# EXPLORING PATTERNS OF HISTORIC SETTLEMENT IN KERR COUNTY, TEXAS FROM 1846 TO 1875: A CASE STUDY IN PREDICTIVE SETTLEMENT MODELING

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EXPLORING PATTERNS OF HISTORIC SETTLEMENT IN KERR COUNTY,

TEXAS FROM 1846 TO 1875: A CASE STUDY IN PREDICTIVE

SETTLEMENT MODELING

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## DEDICATION

I owe my deepest gratitude to my parents for guiding my education and work ethic throughout my schooling and career. Thanks Mom, Dad, and Deborah. I would also like to thank my family for their encouragement and understanding through this whole process. I love you all. And last but definitely not least, I would like to thank my wife, Susan Wilder Chavez, for her words of encouragement, extreme patience, editing skills, and constant help with both my research and the boys. I love you more than I could ever express.

I would like to dedicate this thesis to my sons Israel Mariano and Noah Michael.

"Learn from yesterday, live for today, hope for tomorrow."

~Albert Einstein

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# CHAPTER 1

# INTRODUCTION

Forms of predictive settlement models, often known as archaeological predictive models, are widely used as predictive tools in the cultural resource management (CRM) segment of the environmental consulting industry to determine areas with a high probability of containing archaeological/cultural sites or settlement locations. These predictive models use readily available landscape data such as soils, slope, and proximity to waterways to locate areas that will most likely contain archaeological phenomena of interest based on the location of a sample of previously recorded sites (Verhagen 2007, 13). With the aid of a geographic information system (GIS), CRM uses these predictive models for project planning and to developing field investigation methodology.

Since CRM projects have become a large contributor to the archeological record, this thesis investigates these predictive models by examining their major critiques to give an insight into the overall accuracy and validity of this tool. This was accomplished by conducting a predictive model analysis throughout Kerr County, Texas, and comparing the results to the historical record and recorded historic settlements in the county from 1846 to 1875 (Figures 1 and 2). This thesis identifies the statistically significant predictive environmental variables based on the methodology of popular forms of archaeological predictive models used in previous study areas to establish high

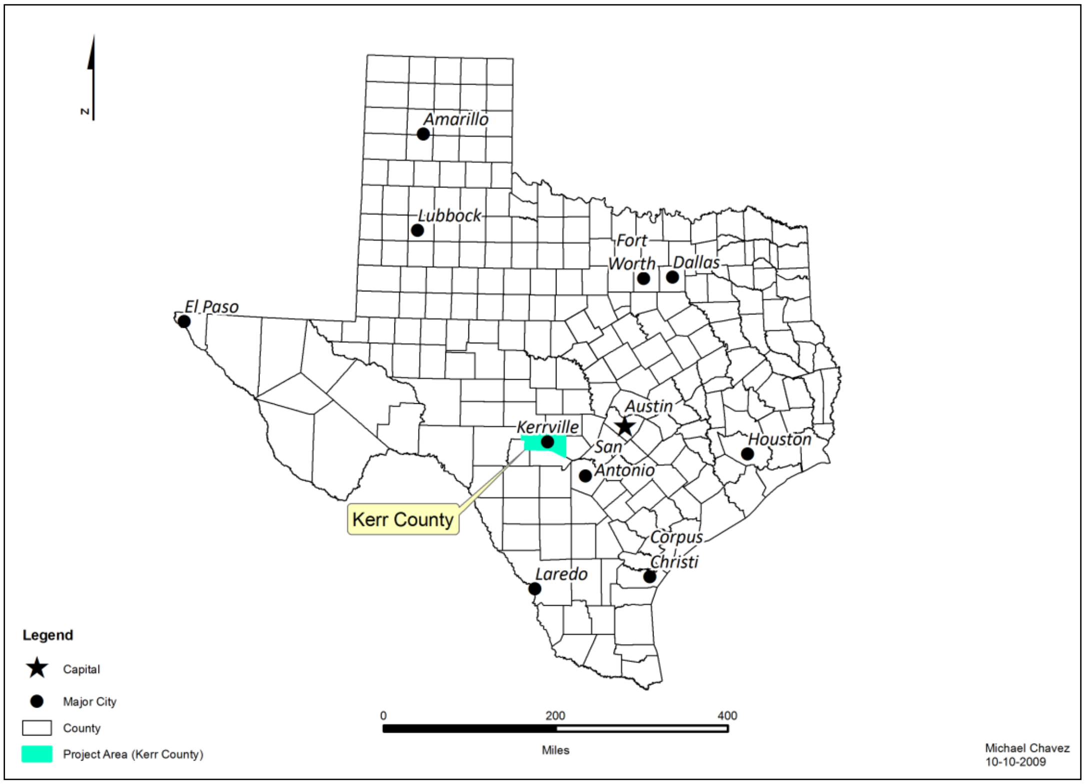


**Figure 1. Project Area Location Map.**

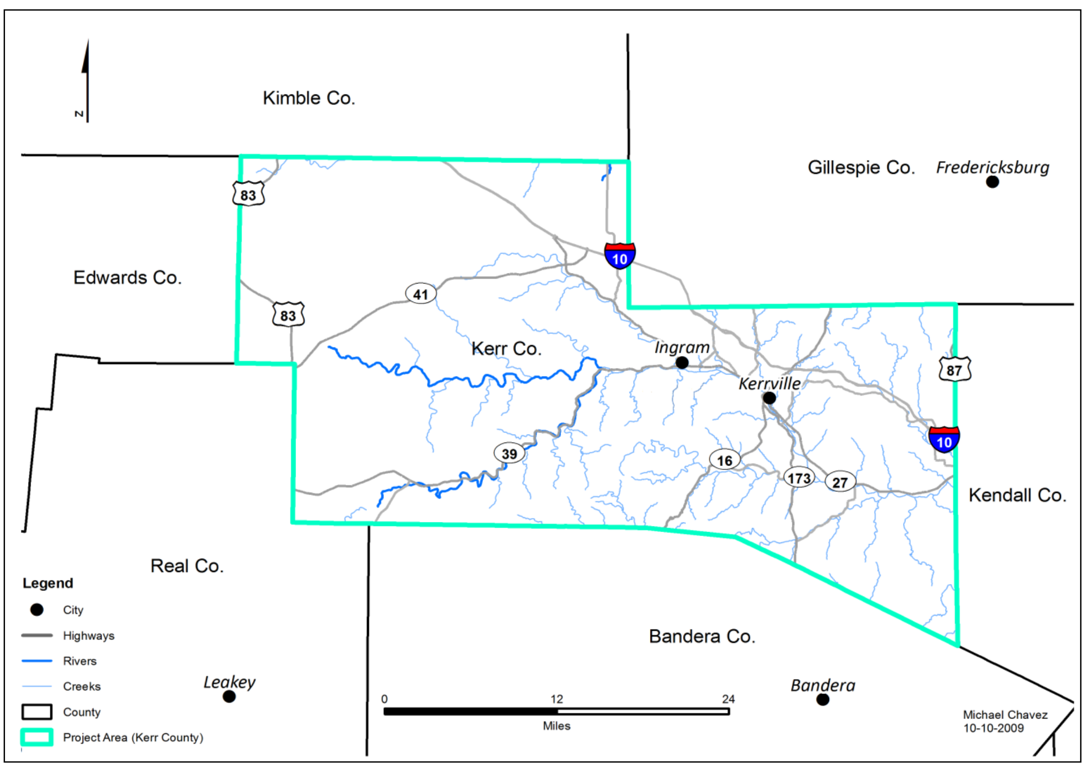


**Figure 2. Map of Project Area.** Modern map of Kerr County, Texas.

probability areas in Kerr County. The high probability areas are then compared to early Anglo-European settlements within the set time period of 1846 to 1875. Since predictive models often determine high probability areas from prehistoric[1] sites and assume early historic sites and settlements in the results, this thesis investigates a major critique of predictive models by addressing cultural variations and the vast differences between prehistoric and historic cultures[2]. In addition, the comparison eliminates the bias of possible compromised data sets in the model by using data separate from the model creation to verify the results. In this study, the verification data are the actual historic record. Finally, this thesis expands on the other major critiques by examining the archaeological data sets, the environmental parameters, and the dynamic nature of the landscape data. These critiques are expanded on further while introducing the problem.

## Introduction to the Problem

Archeological predictive models have been dismissed by academic research because modern settlement theories avoid the abandoned ideas of environmental determinism and site catchment theory (Gaffney and Van Leusen 1995, 374; Wheatley 1996, 275-292; and Wansleeben and Verhart 1997, 53-64; Verhagen 2007, 16). These ideas draw upon

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[1] Prehistoric refers to the general time period prior to European influence and colonization. In central Texas, prehistoric is commonly considered prior to Spanish exploration in the 16th century.

[2] It should be noted that CRM has recognized this critique by requiring a historic records review in addition to investigations on unrecorded archeological locations. However, undiscovered or unrecorded historic sites are often assumed in the archeological field investigations.

environmental and landscape conditions as the sole determinate in the location of sites with little to no emphasis on "…..historical sequence, cosmology or ideology which ought to be central to the interpretation of spatial patterns in prehistoric material" (Wheatley 1998, 1).

In addition to the fundamental theoretical disagreements on landscape based predictive modeling by the academic community, further critiques have risen against the choice and utilization of data by GIS models used in CRM. These critiques include: the use of incomplete archaeological data sets, the biased selection of environmental parameters, negligence in accounting for the changing nature of landscapes, and negligence in addressing cultural factors (Wansleeben and Verhart 1997, 53-64; Wheatley and Gillings 2002, 179-180; Van Leusen et al. 2005, 25-92; Verhagen 2007, 17). Regardless of these theoretical and fundamental base data critiques, CRM continues to use these models to map high and low probability areas and justify investigation methodology on various archaeological survey projects (Abbott 2001; Wheatley and Gillings 2002, 217-230; Mehrer and Westcott 2005, 219-289; Hudak 2005; Madry and Smith 2009). CRM practitioners of these predictive models justify the results by testing the model output against a subset of the archaeological sites data that have been excluded from initial calculations.

By constructing a predictive model and comparing the results to data completely separate from the data used in the model, this thesis will be able to answer the following research questions:

## Research Questions

*Does a predictive settlement model accurately locate high probability areas for historic settlement locations in Kerr County, Texas?*

*Are the results of the predictive settlement model providing accurate data for planning purposes and developing field investigation methodology?*

*Is the landscape data used in the predictive settlement model indicative of the recorded influences on settlement provided by the historical record?*

This thesis expands on the problems with modern predictive settlement models by looking at the literature and history behind its current utilization in Chapter 2. Chapter 2 also provides a summary of the history of the county prior to the investigated period in order to provide a detailed description of the setting prior to Anglo-European settlement. Chapter 3 identifies some popular predictive models for which the current model is based and outlines the methodology used in this investigation. Chapter 4 presents the results of the predictive model as well as issues encountered with the data, and the results of the historical record review of Kerr County during the investigated time period and the influences on their settlement locations. Chapter 5 compares the results of the predictive model against the results of the historical record summary and attempts to answer the research questions. Finally, Chapter 6 summarizes the results of the investigation and provides recommendations on further research.

# CHAPTER 2

# LITERATURE REVIEW

## Settlement Models

Settlement patterns refer to the distribution across the landscape of material traces of human presence (Sabloff and Ashmore 2001, 14). These patterns and the study of human settlement is the basis for the study of most aspects of human life (Boehm and Bednarz 1994). The 18 National Geographic Standards (Boehm and Bednarz 1994), which was created to "help students to see, understand, and appreciate the web of relationships between people, places, and environments (Downs 2009: online)" outlines the importance of knowledge of human settlement in the standard entitled "Processes, Patterns, and Functions of Human Settlement."

> These organized groupings of human habitation [settlements] are the focus of most aspects of human life: economic activities, transportation systems, communications media, political and administrative systems, culture and entertainment. Therefore, to be geographically competent—to appreciate the significance of geography's central theme that Earth is the home of people—a person must understand settlement processes and functions and the patterns of settlements across Earth's surface (Boehm and Bednarz 1994, online).

Basically, in order to understand the spatial structure and character of a region, research has sought to examine the patterns of settlement through its component parts and the process of its development. One method in investigating this process is the use of settlement models.

Settlement models have been used to study the settlement and subsequent community development of various areas by attempting to determine the factors that influence initial settlement and migration. These studies have been conducted by researchers in the fields of geography, archeology, anthropology, history, political science, and sociology (Hudson 1988, 395-413; Mahoney, 1990; Hall and Ruggles 2004, 829-846). These varying fields draw upon several concurring and differing theories for human settlement and the influences of migration. Well known settlement and migration theories include Ernest George Ravenstein's "Laws of Migration" (1889, 167-235; Corbett 2008), Everett Lee's modified interpretation of push/pull theory (1966, 47-57), variations of Walter Christaller's Central Place Theory (1933), and theories related to migration after the industrial revolution such as neoclassical economic theory (Marshall 1890), segmented labor-market theory (Doeringer and Piore 1971; Piore 1979), and world-systems theory (Wallerstein 1974). These theories rely heavily on accurate base data in order to prioritize factors in determining what drives human settlement and migration. For instance, Ravenstein (1889, 198-199) outlined his seven laws of migration by analyzing comprehensive census data from the United Kingdom in the late 1800's. Additionally, each of the post industrialization migration theories was based on investigations with accurate economic and location data. Therefore, in order to accurately investigate the factors of settlement, the actual locations of settlements are a critical piece of data in all settlement and migration studies.

The study of contemporary populations and settlements is facilitated by reliable meticulous modern records such as census data and maps. However, when studying prehistoric and early historic settlements, this information is often difficult to obtain. For this reason, researchers such as archeologists and historians must utilize other means in determining early settlement and cultural sites. Sites are often determined by actual field investigations where a researcher walks an area and records site locations by the presence of cultural materials. However, this method of data recovery is expensive and time consuming. Prior to the implementation of strict environmental regulations, research for such data was minimal as site locations were provided by amateur archeologist or from projects funded by universities and the private sector. This practice changed with the implementation of more stringent environmental regulations.

## Rise of Environmental Regulations

Environmental concerns in the United States in the 1960's stimulated the passing of several federal laws governing environmental resources. Some of these important laws included: the National Environmental Policy Act (NEPA 1969), the National Historic Preservation Act (NHPA 1935, 1966), the Water Pollution Control Act (1948), the Endangered Species Act (1973), the Resource Conservation and Recovery Act (1976), the Clean Water Act (1972, 1977), and the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund 1980). With the burden of compliance to these laws predominantly placed on private subcontractors awarded with government contracts, environmental consulting became a new profession created to help businesses navigate these complex laws. One aspect of environmental consulting created from these laws was CRM.

CRM refers to the "… managing (of) historic places of archaeological, architectural, and historical interests and considering such places in compliance with environmental and historic preservation laws" (King 2004, 9). One of the critical regulations in CRM is Section 106 of the NHPA. This regulation created the National Register of Historic Places, State Historic Preservation Offices, and the Section 106 review process which requires federal agencies to "take into account" the effects that their actions and programs have on significant historic properties (NHPA 1966; King 2004, 81-82). Significant historic properties can be any prehistoric or historic districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, and culture (NHPA 1966).

## CRM and Predictive Settlement Models

The immense number of projects that necessitated compliance with these new laws contributed to a large number of research projects. Due to short time frames and competitive bidding for funding, it was inevitable that private consulting firms would need more efficient techniques to meet scientific requirements in a timely matter. One of these efficient techniques used in CRM is predictive settlement models, referred to as "archaeological predictive models," which can be simply defined as a tool that indicates the likelihood of cultural material being present at a location (Gibbon 2000; Warren and Asch 2000, 6-7). Many of these models are based on the initial work by Kenneth

Kvamme (1983; 1988, 325-428), summarized in the article entitled “The Fundamental Principles and Practice of Predictive Archaeological Modeling” (Kvamme 1990, 257-295). Other influential work in this area includes studies by Kohler and Parker (1986, 397-452), Sebastian and Judge (1988, 1-18), and Warren (1990, 90-111). These studies basically outlined the uses of multivariate statistical analysis in determining significant variables for delineating high probability areas for cultural sites. These key principles have been widely adopted by various researchers (Dalla Bona 1994; Lock and Stancic 1995; Duncan, East, and Beckman 1998; Lock 2000; Warren and Asch 2000, 5-32; Westcott and Brandon 2000; Westcott and Kuiper 2000, 59-72; Krist 2001; Premo 2001; Wheatley and Gillings 2002, 171-175; Hudak 2005).

Archeological predictive models are intended to aid CRM by indicating areas more likely to contain cultural (archaeological) sites thereby minimizing the amount of energy spent, in terms of money and work hours for field survey, and maximizing the return, namely the amount of cultural data recovered (Campbell 2006, 13). These models ideally could evaluate a large project area by identifying the ideal topographical setting for the likelihood of finding unknown cultural sites (Campbell and Johnson 2004, 4). This is accomplished by using non-cultural (landscape) variables in an attempt to identify the spatial pattern based on a sample of site locations and projecting them to a larger study area (Kvamme 1988, 325-428; 1992, 19-38). Often, these models are intended to focus on prehistoric settlement locations (Native American sites) by utilizing contemporary landscape variables (soils, topography, distance to water, etc.) because broader resource data, project budgets, and access to project areas are limited (Westcott and Kuiper 2000, 60, 62).

Several landscape factor based models have taken these initial principals and have applied GIS software and technology as costs have become more reasonable (Lock and Stancic 1995; Lock 2000; Westcott and Brandon 2000; Wheatley and Gillings 2002: Mehrer and Westcott 2005). Even state transportation agencies have begun to use predictive modeling in transportation projects to avoid impacts on cultural sites and potential mitigation costs. These models have been used in Minnesota (Hudak et al. 2009), Vermont (Dillon and Peebles 2009), North Carolina (Madry and Smith 2009), and in the Houston area of Texas (Abbott 2001).

## Problems with Predictive Models

As previously mentioned, archeological predictive models have been dismissed by academic research because of modern settlement theories inference to the obsolete theories of environmental determinism and site catchment (Gaffney and Van Leusen 1995, 374; Wheatley 1996, 275-292; Wansleeben and Verhart 1997, 53-64; Verhagen 2007, 16). Popular until the early 20$^{th}$ century, environmental determinism is the idea that "…environmental factors are the determinative cause of racial differences, cultural practices, moral values, ingenuity, and the ultimate capabilities of any given population" (Judkins et al. 2008, 20). While site catchment theory, which emerged in the 1970's, is the evaluation of a defined area for the economic utilization of natural resources and is believed to be the sole criteria behind site locations (Roper 1979, 120-121).

Besides the theoretical disagreements on predictive modeling, opponents have presented additional critiques such as: incomplete archeological data sets, failure to address cultural factors, lack of justification in the selection of environmental parameters, failure to account for the changing nature of landscapes, and the application of the results (Verhagen 2007, 17; Wansleeben and Verhart 1997, 53-64; Wheatley and Gillings 2002, 179-180; Van Leusen et al. 2005, 25-92). With regards to the archeological data sets, these models use a small sample of known archaeological sites to determine the ideal landscape for the location of archaeological sites. However, these samples are often biased. For example, previously recorded sites are frequently recorded by CRM field investigations and are bound by the project area and not the potential for cultural sites. Basically, the samples only provide the location of previously recorded archaeological sites as they relate to modern development and not to the full landscape. The success of the model will be determined by this degree of bias in the sample data since the bias will be projected over the entire project area (Kohler and Parker 1979, 403). This bias to the sample was apparent in the site data used in this thesis and subsequently was apparent in the predictive model output. This is discussed further in Chapter 6 with the results of comparison.

The incomplete data sets also relates to the failure to address cultural factors. Often, the models used by CRM necessitate high probability of cultural sites regardless of cultural affiliation. This produces a biased sample in of itself. This is best stated in Kohler and Parker's critique of archeological predictive models:

> Despite numerous studies in diverse areas indicating change in site location through time in response to changes in adaptation type, and despite evidence that within any adaptation type, functional subsets of sites may have differing environmental

> [landscape] determinants, most empiric correlative models aggregate sites of all types and ages together for prediction (Kohler and Parker 1979, 408).

The result of ignoring this distinction in temporal affiliation is a reduction in the model's "…predictive power and certainly eliminates any hope of recognizing either change through time or the synchronic dynamics of a settlement system (Kohler and Parker 1979, 408)." However, if an attempt was made to differentiate the data by temporal affiliation, the data from previously recorded sites is often either inadequate or there are not enough sites creating a sample size in which statistical analysis would be inconclusive (Kohler and Parker 1979, 408). In order to test this critique, this thesis explores the locations of historic settlements against the high probability locations of all recorded archaeological sites regardless of temporal affiliation. By choosing historic sites, it is possible to draw an adequate amount of data from sources not related to the archeological site location data set used to create the model. In addition, this kept the results of this comparison away from arguments related to prehistoric cultural transfusion versus migration.

The critique on the selection of environmental parameters and the negligence in accounting for the changing nature of landscapes is interrelated. While contemporary environmental variables such as soils and water data are easy to obtain, the question arises as to the plausibility of these variables. Several of these landscape variables are dynamic and therefore do not accurately represent the same environment that was present at the time in question. This brings in to question the use of the variables themselves. If the model is used to determine the factors on settlement patterns, then a hypothesis for each of the utilized variables effect on the location of the settlements must be established.

Gaffney and Van Leusen (1995, 375) state this point best, “If the significance of a causal variable within the model cannot be proven, we must question the adequacy of the model for predictive purposes.” Often these predictor variables are justified by their level of significance towards the dependent variable (the location of sites). However as Gaffney and Van Leusen (1995, 370) point out, these predictor variables are often chosen based on their availability and not on a relationship to a factor of settlement. Thus, critics describe these models as being solely descriptive and producing a generalization of data with no basis in theory (Butzer 1978, 191-193; Kohl and Parker 1986; Kvamme 1989, 139-203; Kvamme 1990, 257-295; White 2002, 28-31; Mehrer and Westcott 2005, 265-289). In addition, critics point out that these models may only predict the “average” site, thereby discounting the outliers, which may provide critical data in determining factors of influence. The latter critique may have the largest effect on settlement studies and archeological discovery and interpretation. This critique is difficult to explore in the current investigation due to the rather static topographical conditions in Kerr County. In addition, the significant variables in the current model have often been justified by models that utilized “deductive” predictive modeling, which form a hypothesis on utilized variables determined from the speculative preferences of prehistoric people (Verhagen 2007, 14).

Another problem appears to be in the reasoning behind the utilization of predictive modeling themselves. In terms of regulatory compliance, “…attempting to draw correlations between the modern environment and the location of archeological sites is desirable” (Mehrer and Westcott 2005, 80)”. However, regulatory goals often differ from research goals:

> It is here that we see a split between the needs of land managers, who are concerned with identifying potential site locations versus the desires of researchers who use GIS to gain a better understanding of past peoples (White 2002, 30).

Many proponents point to the advantages of these models if the results are kept in context and used solely for determining project budgets. Van Leusen (Gaffney and Van Leusen 1995, 367-382) points out that CRM applications of predictive models are for planning purposes and do not necessarily have 'explanation' as a goal, but the practical identification and preservation of archaeological remains (White 2002, 31). He goes on to say that the identification of spatial patterns using environmental correlations is acceptable as long as no explanation is tied to the pattern (White 2002, 31). However, these models are often used as justification for limiting investigations through modified field methodologies within project areas (Chavez and Acuna 2005; Bonine and Chavez 2007). This is where the fine line is drawn in the use of these models. If the models were used for budgeting purposes only, then the creation of the model is justified. However, the increasing complexity in the creation of these models has some practitioners utilizing the results of the model to justify changing methodology standards used in field investigations. This practice thereby compounds the bias of archeological site data sets by conducting more stringent investigations in high probability areas and consequently recording more archeological sites in those areas.

While these models have been embraced and used by the consulting industry, adequate investigations into their effectiveness and theoretical implications as utilized in CRM have not been fully explored. This thesis explores the theoretical and applied problems by determining if a model using environmental variables can adequately identify a specific cultural period's settlement locations (in this case; historical settlement locations) and aid in describing the true dynamic nature of human decisions on settlement locations.

## Kerr County: Environmental Setting and History Prior to 1846

A review of the written and oral history of Kerr County was conducted to determine the factors behind the counties initial settlement and subsequent growth. In order to determine these factors, the natural environment and history of the area prior to 1846 needed to be summarized before concentrating on the county during the investigated period (1846 to 1875). All these summaries aid in the understanding of those initial inhabitants and which push and pull factors those individuals had to deal with.

### Environmental Setting

Kerr County is located in south central Texas in the upper Guadalupe River basin of the Edwards Plateau. The Edwards Plateau is considered the southern end of the Great Plains, the broad expanse of nearly horizontal sedimentary rocks that lies east of the Rocky Mountains in the United States and Canada. Geographically, the portion of the Edwards Plateau where Kerr County lies typically consists of highly eroded plateaus of thin soil over limestone and deep weathered limestone valleys (Dittmore, W. H. and W. C. Coburn 1986, 90). The Guadalupe River itself bisects the county by flowing to the southeast with numerous tributaries feeding the river from the limestone Edwards and Trinity aquifers.

Climatically, this region is unique in that it not only experiences the influences of its subtropical locality but the extremes that lie in adjacent regions (Earl and Kimmel 1995, 31). These dynamic circumstances create unstable patterns that produce abnormally wet or dry conditions as well as provide the prime environment to experience catastrophic climatic events such as flash floods, tornados, and hurricanes. The topography of the county coupled with these extreme conditions creates an added variable in understanding the settlement patterns of the county. Flood events during the investigated time period often destroyed grist mills and other structures that relied on the flow of the river (Watkins 1975, 5-7). Catastrophic flood events are still experienced today as there are no large scale flood facilities in the county.

## History of Area Prior to 1846

This historic summary includes: the prehistoric Native Americans, Native Americans in historic Texas, and relations along the Texas frontier just prior to the investigated time period.

### *Prehistoric Native American Prior to 1846*

The archaeological record for the Kerr County area is within a research zone traditionally described as the Central Texas archaeological area (Prewitt 1981, 71, fig. 2; Collins 2004, 102-103). This archaeological area is environmentally and topographically diverse, and much of this diversity is expressed in the archaeological record. Archaeological evidence of the earliest human inhabitants in the area that was to become Kerr County extends to at least 11,500 years ago or to approximately 10,000 B.C. (Houk, Miller, Oksanen 2008, 2-8).

Archaeologists generally divide the prehistoric record of this region into three broad archaeological periods; the Paleoindian, the Archaic, and the Late Prehistoric. The earliest distinctive archaeological period was the Paleoindian period, which covers a time frame from ca. 11,500–8,800 B.P. (approx. 10,000-7,000 B.C.). This was followed by the long Archaic period, which lasted from approximately 8,800–1,300 B.P. (approx. 7,000 B.C.-650 A.D.). The last period prior to European contact is the Late Prehistoric period, which began around 1,300 years ago (650 A.D.) and ended with the beginning of the Historic period ca. 400 B.P. (1600 A.D.) with Spanish exploration in Texas (Houk, Miller, Oksanen 2008, 3-3).

The Paleoindian period has been characterized as a time when small bands of highly mobile hunters and gatherers used long spear or lance-like projectile points (e.g., Clovis, Folsom) to hunt megafauna species such as mammoth, mastodon, camel, and Bison antiquus (Houk, Miller, Oksanen 2008, 3-3). These early groups hunted across large geographical areas and supplemented their hunting diet with a diverse assortment of plants and smaller animals (Bousman et al. 2004, 75-84; Collins 2004, 117). In the middle of the Paleoindian period, around 10,500 B.P., a massive extinction of the large megafauna occurred across North America (Houk, Miller, Oksanen 2008, 3-3). This caused a change in the life ways of these early inhabitants lending to the Archaic Period.

The archaeological record and subsistence-settlement pattern of Archaic peoples are distinctively different from those of the preceding Paleoindian period. Generally speaking, Archaic life on the Edwards Plateau reflects a more localized adaptation to the region (Houk, Miller, Oksanen 2008, 3-3). The most commonly recovered materials from the Archaic period are burned rock features and stemmed dart points. The prevalence of burned rock features in the Archaic suggests that there was an increased investment in the cooking of local foods (plants in particular) and infers that residential mobility decreased (Prewitt 1981, 73; Suhm et al. 1954, 18).

Around 1,300 years ago, Archaic spear-thrower technologies were replaced by the bow and arrow. The shift between these two distinctive hunting technologies marks the beginning of the Late Prehistoric period (Collins 2004, 122). The transition from the spear-thrower to the bow and arrow is inferred through the appearance of arrow points, which are much smaller and more lightweight than previous dart point forms. In the latter half of Late Prehistoric, pottery appears alongside specialized bison hunting tools such as beveled bifaces, large thin bifaces, hide scrapers, and prismatic blades (Collins 2004, 123). The appearance of these tools implies that an increased dependence on bison had developed by the end of the Late Prehistoric.

Evidence of these early inhabitants is limited to the few stone tools and features that have survived buried in deep alluvial deposits, usually near the Guadalupe River channel. Famous archaeological sites in the region include the Gatlin Site (Houk et al. 2008), the Bering Sinkhole Site (Bement 1994), the Varga Site (Quigg et al. 2008), and the Camp Pearl Wheat Site (Collins et al. 1990). Of note, the Gatlin Site represents a large continually occupied prehistoric campsite that is located within the current city limits of Kerrville.

*Native Americans in Historic Texas*

With the “discovery” of the New World marked by Christopher Columbus’s voyage to North America from Spain in 1492, the landscape of Native American world would never the same. By the seventeenth century, more than fifty million Native Americans had died as a result of war, enslavement, and disease in what has been described by historian Alvin Josephy as history's greatest holocaust by far. This changing landscape is attributed to European exploration and colonization of North America. Initially, this European presence created alliances and trade with Native Americans which quickly spread new technologies such as guns, ammunition, metals, and advances in warfare techniques (Blackhawk et al. 2009). Many tribes took advantage of the new technology coupled with European diseases to advance their control over less advanced tribes. European diseases had more of a devastating effect on concentrated village peoples thereby elevating traditionally nomadic groups into positions of supremacy. One main “technological advancement” that changed the Southern Plains and Southwest was the introduction of the horse (Blackhawk et al. 2009).

The horse revolutionized the lives of Native Americans in much of the West after their introduction by the Spanish in the 1500s (Blackhawk et al. 2009). Several tribes such as the Navajo, Apache, and Comanche, transitioned their way of life to revolve around the horse. In the southern plains and Texas, the Comanche created a life way sustained by trading, raiding, and stealing horses from the Spanish, Mexican and Anglo settlers (Blackhawk et al. 2009). This continued well into the late 1800’s and along the western frontier of Texas including Kerr County.

***Native Americans and Anglo Settlers along the Texas Frontier***

The Bureau of Indian Affairs was established in 1824 to oversee relations with Native Americans by appointing federal Indian agents to deal with tribes (Blackhawk et al. 2009). These agents treaded delicate negotiations with many tribes who had been victims to years of distrust and broken promises. The signing of the Indian Removal Act in 1830 by President Andrew Jackson, which authorized the removal of eastern tribes to lands west of the Mississippi, created an atmosphere that often escalated to violence. This violence was especially felt along the western frontier, which was the contact point between Anglo settlement and Indian territories. This was the setting in the 1840's along the Texas frontier which included the area to become Kerr County.

Early Native Americans groups encountered by early settlers in the Texas Hill Country and the area to become Kerr County were several bands of Tonkawa (Wilhelm 1968, 33). However, by the mid-19$^{th}$ Century, the rather non-militant Tonkawa had been pushed off prime hunting lands by Apaches and Comanche, becoming a destitute culture, living off what little food they could scavenge (Carlisle 2009). The Comanche tribes in the area sustained their livelihood by often raiding new settlers. Historical accounts by German settlers in central Texas frequently discuss "Indian Attacks" carried out by "…small bands of ten and fifteen Indians and commonly directed toward livestock, mainly horses" (Wilhelm 1968, 35). This eventually led to conflicts between Native Americans and U.S. Army from 1850 to 1880, known as the Indian Wars (Blackhawk et al 2009).

The Indian Wars represent a series of confrontations between the Native American tribes of the Comanche, Apache, and Navajo with early settlers and the U.S. Calvary. The war itself can be said to have been declared by Mirabeau B. Lamar, the second president of the Republic of Texas. Lamar stated in 1839 that the policy of his administration was to remove Native American tribes beyond the reach of the white settlers.

> "The white man and the red man cannot dwell in harmony together," Lamar said. "Nature forbids it." His solution was "to push a rigorous war against them; pursuing them to their hiding places without mitigation or compassion, until they shall be made to feel that flight from our borders without hope of return, is preferable to the scourges of war." (Dial et al. 2009, 1)

These wars saw the creation of several military outposts that stretched from the Red River in the north to the Rio Grande to the south (Figure 3). These forts were placed at the forefront of the hostile territories to aid in the expansion of Anglo settlement. The military presence cumulated in the late 1860's when approximately 25 percent of the full U.S. Army was stationed in Texas. With the start of the Civil War, this presence drastically declined and the native tribes took advantage and increased hostilities towards settlers.

## Kerr County During the Investigated Period (1846 to 1875)

A review of the history of Kerr County during the investigated time period is summarized by key issues affecting the inhabitants at the time. These include influences on the first settlers of the area including the military presence along the frontier and German immigrants as well as the effects of the civil war, and the growing economy.

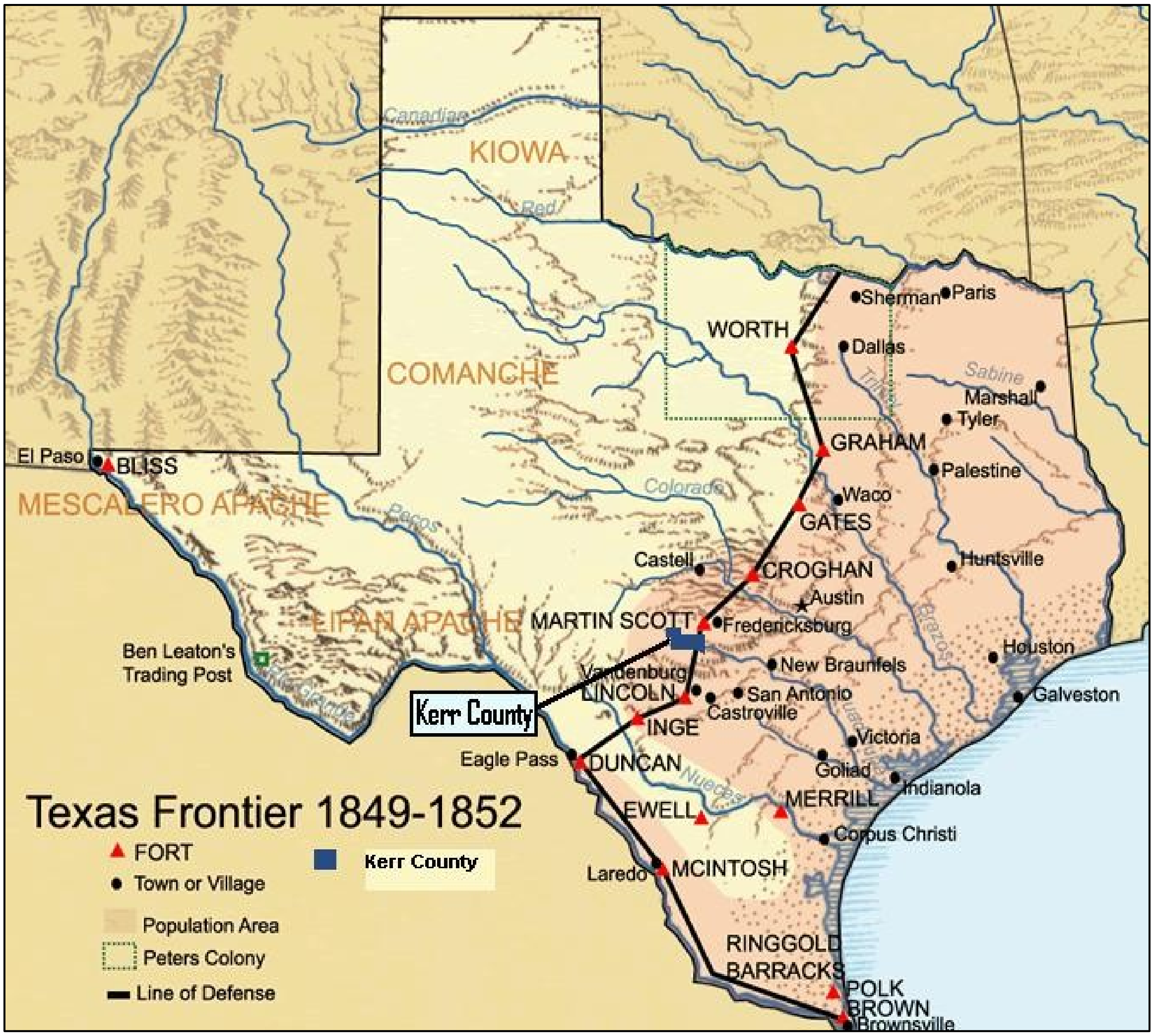


**Figure 3. Location of Military Forts Along the Texas Frontier.** General extent of Anglo occupations at the time of initial settlement in Kerr County. Original Figure provided with permission from Texas Beyond History, Texas Archeological Research Laboratory, University of Texas at Austin 2010.

## Anglo Settlement of Kerr County

Prior to Kerr County's initial Anglo settlement in 1846, Texas had slowly gained in Anglo population. In the late 18th and early 19th centuries, large land grants were provided to Anglo settlers by the Spanish, and later Mexican, governments as incentives to populate and provide economic development along the isolated frontier. This practice was continued by the Texas Republic and after its annexation by the United States in 1845 (Bender 1935; Nance 2009). Kerr County stood on the edge of this Anglo settlement well into the mid 19th century and was originally within the vast boundary of Bexar County (Figure 4). The isolation and relativly sparse population of the area was largely due to ongoing hostilities between early settlers and nomadic indigenous tribes such as the Comanches and Apaches (Jordan 1966; 1969, 34; Wilhelm 1968, 34).

The first Anglo resident of Kerr County is widely accepted as Joshua D. Brown who in 1846 established a shingle-making camp along the Guadalupe River at the present site of Kerrville (Batson 1928: Watkins 1975, 3; Odintz 2009). Joshua Brown was born in Kentucky in 1816 to Edward and Janey Campbell Brown (Watkins 1975, 1). Brown's interested in shingle making began while working in the trade at a shingle making camp in Kendall County. Shingle making at this time was made by sawing wet logs into blocks, hand riving the blocks with a froe, and finishing them with a hand knife (Watkins 1975, 3). Due to a lack of Cypress Trees at the camp, Brown soon began exploring other locations for a growth of trees and a good campsite. Through word of mouth, Brown heard of the abundance of Cypress Trees along the upper reaches of the Guadalupe River and began exploring the area then known as Bexar County which would later be divided

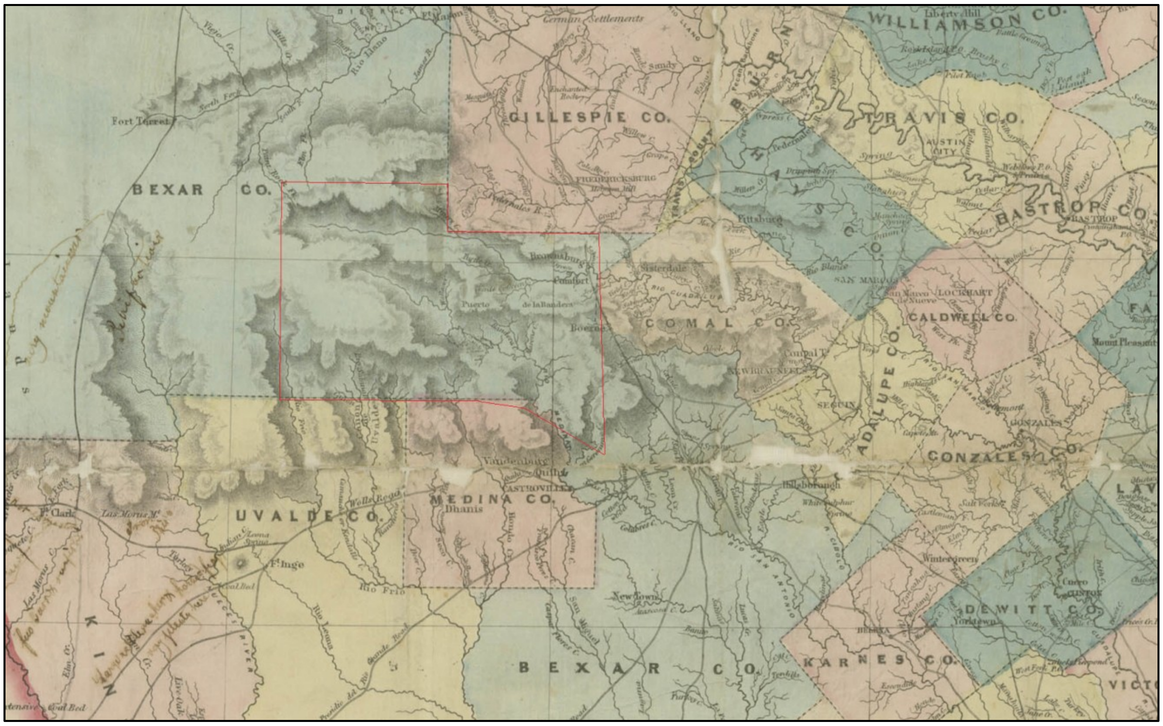


**Figure 4. 1850 Map of Kerr County, Texas.** Early 1850 map of Texas before the creation of Kerr County out of Bexar County. The approximate boundaries of Kerr County are in red (Texas General Land Office).

into what was to become Kerr County. Upon finding a suitable camp spot with ample trees along the river, Brown returned to Gonzalez and recruited 10 men and their families to join him in what was to become Kerr County (Watkins 1975, 3).

Brown's initial camp was only occupied for a few months until the Apache presence in the area became troublesome and Brown and his men were driven from the area. In 1848 Brown and his followers returned. This time they remained, naming their settlement Brownsborough, which later became Kerrville in 1849 (Watkins 1975, 3). A number of settlers followed, establishing sawmills and farms along the river and various streams.

The first settlers led by Brown continued to have several altercations with Native Americans in the area. This led to the United States Army establishing a post at Camp Verde in southern Kerr County. The presence of the Army led to a decline in these altercations and settlers began to move into the area, establishing saw mills and farms (Odintz 2009). Many of these early settlers came to the county from the southeast, while a substantial number of German immigrants moved from the settlements at Fredericksburg and New Braunfels (Odintz 2009). Kerr County was officially formed on January 26, 1856, from Bexar Land District No. 2 with Kerrville as the county seat (Watkins 1975, 8). Kerrville, which was originally named Brownsboro, was named by Joshua Brown after his friend and fellow veteran of the Texas Revolution, Major James Kerr (Odintz 2009). Two years later the county was divided establishing adjacent Kendall County. The majority of the early counties economy was in cattle and sheep ranching, with only 2,201 acres of farmland were devoted to crops (Odintz 2009).

The success of Kerrville and the whole county in general can be linked to the success of two enterprising ventures. This included the starting of a large grist and saw mill in 1857 by Germans Christian Dietert, a master miller, and Bathasar Lich, a millwright (Watkins 1975, 7; Lich 2010a). The grist and saw mill was located on a bluff overlooking the Guadalupe River in current day Kerrville. The mills location was protected from the many floods associated with the river and became the most successful operation of its kind west of New Braunfels and San Antonio (Watkins 1975, 7; Lich 2010a). The Charles Schreiner family quickly jumped on the success of the mill operation and began a number of related mercantile and freighting enterprises (Watkins 1975, 23-40, 201-209; Lich 2010a). This led to the eventual Schreiner family empire of retail, wholesale, banking, ranching, marketing and brokering operations, which became the "…the catalyst of Kerrville's and the area's early prosperity and growth (Lich 2010a, 1)".

## The Civil War and Kerr County

At the time of the onset of the Civil War, the population in Kerr County was 585 (Jordan 1966, 119-125; Odintz 2009). The population was almost equally split between upper south transplants, mostly from Tennessee, and a substantial numbers of German immigrants from the settlements at Fredericksburg and New Braunfels. While most of the German settlers were opposed to leaving the Union, the majority of Anglo settlers favored secession. So in 1861, the county narrowly voted in favor of secession 76 to 57. A large portion of Unionists in Kerr County helped in the formation of the Union Loyal League in the summer of 1861. The Union Loyal League was a militia formed of Unionist from Kerr, Gillespie, and Kendall counties to protect frontier families from

Indians raids and local Confederate forces (Lich 2010b). As tensions increased during the summer of 1862, the Unionists in Kerr, Gillespie, and Kendall counties were declared to be in rebellion against the Confederacy and state of Texas. As Confederate forces moved into the area with orders to suppress the rebellion, a party of unionists made up of mostly German immigrants headed south to seek asylum in Mexico (Handbook of Texas Online 2010; Watkins 1975, 70, Jordan 1966, 184-185). The unionists were intercepted by Confederate forces on the morning of August 10, 1862 in Kinney County at the Battle of the Nueces. Twenty-eight of the 61 to 68 unionist were killed with most escaping temporarily to Mexico or California (Handbook of Texas Online 2010; Watkins 1975, 70-71). Other Kerr County citizens were imprisoned or killed during the suppression of Unionism in the county (Watkins 1975, 69; Odintz 2009).

## Kerr County's Growing Economy

The number of farms and ranches more than doubled between 1860 and 1870, then doubled again during the 1870s to reach 289 in 1880. At the same time the county's population increased to 1,042 in 1870 and 2,108 in 1880. Cattle and sheep ranching dominated the local economy, and wheat and corn were the most important crops (Odintz 2009). In the decade of the 1870s sheep ranching developed dramatically as the number of sheep more than tripled to reach 15,504 in 1880. The continued economic success saw the county surpass many of its neighbors economically and became a regional transportation, banking and medical center for the western Hill Country and Edwards Plateau (Odintz 2009).

# CHAPTER 3

# METHODOLOGY

The following section outlines the methodology used in determining if a predictive model can adequately identify the location of historic cultural sites based on landscape data. This includes the determination of landscape criteria by summarizing previous studies utilizing this data, the method of mapping the high probability areas by using a GIS, and outlining the historical accounts, maps, and records from the investigated time period that were used in comparing the historical settlement locations with the high probability areas.

## Previous Predictive Models

Ideally, to determine the significant environmental variables used in an archeological predictive model, a wide range of environmental and landscape data would be used. This would provide a large sample of independent (predictor) variables in order to determine the dependent variables (site location probability). However, this thesis investigates the results of predictive models often used by the CRM industry. These models are often limited by budget constraints and limitations in access to data. Therefore, in order to simulate popular predictive models used by the CRM industry, the landscape data is limited to easily accessible data that has been used by previous predictive models.

The determination of landscape data was derived from studies that have used forms of popular predictive models using a GIS such as Campbell and Johnson's (2004) tested predictive model in portions of Fort Hood, Texas, Westcott and Kuiper's (2000, 59-72) prehistoric site distribution investigation in the Aberdeen Proving Ground along the Upper Chesapeake Bay in Maryland, Warren and Asch's (2000) archeological site location study in central Illinois, Duncan and Beckman's (2000) site location models within Pennsylvania and West Virginia, and Campbell's (2006) archaeological predictive model of southwest Kansas. All of these models are based on Kvamme's (1981, 1983) methodology for determining settlement patterns of prehistoric sites in Colorado. The basic primary predictive data utilized in these previous studies consisted of soils, geological parent material, topographical relief and slope, and proximity to water in determining high probability areas for site locations from random (non-site) locations.

## Creating a Predictive Model Using a GIS

The basic outline of creating a predictive model is outlined by Duncan and Beckman (2000) in their creation of predictive models within four areas of Pennsylvania and West Virginia. The steps consist of:

1. Collection of primary data sets.

2. Derivation of secondary data sets (landscape criteria).

3. Sampling of environmental (landscape) variables from site locations and random background samples.

4. Exploration and (univariate) statistical analysis of the two populations.

5. Implementing logistic regression analysis to determine significant secondary data sets (landscape criteria).

6. Creation of model formula using a weighted sum of the significant variables.

7. The creation of the predictive surface from the formula.

(Duncan and Beckman 2000, 36)

A benefit of exploratory spatial analysis using a GIS is the ability to sort through vast quantities of spatial data in a relatively short timeframe to uncover possible patterns that do not present themselves when investigating factors individually. In this way, the use of the GIS simulates the tools used by the CRM industry. This application has the unique ability to create, store, analyze, and distribute data in a spatial environment (Wilder 2008, 28). Therefore, this thesis utilized common applications of a GIS in order to conduct exploratory spatial analysis of high probability areas for cultural resources in Kerr County. Exploratory spatial analysis is a method of searching out spatial patterns in complex geographical datasets (Wilder 2008, 28).

To begin the model creation, the primary landscape data was obtained from publicly available GIS data in the form of shapefiles and Digital Elevation Models (DEMs). The secondary data sets were then created from the obtained data in order to represent the site location dependent variable and the landscape criteria for the model. Table 1 outlines the GIS data type, the secondary data derived from the primary GIS data, and their source. Figure 5 is a generalized flow chart that displays the creation of the database from the primary data to GIS layers. The methodology on the creation of the database was derived from the methodology used for the predictive model of Cows Creek Drainage at Fort Hood, Texas by Campbell and Johnson (2004, 9-13).

The USGS DEM is the basic unit of analysis with a $30m^2$ pixel size used as the standard raster grid cell size for the model (Campbell and Johnson 2004, 12). The DEM was used to calculate the slope and relief (Figure 6). Slope was created using the ESRI's Spatial Analyst extension for ArcGIS. The relief was generated using "focal (neighborhood) functions using the Raster Calculator within Spatial Analyst" Campbell (2006, 54). Similar to Campbell's (2006, 54) study, relief was calculated by determining the range of elevation values (range = maximum – minimum value) within the $30m^2$ neighborhood area.

The water data were subdivided into rivers and creeks (Figure 7). Using the Spatial Analyst function of ArcGIS, the individual parcels were calculated for distance to nearest river and creek. The calculations for the distance to rivers and creeks data was calculated into two categories representing the waterway type (e.g. Distance to River, Distance to Creek). This distinction was similar to the stream and permanent stream distinction used in Warren and Asch's (2000, 14) model.

The soils and geology variables were modified to identify characteristics relevant to the current study similar to categories used in previous study areas. This investigation expanded on the soils of Kerr County and their parent material (geological) by analyzing United States Department of Agriculture's Soil Survey of Kerr County, Texas soil data

**Table 1. GIS Data for Predicitive Model**

| Data Type | Variable Used | Source |
|---|---|---|
| Digital Elevation Model | Slope | USGS |
| | Relief | |
| | Shelter Index | |
| General Soils Map | Soil Landform | USDA NRCS |
| | Surface Runoff | |
| Geology Map | Geologic Parent Material | UT Bureau of Economic Geology |
| Hydrography Data Set | Distance to major waterway | USGS |
| | Distance to minor waterway | |

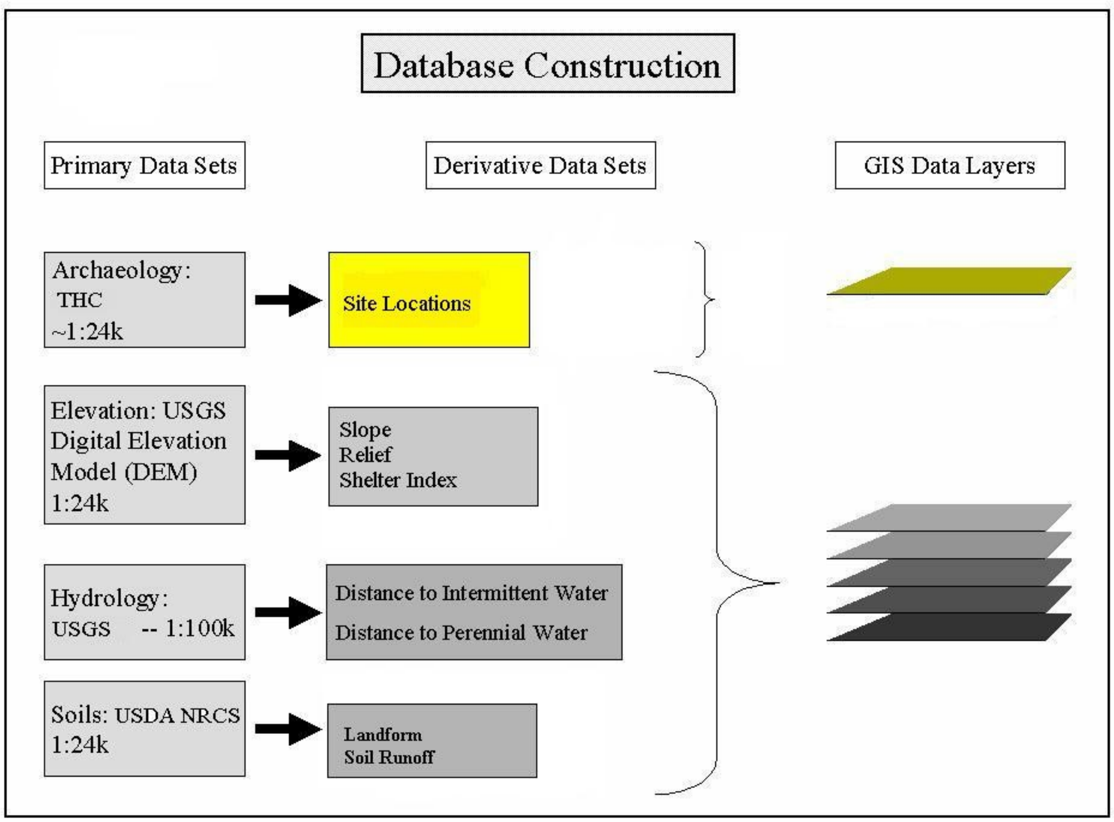


**Figure 5. GIS Data for Predictive Model.** Flow chart displaying the creation of the database from the primary data to GIS layers (Based on Campbell 2006, fig. 4.2).

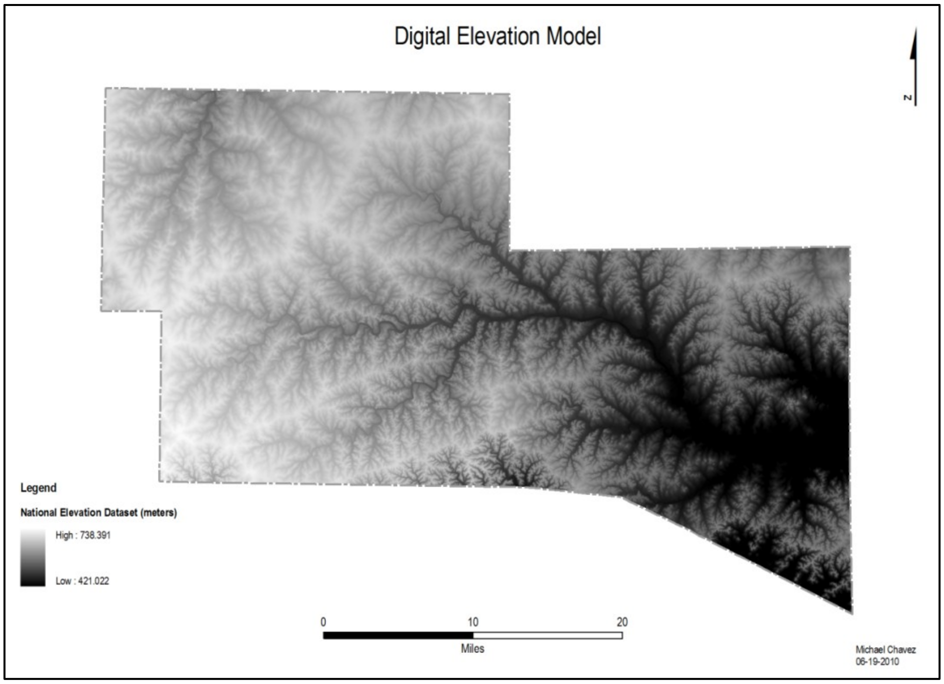


**Figure 6. Digital Elevation Model of Kerr County.**

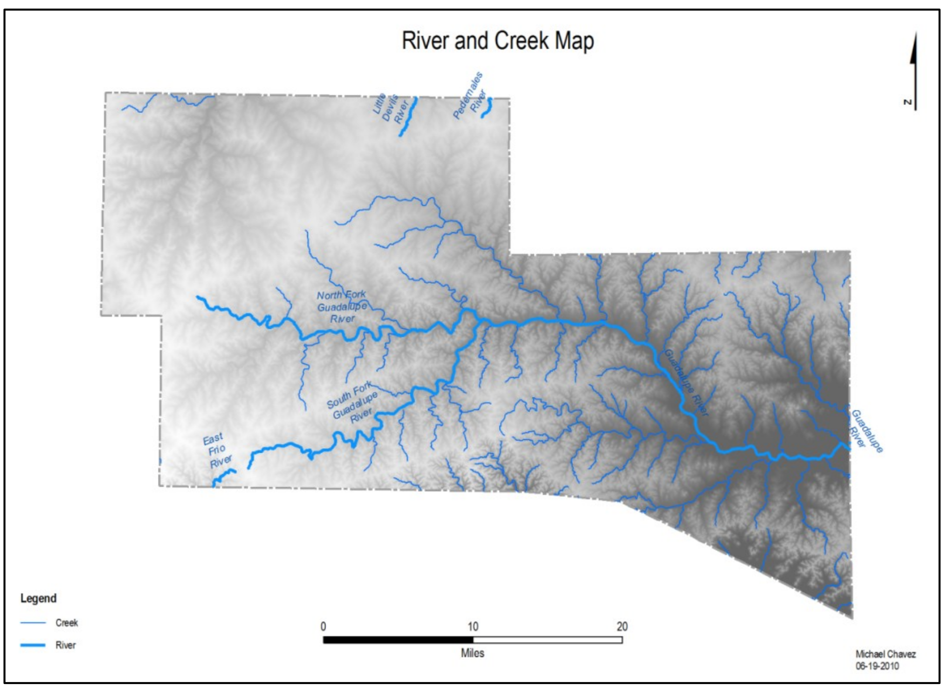


**Figure 7. River and Creek Locations Throughout Kerr County.**

and the Bureau of Economic Geology's Geologic Atlas of Texas, Llano Sheet geology map (Barnes 1983; Dittmore and Coburn 1986). The soil data were analyzed to determine landform similar to Roy, Domon, and Paquette (2002, 145) in determining "best farmland available". In the current study, the soils were categorized into floodplains, uplands, and indeterminate (Figure 8). Floodplains represent fluvial deposits of clays and loams based on the county soil data. These soils tend to lay adjacent to major waterways which provide the ideal conditions for farming activities from low energy soil deposits (such as loams and clays) and proximity to water for irrigation. Uplands, for the sake of this investigation, consist of non-fluvial upland soils which often consist of shallow soil deposits or exposed limestone bedrock. The last category, labeled indeterminate, incorporated those conditions that do not fit into the previous two categories. However, none of the sites fell into the indeterminate soil category.

The geologic conditions were analyzed in the same manner with locations categorized into alluvium, terrace deposits, and shallow limestone (Figure 9). The alluvium deposits were identified as alluvium on the geologic maps while the terrace deposits included the mapped "low terrace deposits" and the "fluviatile terrace deposits" and the remaining mapped limestone types were combined into the shallow limestone category. Because of Kerr County's location on the southern end of the Edwards Plateau, the uplands and shallow limestone deposits conditions dominate the county. Ordinal categories were determined for the soil and geologic data based on the deductive probability of site preference throughout Kerr County.

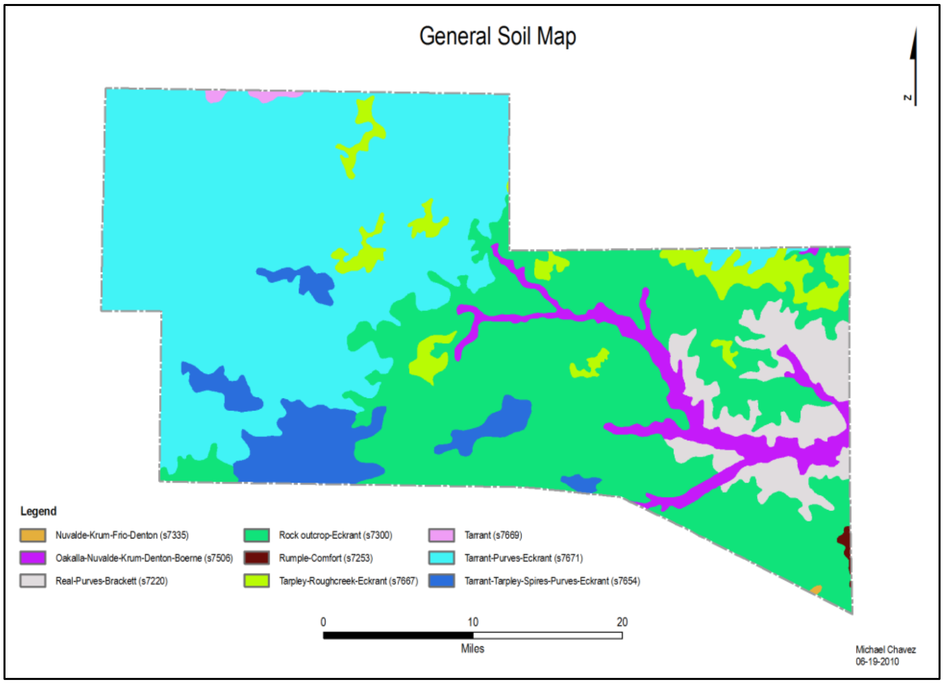


**Figure 8. General Soil Map of Kerr County.**

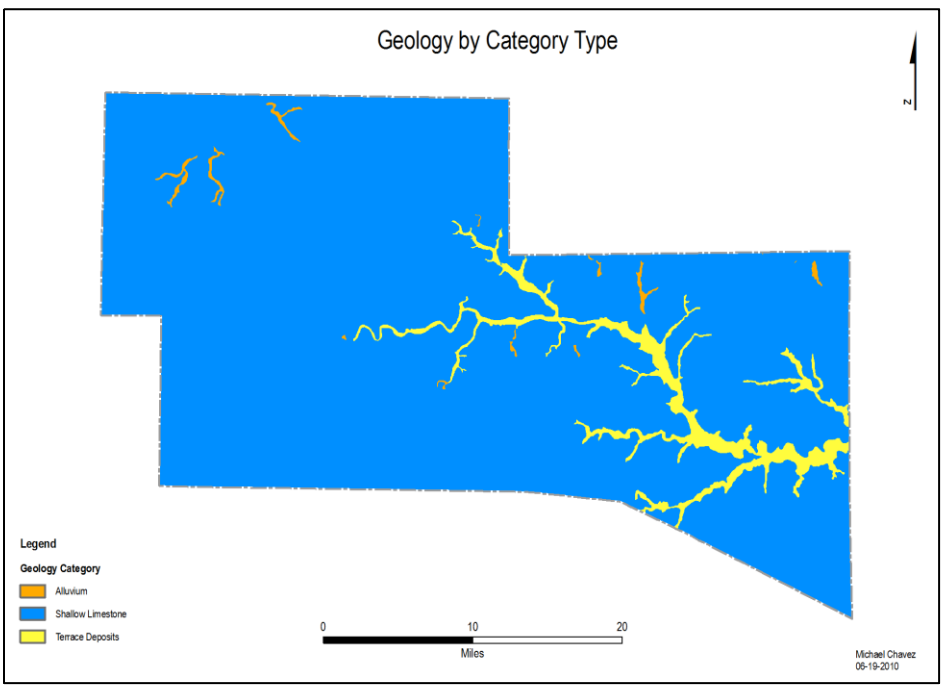


**Figure 9. Geology Map of Kerr County by Category Type.**

In determining a proper sample of recorded site locations, this thesis was constrained by a typical example of limitations on predictive models. The data available on previously recorded sites in Kerr County are maintained by the Texas Historical Commission (2010) through the Texas Archeological Sites Atlas. Site data are readily available for use by the professional archeological community and academia. However, site location data are heavily protected due to the threat of illegal site looting and pillaging. Therefore, previous site location data for Kerr County is protected by applicable state and federal laws and regulations (§191.004 Texas Natural Resources Code (VTCA 1995), §191.132 Texas Natural Resources Code (VTCA 1995), §191.133 Texas Natural Resources Code (VTCA 1995), Federal Regulation 36-CFR-800, and the Archeological Resources Protection Act of 1979, 16 USC §470aa et. seq.). The location data were obtained from the THC archeology site atlas (a secure site) and due to the sensitive nature of the data, detailed locations of archaeological sites are not provided in this investigation. However, the predictive model output was derived from the point specific site location data provided by the Atlas to derive the high probability areas in the model.

A total of 390 sites comprise the sample size of previously recorded sites and 390 random locations representing non-site locations were utilized to determine the significant environmental predictor variables applicable to Kerr County in determining the high probability areas for archeological resources in Kerr County (Figure 10). The random site locations were generated using the random point generator function in ArcGIS. A critical concern regarding the non-site selections relates to the assuming of a non-site to actually be a non-site (Campbell 2006, 49). The problem with non-site location random generation was addressed by Kvamme (1992, 19-32) in earlier model developments.

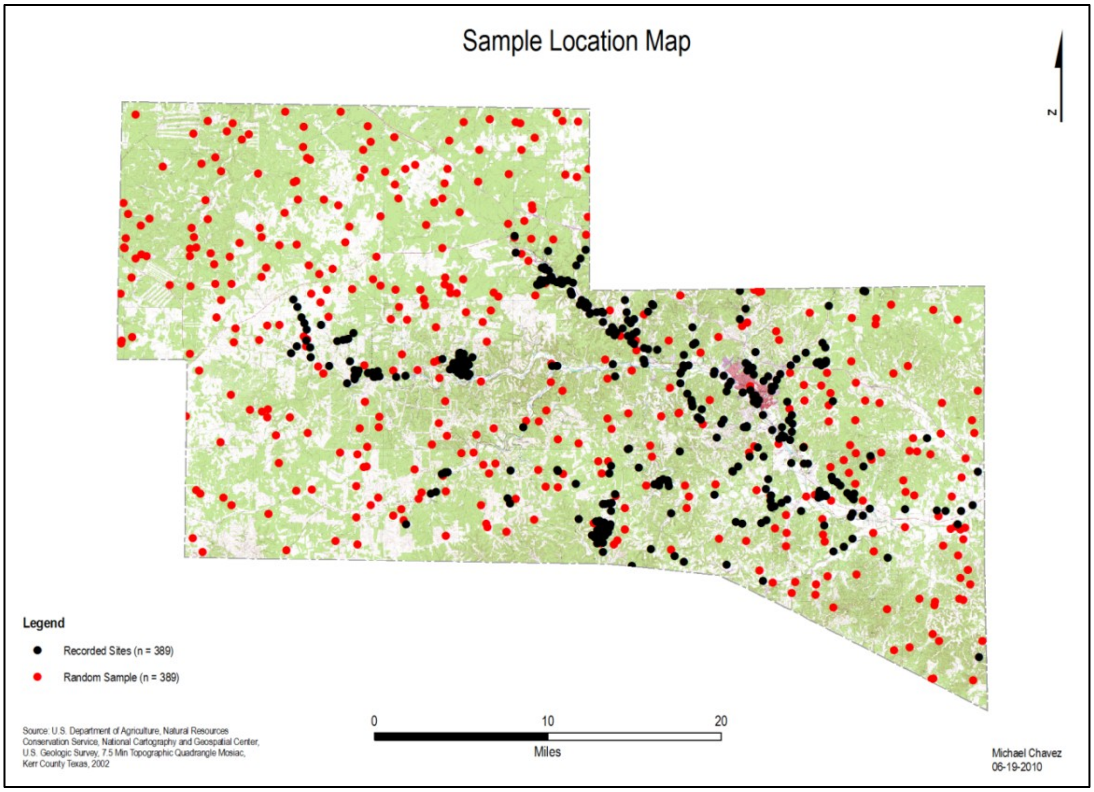


**Figure 10. Recorded Sites and Random Sample Location Map.**

This problem concerns the assumption that the non-site samples are in fact non-site locations. The inherent problem with this assumption is that it is impossible to know whether a non-site is actually a non-site without an archeological field survey (Campbell and Johnson 2004, 10). However, Kvamme (1992, 19-32) justifies the use of the non-site data due to the assumption that "….archaeological sites are rare events and because of the low density of sites on the landscape, most likely a randomly generated non-site is in fact a non-site (Campbell 2006, 49)". This reasoning has been subsequently used by several predictive models since.

The determination of significant variables was accomplished by using logistic regression analysis (Kvamme 1988, 325-428). Logistic regression allows for analysis of a dependent variable by predictive variables with a binary outcome such as site present or site not present. Logistic regression allows for the determination of a relationship between predictor variables (landscape criteria) and an outcome variable (cultural site) by estimating a probability that the phenomena will occur (Madry, Cole, and Seibel 2005). Like Campbell and Johnson (2006, 15), this model utilized a backward, step-wise binary logistic regression through SPSS to determine the significant landscape variables. The SPSS equation output was applied to all parcels throughout Kerr County using GIS methods referred to as 'Map Algebra' or 'Cartographic Modeling' (Tomlin 1990). The equations was re-entered to the GIS using the Raster Calculator tool within Spatial Analyst (Campbell 2006, 54). The resulting probability map is a "…a decision surface of continuous data values containing the probability score for each land parcel in the study area (Campbell 2006, 62)."

## Historical Records Comparison

In order to test the accuracy of the high probability areas outlined from the model above, the areas were compared to historical parcel maps, historical literature, and to Kerr County land records. The parcel maps offered a comparative of the high probability areas outlined in the predictive model with the location of historic parcels within the time period in question. The historic parcel maps of Kerr County from circa 1855 and circa 1873 were obtained from the General Land Office (Figures 11 and 12) in digital TIFF image format. The 1855 map does not have a definite date; however, the map is an earlier base map of the later 1873 map and an additional map from 1864. Based on the amount of tracts outlined and the variation from the 1864 map, the earlier map is likely from between 1855 to 1860. Although maps of Kerr County from the investigated time period are rare, the two maps display sufficient variation in settlement throughout the county from the early portion of the investigated time period through the later portion of the investigated time period. As this variation displays the actual settlement trends for the county, the map has sufficient data to be utilized in determining the accuracy of the high probability areas outlined by the predictive model.

The earlier historic map was geo-referenced to the modern Kerr County political boundaries layer in the GIS. Geo-referencing in a GIS environment is often used by historians to spatially analyze the context of historic maps with other spatial feature data (Knowles 2002, vii-x; 2005, 2). Basically the process coordinates selected control points on a scan of an original map with their actual geographical location thereby allowing the map features to be geo-referenced. Due to the differences in the historic and modern boundaries, the spatial accuracy should be considered approximate. Next, polygon

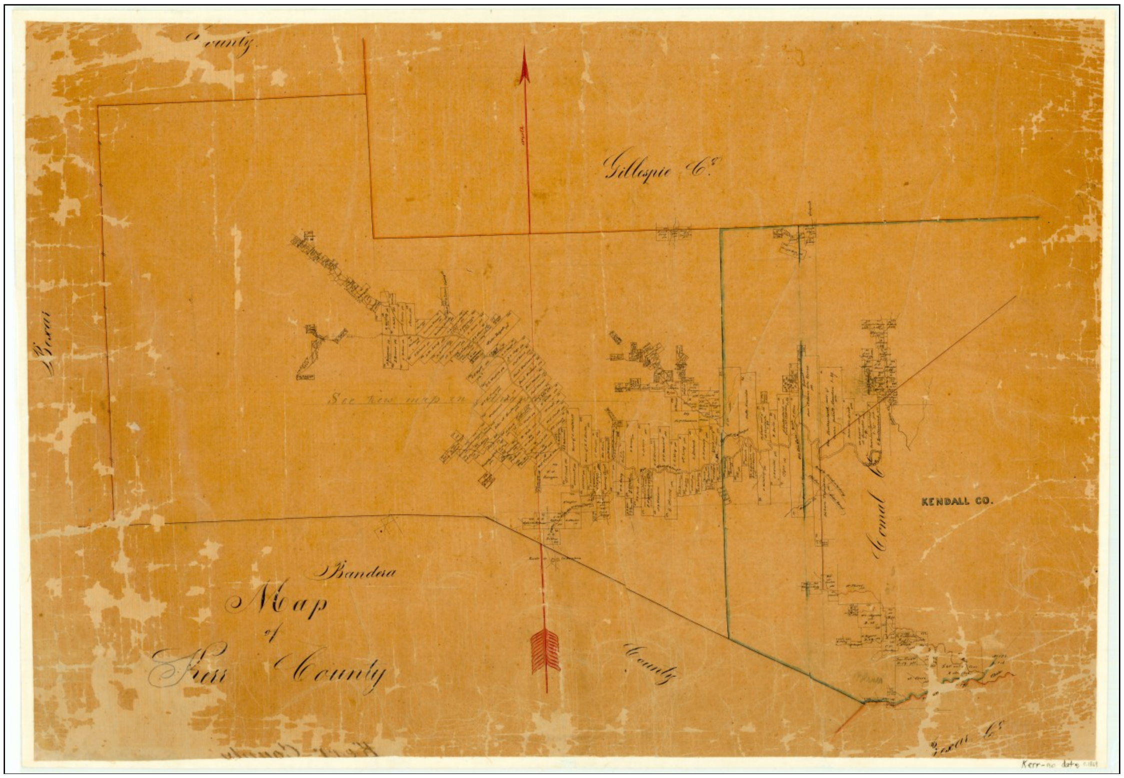


**Figure 11. Historic Map of Kerr County circa 1855 (Texas General Land Office).**

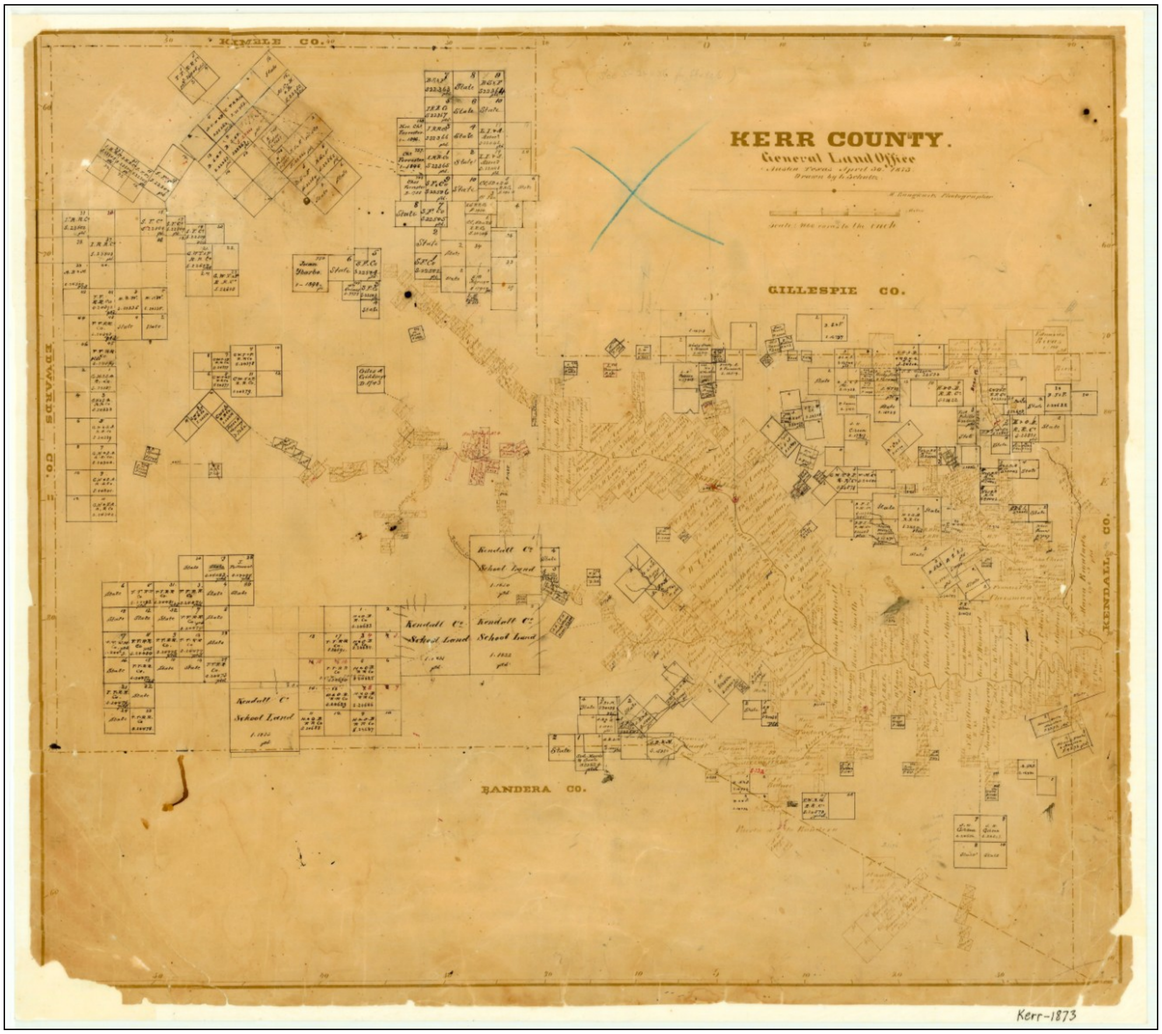


**Figure 12. Historic Map of Kerr County circa 1873 (Texas General Land Office).**

features were created from the displayed parcels from the early historical map. Although the maps provide an approximation of actual settlement locations, for the sake of this investigation and to the scale that a county wide predictive model produces, the approximation allowed for an overview of settlement locations as compared to the predictive model.

In order to test the model at a smaller scale, historic locations derived from the THC's online Texas Historic Sites Atlas (Atlas) were compared to the high probability area on the predictive map. The historical atlas lists national register properties, historical markers, cemeteries, museums, military sites, sawmills, and historic county courthouses (THC 2010). The Atlas provided 150 historic locations throughout Kerr County. Each of these locations was reviewed to determine if settlement or cultural location can be derived from the record. In addition, the locations were reviewed for temporal relation to the investigated time period. A total of 19 of the 150 locations were associated with the investigated time period (Table 2).

The qualitative examination of the environmental variables included a look at the environmental conditions during initial settlement from historical accounts and paleoenvironmental patterning studies to determine if and how the local weather and climate of the region played a part (a variable) in the county's settlement. This included evidence of catastrophic flood events and their role in the settlement of a region. Such events are often not accounted for in environmental settlement models.

To identify the cultural and economic influences of the county, numerous resources were utilized. The majority of this information was derived from historical accounts of the

| **Table 2. Historic Locations.**<br>Historic location in Kerr County during the investigate time period as recognized by the THC Atlas | |
|---|---|
| **Historical Marker Name** | **High Probability Area** |
| Camp Verde | Yes |
| Center Point United Methodist Church | Yes |
| Cypress Creek School | Yes |
| Dietert, Christian | Yes |
| Dowdy, The Tragedy of 1878 | Yes |
| First School House | **Yes (originally)** |
| Ingram | Yes |
| Kerrville | Yes |
| Mary Ann Kent Byas Chambers Morriss | Yes |
| Remount Station | **Yes (originally)** |
| Roggenbucke Homestead | Yes |
| Schreiner, Captain Charles | Yes |
| Sherman's Mill | Yes |
| Tivy, Captain Joseph A. | Yes |
| Turtle Creek School and Cemetery | Yes |
| Woolls Building | Yes |
| Woolls Building | Yes |
| Y.O. Ranch | **No** |
| Zanzenberg | Yes |

time period such as the Kerr County history chronicled by Bennett (1956) and Watkins (1975) as well as the works of Jordan (1966) and Wilhelm (1968) that draw upon the vast amounts of records on the German populace during the 19th Century to provide early historical accounts of central Texas and the “Hill Country”. These historical accounts are summarized in Chapter 4 and further analyzed for their relation to the historic settlement locations. This was analyzed under the assumption of central place theory of settlement (introduced by Christaller in 1933), in order to determine the cause or the resources that were the driving force behind continued settlement and expansion in the county (Vance 1970, 2-10). These factors included the local economy, cultural affiliations, and socioeconomic status with relation to opportunity.

# CHAPTER 4

# RESULTS OF GIS PREDICTIVE MODEL

The six predictor variables (soils, geology, relief, slope, distance to river, and distance to creek) were entered into the SPSS logistic regression analysis. The analysis determined that relief, distance to river, and distance to creek are the only three variables that were determined significant in determining the location of archeological sites. The use of backward stepwise logistic regression analysis was favorable due to the approach involving using all the predictor variables and testing them one by one for statistical significance, deleting any that are not significant. In this way, the three variables were determined to give a 71.6 percent success rate in determining the presence or non-presence of archeological sites at any given location within Kerr County. Therefore, this success rate gives a higher probability of determining site location than chance alone. In order to investigate the use of the correct variables in the formula, a forward step-wise logistic regression analysis was also conducted with the six predictor variables. The forward step-wise analysis enters the predictor variables one at a time until the significance of the variables on the dependent variable is no longer improving significance of the predictors.

The logistic regression formula was then entered into the GIS application using the Raster Calculator function. The output map provides a surface depiction of the high-to-low probability areas throughout Kerr County (Figure 13). An observation of the output

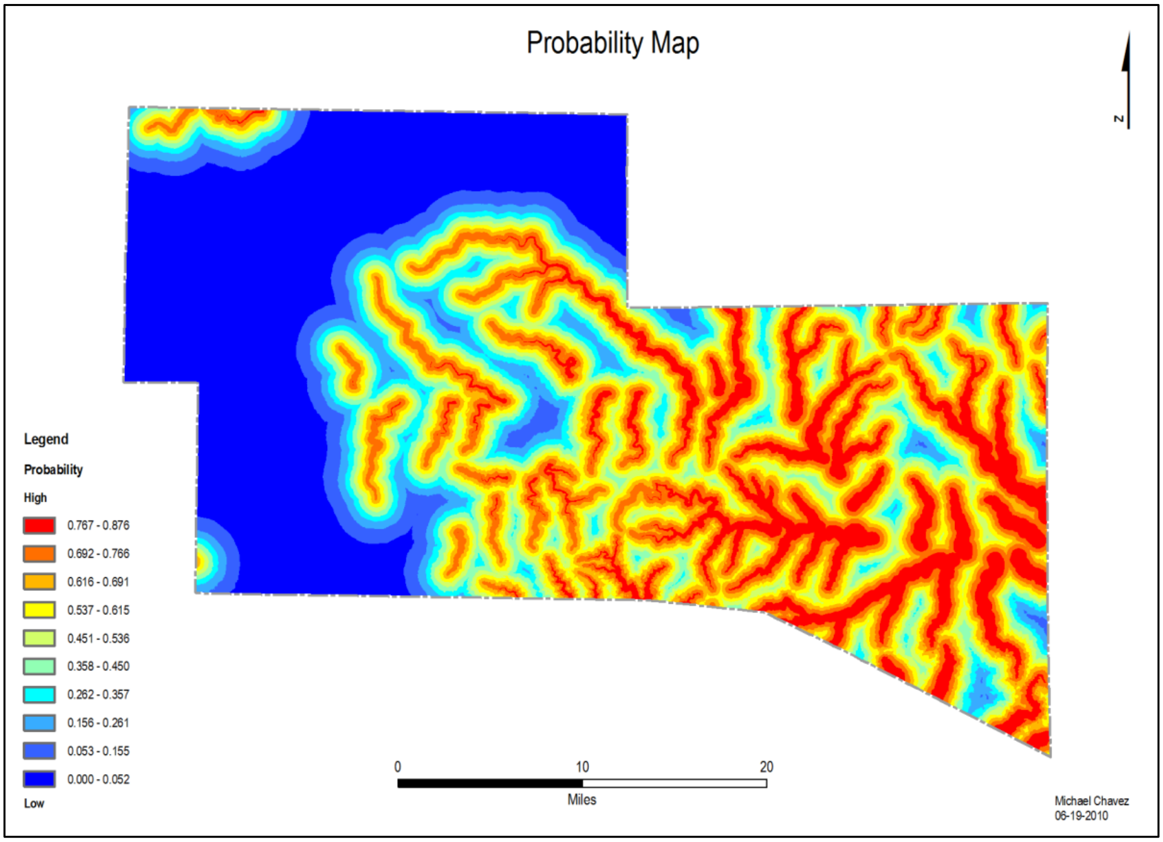


**Figure 13. Archeological Predictive Probability Map of Kerr County.**

map shows a tendency for the location of high probability areas towards the eastern portion of the site. In addition, the output shows a general concentration of high probability areas adjacent to waterways.

It should be noted that stepwise regression is used in the exploratory phase of research or for purposes of pure prediction, not theory testing (Garson 2010). Garson (2010) notes that any theoretical justification should be conducted during the selection of variables portion of the research. Menard (1995, 54) writes, "there appears to be general agreement that the use of computer-controlled stepwise procedures to select variables is inappropriate for theory testing because it capitalizes on random variations in the data and produces results that tend to be idosyncratic and difficult to replicate in any sample other than the sample in which they were originally obtained."

# CHAPTER 5

## RESULTS OF COMPARISON BETWEEN MODEL AND HISTORICAL RECORD

The archeological predictive model was able to provide a predictive surface or map of the high probability areas of archeological sites in Kerr County (see Figure 13). The recorded site locations were overlaid on the GIS archeological predictive model to determine if the sites generally agreed with the high probability areas throughout Kerr County (Figure 14). This output can be utilized solely as a determination that the predictive model used the correct values in the predictor variable to determine high probability areas and not as a way of justifying the results of the model. This is because the site locations were used in the creation of the model and has a direct correlation with the predictive surface output.

In order to determine the effectiveness of the predictive surface output, the high probability areas were compared to historic locations derived from the historical record to determine the accuracy of the predictive model. The visual comparison of actual historic locations as compared to the high probability areas was taken from three sources. The first source was the circa. 1855 parcel map (see Figure 11). The map provided a general overview of parcels near the beginning of the investigated time period. The georeferenced parcel layer was overlaid on the high probability map in order to compare the location of parcels in 1855 with the areas predicted to contain archeological sites (Figure 15). It is apparent that settlement concentrated near the Guadalupe River and a

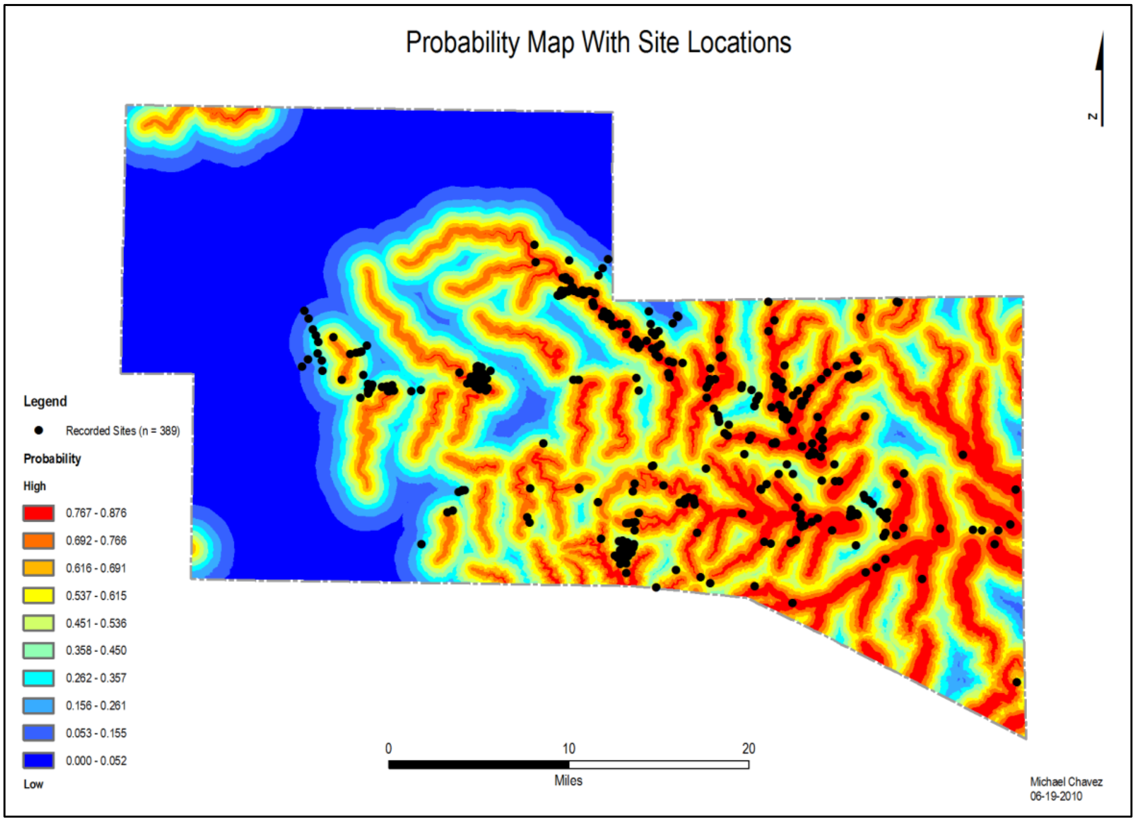


**Figure 14. Predictive Probability Map with Site locations.** Archeological Predictive Probability Map with overlayed site locations in Kerr County.

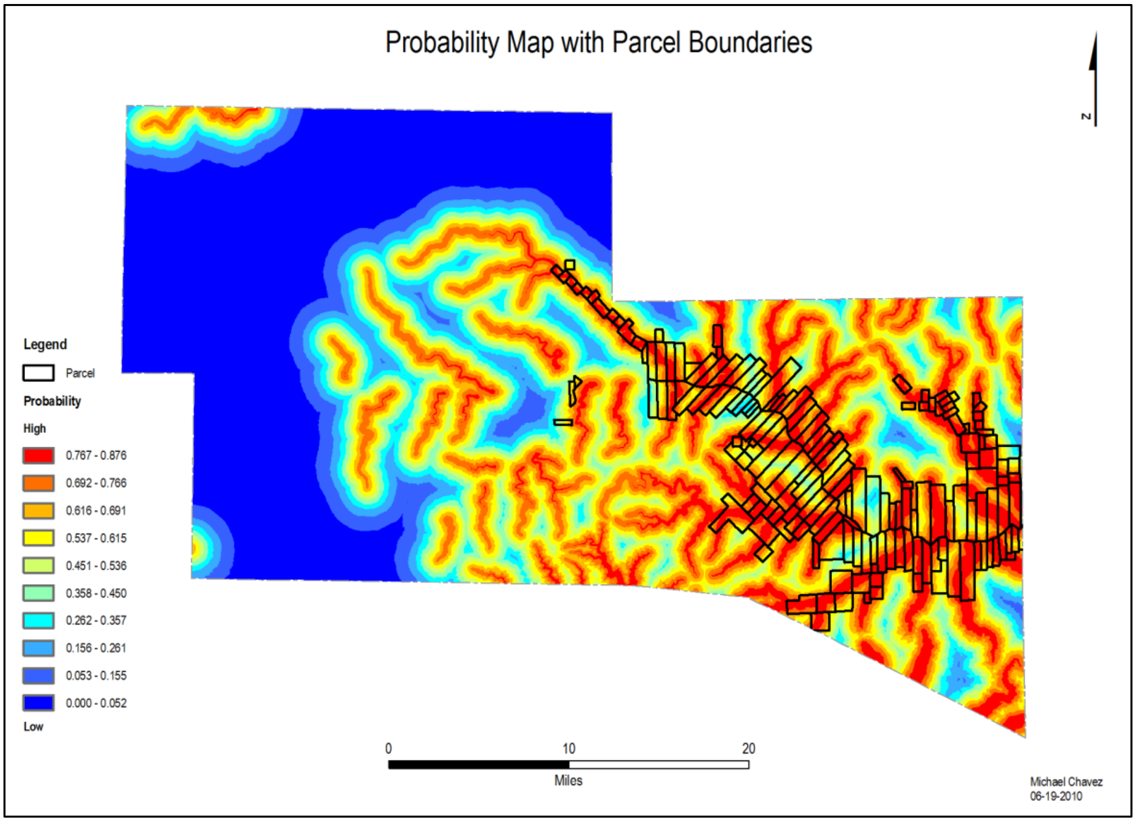


**Figure 15. Predictive Probability Map with overlaid 1855 parcels.** Map depicts the 1855 parcels overlaid on the results of the archeological predictive model.

few major tributaries especially along the eastern portion of the county. This coincided with the predictive models output of high probability areas along the Guadalupe River, Johnson Creek, and other major tributaries.

The next source was the circa 1875 map (Figure 16). This parcel map shows increased activity throughout the county due to the dramatic increase in recorded parcels especially along the western portion of the county. This was the point in Kerr County history when cattle ranching had its initial success and ranches began to develop along and near “The Divide” in central Kerr County. The divide is a strip of land, five to fifteen miles wide, that roughly marks the boundary between the now recognized Llano and Upper Guadalupe watershed (Jasinski 2010). This area became the preferred location for livestock and sheep ranching with the Hughes, Dietert, Klein, and Y.O. Ranches located in the area (Jasinski 2010). The 1873 historic map shows several new parcels in this area especially along the western county boundary. The predictive model shows a low probability for archeological sites in the portion of the county that includes “The Divide”. Therefore, “The Divide” and several successful ranches in the area are not reflected as a high probability area on the map.

The third source for a visual comparison was location of the 19 historical markers as depicted on the publically available THC Historic Sites Atlas (Figure 17). The historic atlas output map shows that the majority of locations are clustered towards the center and eastern portions of the county in the high probability areas depicted on the predictive model output. The majority of these historic locations are headquartered within or adjacent to Kerrville. This is understandable as Kerrville is the site of the first Anglo

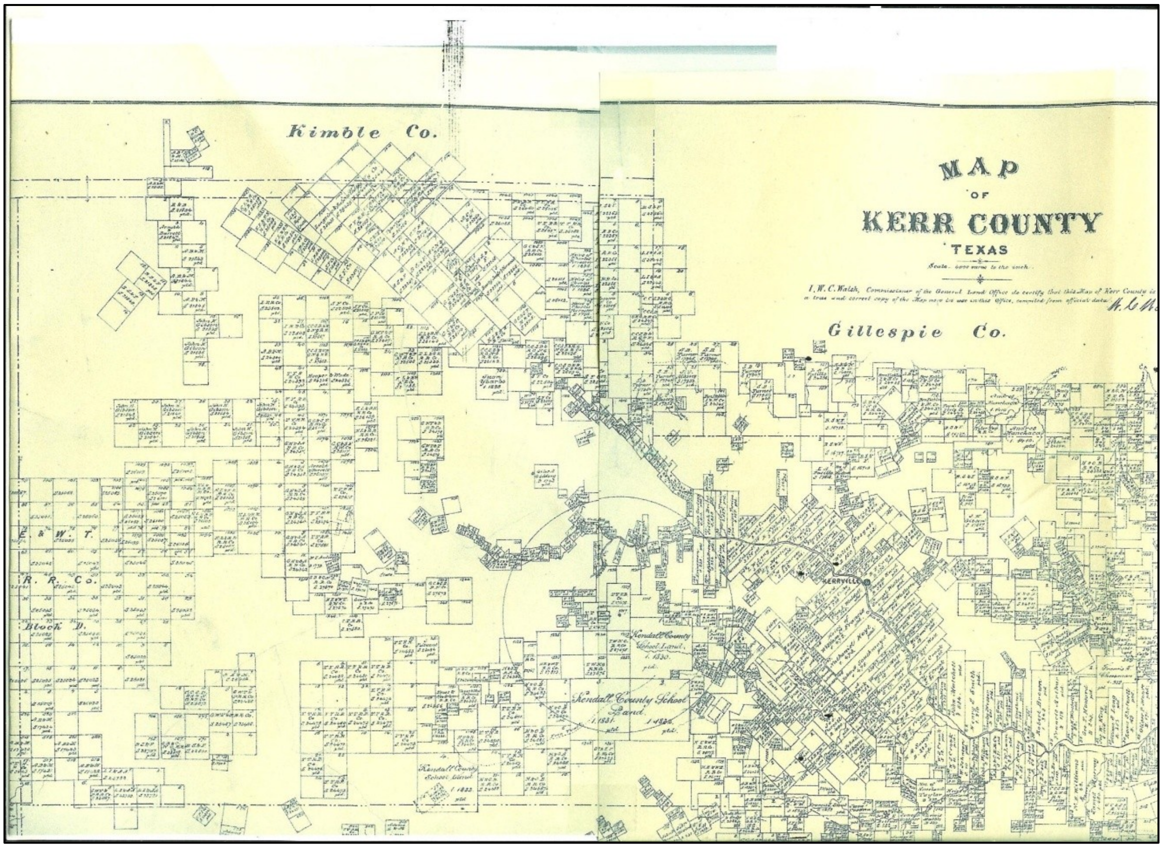


**Figure 16. Map of Parcel Locations in Kerr County circa 1873.**

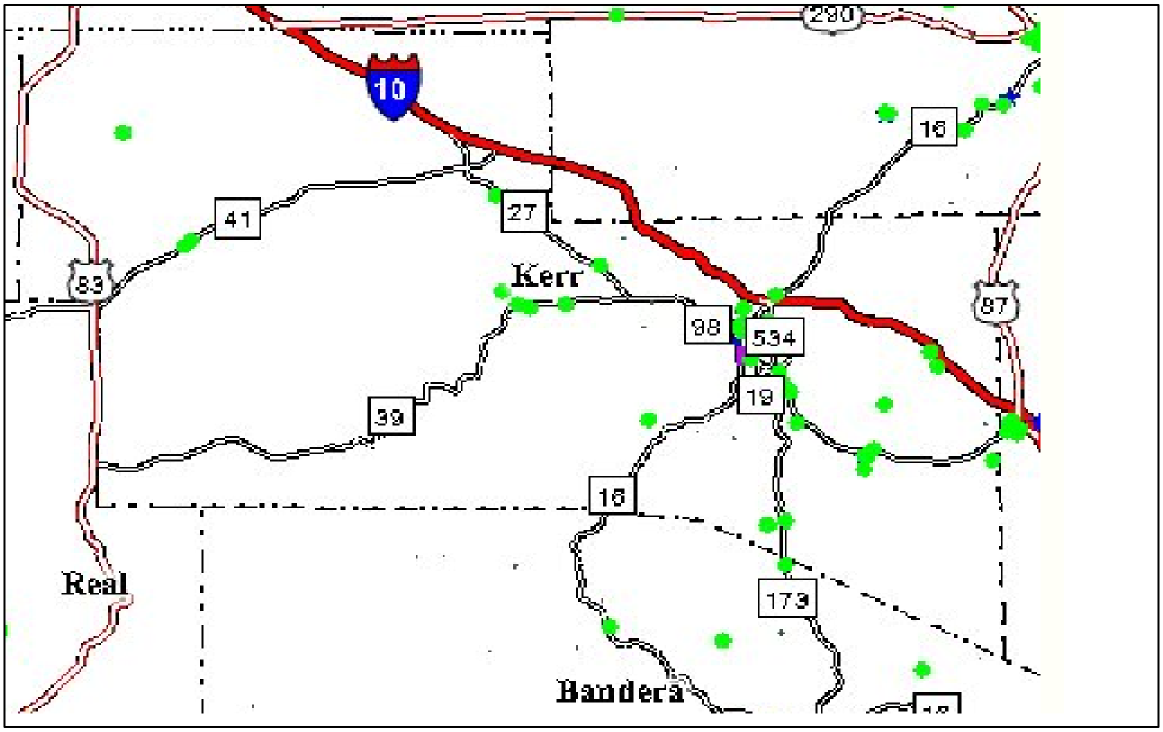


**Figure 17. Historical Marker Locations in Kerr County.** Historical markers of activities and/or structures that originated from the investigated time period (THC Historic Sites Atlas).

settlement in the county and the center of commerce, which is the same in modern times. However, three locations are located towards the western portion of the county outside of the high probability areas. These locations are the First School House, the Remount Station, and the Y.O. Ranch (Table 3). The Y.O. Ranch played a unique role in the history of Kerr County and its future growth.

The First School House was built in 1852 by J.L. O'Conner to provide schooling for children in the Center Point area. Center Point is actually located near the eastern portion of the county within the high probability areas depicted by our predictive model. The Remount Station, which was a stagecoach stop built during the 1850s, is similar to the First School house in that it was actually constructed away from its mapped location. The Remount Station was originally constructed in Waring, Texas in Kendall County near Comfort. The cabin structure was once inhabited by a settler who provided horses for Pony Express riders, hence the name Remount Station (Historic Marker Text 1967). Both historic marker locations are in the western portion of the county because the structures were reconstructed on the grounds of the Y.O. Ranch in 1967 (Historic Marker Text 1967).

The Y.O. Ranch, located in the northwestern portion of the county, was created by Charles A. Schreiner in 1880 out of several earlier ranches in the area. Most notable of the original ranches was the Taylor-Clement Ranch and its Y.O. brand from which Charles Schreiner acquired the name. Although the Y.O. Ranch started in 1880, outside of the investigated time period, it was formed from several existing ranches that were created during the investigated time period. In addition, the Y.O. Ranch played a major

**Table 3. Texas Family Land Heritage Program Ranches**

Ranches recognized by the Texas Family Land Heritage Program as being in continuous agricultural operation by the same family for 100 years or more

| Ranch Name | Date Found | Location | High Probability Area |
|---|---|---|---|
| 5 H Dairy | 1859 | 12 miles east of Kerrville on IH-10. | Yes |
| Allerkamp Ranch | 1863 | 9 miles east of Kerrville. | Yes |
| Bartel Farm | 1875 | 12 miles southeast of Kerrville. | Yes |
| Black Bull Ranch | 1850s | 30 miles northwest of Kerrville on Highway 41. | **No** |
| Bonita Oaks | 1873 | 10.5 miles northwest of Kerrville. | Yes |
| Emilie Neill-Jeanette Boster Ranch | 1875 | 7 miles south of Kerrville. | Yes |
| Crowder Ranch | 1859 | 1 mile north of the Center Point Post Office. | Yes |
| Doebbler Ranch | 1876 | 8 miles northwest of Interstate 10. | Yes |
| Kerr-Wes Farm | 1854 | 12 miles southeast of Kerrville off of FM 1341. | Yes |
| Robert Lindner Ranch | 1875 | 5 miles southwest of Comfort. | Yes |
| Ranchos De Las Puertas | 1874 | 45 miles northwest of San Antonio. | Yes |
| Julius Real Ranch | 1875 | 7 miles southwest of Kerrville. | Yes |
| Schumacher Ranch | 1873 | 1 mile east of the Hunt Post Office. | Yes |
| Seidensticker Farm | 1861 | 1 mile north of Comfort. | Yes |
| Spenrath Farm | 1876 | 2.25 miles southwest of Comfort. | Yes |
| Henry Wellborn Ranch | 1867 | 2 miles southwest of Center Point on FM 280. | Yes |
| Y.O. Ranch (formerly Taylor-Clement) | 1880* | 16 miles west of Mountain Home. | **No** |

role in Kerr County as it represents the most successful livestock and sheep ranch in the county up to modern times. Schreiner himself was successful in many economic ventures centered on the ranch and the growing Kerrville community. Aside from ranching, Schreiner's business ventures included banking, railroad, merchandise stores, and marketing wool and mohair (Hollan 2010). Mohair is the fabric made from the hair of the Angora goat and due to Schreiner's interest, Kerrville became the leading producer of Mohair for the U.S in the late 19$^{th}$ century with the area producing 90 percent of Mohair throughout the nation (Carlson 2010).

Generally, the predictive model was able to include the vast majority of early settlements and historical locations throughout the early part of Kerr County. However, as we move further along through our investigated time period, the relationship between high probability areas depicted on our predictive model surface output map and the location of new settlements begins to differ greatly. It was between the 1860 and 1870 that the general economy in Kerr County began to diversify. This diversification meant a lesser reliance on the Guadalupe River for economic success especially with ranching taking a lead role in the financial prosperity of the county. Several ranches such as the Y.O. Ranch, Deitert Ranch, Warren Klein Ranch, and other ranches along "The Divide" in northwest Kerr County are mapped in low probability areas. "The Divide" is the strip of Edwards Plateau that serves as the dividing line between the Llano River watershed to the north and the Guadalupe River to the south. However, due to the entrenchment of Kerrville as the center of commerce in the county, the city continued to grow with new settlements being established in the vicinity of the city. Therefore, the model was able to include a large portion of historic sites within the mapped high probability areas.

The results of the historic records search was able to provide areas of historic settlement that were not identified as high probability locations by the predictive model, thereby excluding prosperous ranching locations that played a major role in the continued settlement and growth of the county. The results of this study suggest that the qualitative analysis (historic records search) based on the actual historical accounts was able to provide a better understanding of the settlement patterns and community development of Kerr County than a broad settlement model that relies on isolated quantitative landscape variables.

# CHAPTER 6

# CONCLUSIONS

The output of the archeological predictive model showed a high probability of locating archeological sites and settlement locations near waterways and along the lower elevations throughout Kerr County. This correlated with the earlier historic settlements during the investigated time period. However, this changed the further along in the investigated time period. This coincided with the changing business successes such as livestock and sheep ranching. The Y.O. ranch and other assorted historic ranches were not located in the high probability areas throughout the county. In fact, the ranches were located in the lowest probability zones displayed on the predictive models surface output. A review of existing ranches that are recognized by the Texas Family Land Heritage Program, a program that honors farms and ranches that have been in continuous agricultural operation by the same family for 100 years or more, has the currently running Y.O Ranch and the Black Bull Ranch listed, which are located in low probability zones.

Based on the results of the comparison of the archeological predictive map and historical record summary, this thesis sought to answer the following research questions.

*Does a predictive settlement model accurately locate high probability areas for historic settlement locations in Kerr County, Texas?*

Overall, the predictive settlement model does accurately locate the high probability areas for historic settlement locations in Kerr County. However, the critique of incomplete archeological data sets and failure to address cultural factors directly apply to this outcome. Initial settlement of the county relied on the Cypress trees along the Guadalupe River. This reliance influenced the settlement of Kerrville, which served as the center of commerce for the county from the beginning of the investigated time period up to modern times. Therefore, continued development in the county centers around Kerrville and the western portion of the county. This is apparent with the location of archeological surveys conducted by CRM firms as reflected by a map provided by the THC archeological sites atlas (Figure 18). This reinforces the idea of an incomplete archeological data set with the concentration of archeological sites and surveys conducted in the high probability areas. Additionally, by not recognizing the cultural influence of a changing economy, the influential ranches during the investigated time period where not mapped in the high probability areas.

*Are the results of the predictive settlement model providing accurate data for planning purposes and developing field investigation methodology?*

The results of the predictive settlement model do not provide accurate data for planning purposes and developing field investigation methodology. By having the high probability areas located predominantly along the eastern portion of the county, CRM firms will have the tendency to assume the low probability of encountering sites in the western portion of the county. This assumption could be false due to the increasing amount of ranches and parcels in the low probability areas during the latter half of the investigated time period.

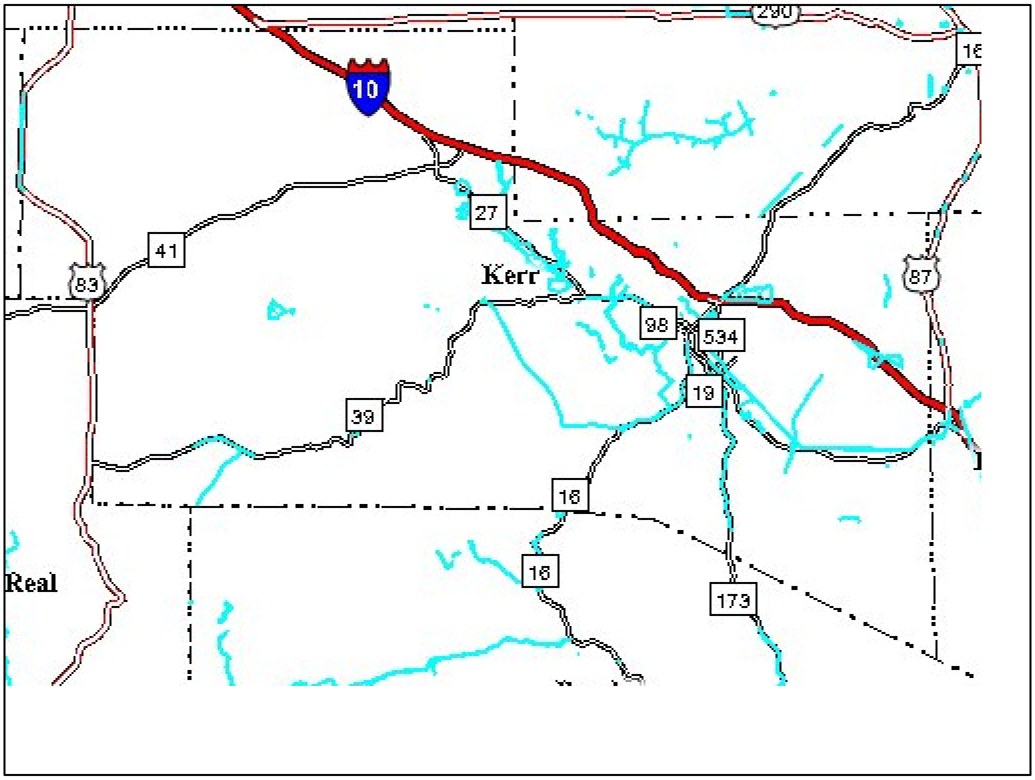


**Figure 18. Location of CRM Surveys in Kerr County (THC Sites Atlas).**

*Is the landscape data used in the predictive settlement model indicative of the recorded influences on settlement provided by the historical record?*

Yes and no. With regards to the initial settlement of the county, the landscape data (especially the distance to river data) is indicative of the recorded influences on ***initial*** settlement as provided by the historical record. However, in the latter portions of the investigated time period, the landscape data is not indicative of the recorded influences on settlement provided by the historical record. The landscape criteria changed in a matter of 15 years with the local economies reliance on ranching activities.

Overall, the models inability to account for the incomplete archeological data sets, the failure to address cultural factors, and the lack of justification in the selection of environmental parameters showed the ineffectiveness in creating a predictive model of archeological sites in Kerr County. This thesis determined that the predominant influences during initial settlement of the county had changed over the investigated time period. Additionally, this study illustrates the vast influences and driving forces that influenced the early Texas settlers and their settlement patterns. The results also showed that although environmental models are an adequate tool in identifying the high probability of settlement locales for planning purposes, a thorough field investigation of all project areas must be undertaken before concluding the existence of archeological sites. In other words, although a settlement model may find statistically significant landscape variables for the settlement and cultural site locales, the results may not tell the full story of the dynamic nature of mankind or the dynamic fluctuation of influences on the individual settler.

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## Vita

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