoxville, Tennessee* by Michael G Angst. Submitted to the University of Tennessee Facilities Planning Office by the Archaeological Research Laboratory, University of Tennessee, Knoxville.

1998 Moore, Michael and Cameron Howell. Phase I Archaeological Reconnaissance of Parcel ED-1 Roane County, Tennessee. Manuscript on file with Lockwood Greene Technologies, Oak Ridge, Tennessee.

Presented Papers: (* denotes primary author)

2015* Using Least Cost Path Analysis to Reconstruct Trail Systems in Fort Jackson and the Sandhills Region, Paper presented at the Archaeological Society of South Carolina's annual meeting, Columbia.

2014* Dynamics of the Mississippian Period Fission-Fusion Process: a Case Study from Eastern Tennessee. Paper presented at the 71st Annual Meeting of the Southeastern Archaeological Conference, Greenville, SC.

2014* Woodland Components at 38PN35 and 38GR1. Paper presented at the Archaeological Society of South Carolina's annual meeting, Columbia.

2012* Evaluating Mississippian Period Settlement Hierarchies in Light of Survey Bias: Three Case Studies from the Southeast. Paper presented at the 69th Annual Meeting of the Southeastern Archaeological Conference, Baton Rouge, Louisiana.

2012* Interaction Along the Mississippian Frontier: Oscillation, Migration, or Integration in Upstate South Carolina. Paper presented at the 77th Annual Meeting of the Society of American Archaeology, Memphis, Tennessee

2011* The Carved Paddle Tradition in East Tennessee Middle to Late Woodland Ceramics. Poster presented at the 68th Annual Meeting of the Southeastern Archaeological Conference, Jacksonville, Florida.

2011* Airborne and Satellite Remote Sensing of Shell Middens Along the South Carolina Coast. Poster presented at the 76th Annual Meeting of the Society of American Archaeology, Sacramento, California

2010* Comparing Methodologies: Shovel Testing versus Surface Collection. Paper presented at the 67th Annual Meeting of the Southeastern Archaeological Conference, Charlotte, North Carolina.

2007* The Greater Southeast Online Chronometric Database. Poster presented at the 64th Annual Meeting of the Southeastern Archaeological Conference, Knoxville Tennessee.

2007 Hammerstedt, Scott and Cameron Howell. Middle Woodland Ceramics from Tuckaleechee Cove. Paper presented at the 64th Annual Meeting of the Southeastern Archaeological Conference, Knoxville Tennessee.

2006 Sullivan, Lynne, Michaelyn Harle, and Cameron Howell. Mortuary Practices and Cultural Identity at the Turn of the Sixteenth Century in Eastern Tennessee. Paper presented at the 63rd Annual Meeting of the Southeastern Archaeological Conference, Little Rock, Arkansas.

 2005^* Ceramic Analysis of Fain's Island (40JE1), a Late Dallas Phase Mississippian Site in Upper East Tennessee. Paper presented at the 62^{nd} Annual Meeting of the Southeastern Archaeological Conference, Columbia, South Carolina.

2005* Historic Cherokee Ceramics from the Townsend Archaeological Project, Tennessee. Paper presented at the Qualla Ceramics Workshop, University of North Carolina, Chapel Hill.

2002* A Preliminary Survey of Mississippian Structures and Settlement Patterns in Townsend, Tennessee. Paper presented at the 59th Annual Meeting of the Southeastern Archaeological Conference, Biloxi, Mississippi.

Selected Projects

Artifact Analysis from Cultural Resources Surveys from various pipeline projects in Illinois, Kentucky, North Carolina, Tennessee, Virginia, West Virginia, and Wisconsin. September 2015 to May 2016.

Cultural Resources Survey, El Paso, Texas for a private client pipeline project. October 2015.

Phase I cultural resources survey of borrow pits and solar farm locations for various clients near Greenville, North Carolina. May through August 2015.

Phase I cultural resource survey for the Hitchcock Woods Foundation, Aiken SC. Spring 2015.

Phase I cultural resources survey for US Forestry Service in Francis Marion National Forest, South Carolina. December 2014 through March 2015.

Cultural resources surveys and visual impacts on historic properties by cell towers for T-Mobile. Sites located in Georgia, North and South Carolina. August 2014- June 2015.

Artifact analysis from the 2013 University of South Carolina field school at the Etowah Mounds site 9BR1. September 2014 through September 2015.

Development of an Integrated Cultural Resources Management Plans for The McCrady Training Center. For the South Carolina Army National Guard. January through May of 2014.

Research investigations at 38PN35, a multicomponent Native American site. As a consultant for the Piedmont Archaeological Studies Team. June through July 2011.

Satellite imagery training for machine learning to identify hurricane damaged roofs. Research funded by SERRI, The Southeast Regional Research Initiative at Oak Ridge National Laboratory. January through April 2010.

Bus Route Mapping, for the University of Mississippi. April 2010.

Analysis of ceramics from 22LE500, a Chickasaw midden pit site. For the University of Mississippi. August through December 2009.

Phase II Archaeological Testing of 40KN45 on the Cherokee Farms Campus of the University of Tennessee, Knoxville. February to April 2008

Archaeological Investigations of Sites within the Proposed Water and Sewer Construction Corridor in the Great Smoky Mountains National Park, Swain County, North Carolina. For the Eastern Band of Cherokee Indians and the National Park Service. August to November 2007

Phase I Archaeological Survey at the Grand Gulf Nuclear Station, Port Gibson, Claiborne County, Mississippi. April to May 2007

Archaeological Mitigation of Site 40SV183, Sevier County, Tennessee for a private developer. November 2006

Archaeological Investigations at the Morgan County Regional Correctional Facility, Morgan County, Tennessee. For the Tennessee Department of Corrections. June to July 2006

Phase I Archaeological Survey of Caves and Rockshelters within the Proposed Corridor of the Knoxville Parkway (SR475) in Anderson, Knoxville, Loudon Counties, Tennessee for the Tennessee Department of transportation. September 2005 to March 2006.

Archaeological resources survey and erosion monitoring: TVA Reservoir Operations Study of Several Reservoirs in Tennessee, North Carolina, and Alabama. Recurring during winter months 2004 to 2008.

Phase II Archaeological Evaluations of 40MO13 and 40MO14, Morgan County, Tennessee. For the Tennessee Department of Corrections. February to March 2004.

Phase III Salvage Data Recovery of 40RE69, a late Mississippian village prior to destruction by new house construction. Private client. Roane County, Tennessee. June to September 2003.

Townsend Archaeological Project: Phase II of sites 40BT90 and 40BT91 and Phase III data recovery of sites 40BT89, 40BT90, 40BT91, and 40BT94 in Blount County, Tennessee for the Tennessee Department of transportation. July 1999 through December 2001

Field Schools

Volunteer archaeologist University of Georgia: Archaeological Field School, Ossabaw Island, Georgia June 2014 and 2015

Volunteer archaeologist University of South Carolina: Archaeological Field School, Etowah Mounds Site, Georgia June 2013

Volunteer archaeologist University of South Carolina: Archaeological Field School, Fort Congaree, Cayce, South Carolina. Winter 2012

Graduate Assistant Field Staff University of Mississippi: Caves Branch Archaeological Survey, Belize. Summer 2009 and 2010

Student

University of Tennessee, Knoxville: Chattooga Archaeological Project field school, South Carolina. June-July 1992