Colonial South Carolina Cowpens and Savannas: Analyzing the Distribution of Colonial Cattle Grazing Sites Using GIS and Predictive Modeling

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COLONIAL SOUTH CAROLINA COWPENS AND SAVANNAS: ANALYZING THE DISTRIBUTION OF COLONIAL CATTLE GRAZING SITES USING GIS AND PREDICTIVE MODELING

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Historic Preservation

by
J. Benjamen Thomas
May 2021

Accepted by:
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ABSTRACT

Some of colonial Charleston’s most significant landscapes are rural savannas. While it is often overlooked, the colonial cattle industry centered in South Carolina’s Lowcountry savannas played a large role in the early economy. Ultimately, the cattle trade provided many of the resources that made Charleston one of the wealthiest cities in colonial America. Today, the preservation of the physical landscapes associated with the cattle industry is more important than ever as issues like climate change and urban growth and development threaten to destroy these historic landscapes.

The purpose of this thesis is to test the applicability of modeling techniques as it relates to the historic cattle industry in colonial South Carolina and determine if modeling can accurately predict sites of colonial cattle grazing relating to the time period from 1670-1750. Using predictive modeling and GIS, this thesis analyzes the environmental criteria within a known area of colonial cattle grazing in order to create a predictive model. While the environmental data sets used to populate the model are from modern surveys, many environmental changes require long periods of time for drastic changes to occur; thus results of the model show the statewide distribution of ideal colonial cattle grazing habitat. Specific results of the model suggest that the most ideal habitat for cattle raising is concentrated along the coastal zone of South Carolina, predominantly in the Sea Islands and Santee Delta regions. This is largely due to the natural geomorphology of these regions and the abundance of proffered fodder for cattle.
ACKNOWLEDGMENTS

This thesis would not have been possible without the guidance, support and assistance from many individuals.

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A special thank you to my class. Thank you for the friendship, laughs, and memories exploring old buildings together. Thank you to Bernie, Gabe, and Darcy for keeping me sane in the studio during the writing process.

Finally, a huge thank you to my family and friends. Mom and Dad, thank you for all your support and genuine interest in my research along with all the opportunities you have granted me. Julia Rose, thank you for all your love and encouragement and for believing in me to accomplish all of my goals.
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A growing trend in the field of preservation is the acknowledgement that both natural and cultural landscapes contribute to the built environment. Today, in cities like Charleston, the preservation of natural and cultural landscapes is more important than ever, as issues like climate change and urban growth and development threaten to destroy important physical landscapes that were critical to the early economic success of the city. Ultimately, these landscapes provided many of the resources that made Charleston one of the wealthiest cities in colonial America. Specifically, one of colonial Charleston’s most significant landscape types is the rural savannas. In these savannas, thousands of free ranging cattle once grazed before being butchered and sold in either nearby markets or exported out of the colony. Today, these historic cattle grazing sites are often sites of new development. An example of how these significant rural landscapes are being threatened from development can be seen through efforts to expand S.C. Highway 61, a National Scenic Byway¹.

The history of the cattle industry in Charleston begins when the first English settlers came to the Lowcountry in the late 17th century². In the early years of the colony, settlers were experimenting with a variety of cash crops to determine which plants would

bring the highest profits. During these first years of experimentation, the raising of cattle and other livestock supported the colony\(^3\). By as early as 1680 several thousand cattle were present in the marsh lands surrounding Charleston, with individual herds consisting of 700 to 800 heads. The highest concentrations of cattle were located in the outer coastal plain of South Carolina and in the lands situated between the Edisto and Savannah Rivers\(^4\). This coastal plain extends roughly 60 km inland\(^5\). The term cowpens as it relates to colonial South Carolina refers to large scale free ranging systems that includes the combination of land, buildings, and enclosures associated with the management of cattle\(^6\).

The cattle industry in the coastal plain grew rapidly largely due to the cheap initial investment that was required to begin ranching and a high demand for cattle products\(^7\). The economic incentives of high demand for cattle products and cheap startup costs were not the only drivers of growth for the cattle industry as the habitat in colonial Charleston featured the ideal habitat and an abundance of the fodder cattle preferred\(^8\). Herds of cattle grew rapidly between the years 1670-1712, when ultimately rice would replace cattle ranching as the leading agricultural pursuit\(^9\).

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\(^6\) Dunbar, “Colonial Carolina Cowpens”, 126

\(^7\) Otto, “The Origins of Cattle-Ranching in Colonial South Carolina, 1670-1715.”


The research on the cattle industry of colonial Charleston has focused on economic origins, ranching techniques and practices, ideal ranging habitat, and economic and cultural impacts. Surprisingly, few studies have been conducted on the application of modeling techniques to study historic cattle habitat distribution. This thesis seeks to use geographic information systems (GIS) to create a predictive model that identifies the distribution of the ideal habitats for colonial cattle grazing. The thesis also employs the model to test whether these habitats can be accurately modeled and located using computer modeling techniques. GIS as defined by the U.S. Geological Survey is “a computer system that analyzes and displays geographically referenced information…[that] uses data that is attached to a unique location.” The data populating this model are based on environmental characteristics located within known areas of colonial cattle grazing and also served as a way to compare environmental characteristics referenced in the literature. The application of large-scale computer modeling will provide a new way of analyzing and visualizing colonial cowpens.

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While cattle grazing was taking place throughout the entire coastal plain, this study focused on the present-day Ashley River Road corridor. This area of study was chosen for three main reasons. First, the Ashley River features some of the oldest and most prominent settlements in the greater Charleston area including Middleton Plantation, Drayton Hall and the Lord Ashley Archaeological site (St. Glies Kussoe). These settlements were all occupied during the times when cattle raising was in its peak. Second, because these homes were among the most prominent plantations, there is a robust collection of records that prove cattle were on the property and land plats that can be used to create data within the GIS software. Third, a concentration of archaeological investigations that have occurred within the Ashley River Road corridor have confirmed
the presence of cattle (See Figure 1.1). This study is also focused on the distribution of colonial South Carolina focusing on the time from the settlement of Charleston in the 1670s to the mid 18th century. By the middle of the 18th century, the cattle industry suffered a significant decline largely due to disease (babesiosis)\textsuperscript{11}.

GIS data used to create the model came mainly from environmental databases like the Gridded Soil Survey Geographic (gSSURGO) and featured data layers like soil type, elevation, and geomorphology. The collection of data layers that were used, describe features within the habitat in which cattle were known to be grazing like long leaf pine stands or savannas. The locations of savannas were obtained through historic plats and maps that were georeferenced and digitized to create a data layer in the GIS software. Digitization is the term for the process of converting data from a paper source into a digital file format\textsuperscript{12}. Georeferencing refers to the process of aligning and fitting an image file within GIS by establishing correlations between individual points within the image and the modern day coordinates of those same points. By georeferencing historic plats, exact locations of known cattle grazing habitats were determined and thus served as a study area to investigate environmental characteristics that were located within these known areas of cattle grazing.

Given the importance and close relationship of landform features like savannas to the early cattle grazing industry it was hypothesized that the ideal cattle grazing sites


would be concentrated near the tracts of land between the Ashley and Edisto Rivers due
to the high concentration of savannas in this area\(^\text{13}\). As one moved further away from this
location it was hypothesized that few locations would represent ideal cattle habitat due to
changes in the environment in comparison to the study area.

Since the historic savannas have been largely overlooked in the history of
Charleston, these habitats have become prone to destruction as a result of urban growth
and development. Specifically, recent discussions by SCDOT have focused on expanding
roadways running through the Ashley River Road corridor. If these expansions were to
occur, it is likely that many of these historic cattle grazing savannas would be destroyed
along with the potential to conduct archaeology and learn more about these important
colonial landscapes. Given that these landscapes are often hundreds of acres, archaeology
in these locations would differ from traditional archaeology of the built environment.
Investigations in these locations would include core studies, charcoal analysis, and pollen
and fungal spore analysis in order to better understand the historic environment. Not only
will the predictive model developed in this thesis allow for analysis of the distribution of
these habitats, but it will also highlight locations in most need of preservation.

Results of this model be applied to current research on the movement of colonial
cattle within the coastal plain of South Carolina. The vegetation data layers created
through this model can serve as an important tool for current research focusing on
isotopic analysis of historic cattle bones in order to better understand what cattle were

\(^{13}\) David Baluha. “This ‘Pestilential Miasma’ Was ‘Emphatically a Rice Country’: Creation and
Consolidation of Authority in Cane Acre, a Plantation Community in St. Paul’s Parish, S.C.” Thesis, The
Citadel, 2017, 46.
eating and where these sources of food were located in relationship to where the bones were found. The vegetation data layers can serve as an interesting comparison to this study by showing locations where fodder species could be located in relation to the results from their study. The model also argues for the preservation of often overlooked large scale landscapes as they provide context to localized features.

In order to organize and report the results of the predicative model, this thesis has been divided into five chapters. Chapter two provides a review of the literature that relates to the origins of the colonial cattle grazing system, economic impacts from the cattle industry in South Carolina, habitat and landscape features that relate to cattle grazing sites, and the application of ecological modeling to various fields of study.

Chapter three outlines the methods used to develop the model. Specific discussions within this chapter include collection of environmental data used to populate the model, how the Boolean model works, and the analysis of the results of the model.

Chapter four describes the results of the model. In this chapter details on the analysis of the model are presented in four sections. First, environmental characteristics within my study area. Second, analysis of the results of the statewide model. Third, analysis on the environmental characteristics across the physiographic regions across the state. Fourth, analysis on the capabilities of the model to predict known cattle grazing sites outside of the study area.

Chapter five features a summary of conclusions that were derived from review of the results of the model as well as a brief discussion on areas of future research on this topic.
The results of the model report an index of suitability, meaning it shows how many environmental characteristics which relate to lands of known colonial cattle grazing sites are present in the same location. Therefore, it does not present definitive areas where could live, rather it shows the distribution of ideal habitat that could support cattle grazing activities.
CHAPTER TWO
LITERATURE REVIEW

The land surrounding Charleston has served as the setting for some of the city’s most significant industries. One of the earliest industries located in these rural areas was cattle ranching. While a considerable amount of historic research has been conducted on the origins and impacts of the cattle industry in Charleston, there has been very little conducted on the distribution of cattle savannas in the greater Charleston area.

As this chapter will discuss, scholarly research has been conducted to tell the history of the early cattle industry along the inner coastal plain of the Southeastern United States. Specific areas of research have included source of cattle stock, cattle ranching techniques, economic and cultural impacts of the cattle industry, descriptions of the ideal habitat for cattle grazing, and applications of ecological modeling in various fields. Spatial analysis and distribution of the ideal cattle grazing habitats have been largely overlooked in current scholarly research. Through the use of GIS and predictive modeling detailed characteristics of cattle grazing lands can be further understood and

mapped. By mapping these landscapes and studying the distribution of these features the scale and impact of the early cattle industry can not only be visualized, but can be used by preservationists and other academics to pinpoint the most likely landscapes associated with colonial cattle raising.

This literary review is broken down by theme. The thematic organization is intended to illustrate those topics that scholars have focused on, as well as, show the lack of application of modeling within this area of research.

**Origins**

The origins of the open range cattle system that became dominant in the colonial Charleston area has its roots in the older traditions of the West Indies. Geographer, Andrew Sluyter, details the origins of these practices in his book *Black Ranching Frontiers: African Cattle Herders of the Atlantic World, 1500-1900*, as a modified and hybridized version of sixteenth century cattle ranching practices that were occurring in the British Isles, Andalusian Spain and sub-Saharan West Africa. This hybridization occurred due to the influences of all of these cultures being active in colonizing the West Indies and resulted in a unique Antillean system of cattle ranching. Specifically, Sluyter argues that there were two locations within the Antilles where open ranching systems were used and thus significantly influenced cattle ranching activities in America the most. These two locations are Jamaica and Barbuda. Sluyter provides an example of this

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blending of cultures through the cattle practices on Barbuda in the Leeward Islands. In this example Sluyter notes that the Spanish attempted to settle the islands in the 1520s. Before being run off by the native Carib people, it is likely that the Spanish introduced cattle and cattle ranching techniques to this area.

The British adopted the Spanish techniques of open range grazing and the use of dogs paired with riders on horseback to manage the cattle, but also introduced some of their own practices for cattle ranching that were common in Britain. One of these British practices included nightly penning of the cattle, which occurred during their occupation of these lands beginning in the late 1620s\textsuperscript{16}. A second change implemented under the British system was the use of the bullwhip to manage cattle which replaced the Spanish lance with a sickle blade and was used to cripple feral cattle\textsuperscript{17}.

African influences would have come from the enslaved peoples performing the physical hunting of the cattle. Jamaica also featured a similar history to Barbuda in terms of colonization and cattle ranching practices. In this article, Sluyter describes both the Barbuda and Jamaican open ranch systems. Both of these systems implemented the use of enslaved “cow runners” that rode on horseback to round up free ranging cattle with the assistance of dogs in order to bring them into stone walled or picket fenced enclosures. Sluyter does note one major difference between the Barbuda and Jamaican system. In the Jamaican system, the cow hunters would round up cattle nightly into a pen so that the


\textsuperscript{17} Ibid
manure would fertilize the ground for future crops once the cow pen was moved. The hybridized British, Spanish and African system was established by 1670.

In his book *North American Cattle Ranching Frontiers* Terry G. Jordan discusses the earliest introduction of cattle into what would become the United States. Jordan argues that some of the earliest cattle in America were brought to northern Florida and likely Southern South Carolina near Santa Elena from the Antilles by the Spanish. Herds of cattle were brought to America by Spanish explorers as early as 1521. During the sixteenth century, cattle struggled to grow in Spanish Florida and few, if any, of these early cattle survived.18. Zooarchaeologist Dr. Elizabeth Reitz attributes this struggle for livestock to develop in Florida due to disease, high humidity, competition for fodder, and predators19. Throughout the sixteenth century, the cattle industry would struggle to prosper until the establishment of permanent ranches in the early 1600s. Prior to the establishment of ranches, few settlements were established in areas where cattle were grazing leaving the cattle to be unmanaged. With the establishment of permanent ranches, significant ranching activities began to occur in the 1650s and resulted in a ranching “boom” by the 1680s20.

Along with describing the introduction of cattle into America, Jordan also describes the history of the Spanish ranching system in Florida. In essence, the ranching happening in Florida closely resembled the ranching that was occurring in the West

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Indies. The ranching occurring in Florida involved cattle, hogs, and horses. In this system cattle and hogs were free ranging and were managed and rounded up by mounted cowboys. Round ups occurred twice a year, once in the spring and once in the fall. The spring round up was geared towards branding new cattle and the fall round up for culling.

Jordan notes that the Spanish ranching activities and mission culture continued in Spanish Florida until the early 18th century. Beginning in 1702, South Carolinian colonists and Native American groups conducted a series of raids on these mission outposts in the remote Florida backcountry. As a result of these raids, Florida longhorn cattle were captured by the Carolina English and ultimately interbred with British species of cattle already free ranging in South Carolina. While the species of cattle present in Florida were inadvertently being bred with Carolina cattle, the ranching practices taking place in South Carolina were more similar to practices occurring in Jamaica. The similarities between these two systems include, the use of enslaved workers to manage cattle, the relationship of cowpens and plantation being spatially separated operations, and the managing of hogs alongside cattle. Jordan argues that while the majority of

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21 Jordan "North American Cattle-Ranching Frontiers: Origins Diffusion, and Differentiation", 107
22 Ibid, 108
early colonists in South Carolina were from Barbadoes the open range cattle systems present there developed too late to influence cattle practices in Charleston.

With this thought, Jordan hypothesizes that the minority population from Jamaica influenced South Carolina cattle ranching practices the most. Other historians, like John S. Otto, acknowledge that the South Carolinian system of cattle ranching did closely resemble those occurring in Jamaica. However, the small number of English colonists from Jamaica that immigrated to South Carolina by the 1700s could not be most responsible for establishing the cattle ranching system in South Carolina. Otto suggests that English, immigrating directly from West Britain, along with enslaved Africans, specifically from West Africa, were a more likely origin for the Carolina cattle grazing system. These settlers from West Britain and West Africa had already developed open range cattle grazing systems and were present in 17th century South Carolina in large numbers. While much research has been conducted on the origins of the South Carolina system, Sluyter summarizes the similarities and differences between the Barbuda, Jamaican and South Carolina systems and notes that all three depended on open range grazing systems and used pens or enclosures of some type.

While the cattle ranching practices in Charleston were likely influenced by a number of different cultures, research by Jordan and others suggest the cattle breeds

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present in colonial Charleston were mostly English and Barbadian breeds\textsuperscript{26}. Most research suggests that the early cattle were imported to South Carolina from other English colonies mainly Virginia\textsuperscript{27}. Jordan notes that the bloodlines of the cattle in South Carolina were predominantly of English background through most of the colonial period with minor breeding of Spanish cattle as previously mentioned. The early cattle that arrived from Virginia were small, black Irish stock with some English red-browns\textsuperscript{28}. Historians Brooks, Goover, and Smith and cite several quotes from early colonist of South Carolina complaining about the small size of cattle in the colony and the need for bigger breeds to be brought to the colony from Bermuda and New York\textsuperscript{29}. Larger breeds of cattle were also obtained in the state as a result of incidental interbreeding with captured Spanish cattle from Florida\textsuperscript{30}.

Historian John S. Otto describes the early history of cattle ranching in South Carolina in his article \textit{The Origins of Cattle-Ranching in Colonial South Carolina, 1670-1715}. Otto notes that the first cattle in South Carolina arrived in the colony soon after the first settlers in the 1670s. The earliest cattle ranching activity was rather meager with


\textsuperscript{28} Jordan, "North American Cattle-Ranching Frontiers: Origins Diffusion, and Differentiation", 110.

\textsuperscript{29} Brooks, et al., \textit{Living on the Edge: The Archaeology of Cattle Raisers in the South Carolina Backcountry}, 30.

most colonists owning only a few heads of cattle. However, the industry quickly boomed, and by 1710, most cattle ranchers owned a couple hundred heads. The largest herds numbered around 1,000 heads of cattle. With such large herds present in Charleston, Otto notes the importance of having an open range system to provide the necessary fodder to support the cattle. Otto suggests that an individual cow would need fifteen acres of land for fodder per year. For a herd of 200 heads of cattle that would mean 3,000 acres of land would be required to support the cattle. Since most early Carolinians lived on small homesteads and did not have this much land, a free ranging system was necessary for the cattle industry.

Figure 2.1 A hypothesized rendering showing the layout of the Catherine Brown cowpen located in the South Carolina backcountry. Image from “The Catherine Brown Cowpen and Thomas Howell Site: Material Characteristics of Cattle Raisers in the South Carolina Backcountry” page 103.

Focusing on South Carolina’s inner coastal plain, historian and geographer Gary S. Dunbar wrote *Colonial Carolina Cowpens*. This book focuses on defining the term
cowpens as it applies to colonial Charleston, discussing vegetation and physical
descriptions of cowpens, as well as general locations of cowpens in South Carolina.
According to Dunbar, the term cowpens is first used in Virginia in the first half of the
17th century. Under this definition, the term refers to small scale enclosures or fences for
cattle. However, the term as it is used in colonial Charleston refers to large scale free
ranging systems that includes the combination of land, buildings, and enclosures
associated with the management of cattle (See Figure 2.1). A typical Carolina cowpens
would consist of about 100-400 acres of land on which there were enclosures for animals,
dwellings for the manager of the cattle, and a garden for food\textsuperscript{31}. These cowpens were also
established in close proximity to savannas and cane swamps as these locations served as
ideal feeding grounds\textsuperscript{32}. This system, born in South Carolina would later spread into the
nearby states of North Carolina and Georgia.

**Economics**

Along with research done on the origins of the cattle ranching industry in colonial
Charleston, a considerable amount of research has been undertaken on the economic
structure of the cattle industry. This section discusses the role that cattle and cattle
products played in the overall economy of Charleston.

The earlier proprietary South Carolina economy and the evolution to the
plantation economy beginning around 1700 is analyzed by Gary L. Hewitt in the book

\textsuperscript{31} Dunbar, “Colonial Carolina Cowpens”, 126.; Mark D. Groover and Richard D Brooks, “The
Catherine Brown Cowpen And Thomas Howell Site: Material Characteristics Of Cattle Raisers In The

\textsuperscript{32} Ibid
Money, Trade and Power: The Evolution of Colonial South Carolina’s Plantation Society. In this chapter Hewitt argues that the earliest economy was largely dependent on trade with local Indians and that the staple crop production and the plantation system did not begin to be established until after 1690. Specific goods being traded with Natives during this time included animal skins, guns, and textiles. The thriving Indian trade was so significant that historian Eirlys M. Barker states “it provided economic justification for the colony to exist.” This thriving trade with local Indian groups would last until the 1750’s when trade with Britain and its other colonies would begin to dominate the economic market. While cattle products were not being traded with Native peoples, cattle products were being exported to other English colonies.

Historian Walter Edgar provides background on the founding of the colony of South Carolina in his book South Carolina: A History. In this text, Edgar argues that the proprietary colony of South Carolina was originally established as a money-making venture. Specifically, the proprietors, or founders of the colony, saw South Carolina as an extension of the English colonies in the West Indies like Barbados. Based on the economic systems and the fortunes already made in Barbados, research suggests that the

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34 Hewitt "The State in the Planters’ Service: Politics and the Emergence of a Plantation Economy in South Carolina.", 53.
earliest English settlers in South Carolina sought to grow cash crops like tobacco, citrus, grapes, ginger, indigo, and sugarcane that were already established in the West Indies\textsuperscript{36}.

This desire to make the colony rich through large scale agricultural operations is supported by Hayden Smith in his book titled \textit{Carolina’s Golden Fields: Inland Rice Cultivation in the South Carolina Lowcountry} when he says “from the outset of colonization, Lord Proprietor Anthony Ashley Cooper instructed colonists to plant ‘cotton seed, indigo seed, [and] ginger roots’ in a variety of soils for ‘our reason for this is that being unacquainted with ye nature of ye soyle[sic], we shall have conveniency of trying which sort of soile[sic] agrees best with ye severall[sic] things planted in them.’ ” Ultimately, this early planting based economy failed\textsuperscript{37}. Smith attributes this failed economy to limited agricultural knowledge in the Lowcountry environment, environmental difficulties and a lack of labor required to work the landscape. With limited income coming from crops, Lowcountry planters turned to low labor activities that could be of value in the world market\textsuperscript{38}. Two examples of low labor systems common in 17th century Charleston was the deer skin trade and the raising of cattle. At the turn of the 18th century the most common exports from Charleston were deerskins and cattle products\textsuperscript{39}.


Given the struggles of those early agricultural pursuits, Otto argues that most colonists turned to raising livestock in the early years of the colony in this article *Livestock-Raising in Early South Carolina, 1670-1700: Prelude to the Rice Plantation Economy*. In this article, Otto suggests that livestock were originally brought to the colony as a food source for the residents. However, their numbers quickly grew as the cattle thrived in the climate of South Carolina’s Lowcountry. Along with the ideal climate and ecosystems to support cattle ranching activities, Otto notes that the young colony also had an abundance of land that could support large herds of cattle. The free ranging system used in South Carolina allowed the cattle to move freely throughout the frontiers in search for food. By not having to have animals kept in enclosed pens, large herds could be supported by the natural vegetation of the vastly uninhabited frontiers of the colony.

The geographic location of Charleston provided an opportunity for the city to serve a major role in the global trade occurring in the 17th and 18th centuries. Reitsema et al. argues that Charleston was a critical port that linked not only Europe with North America and the Caribbean but also connected the colony’s frontier with the happenings of the coast\(^40\). Smith further expands on this idea by arguing that the demand of provisions and other goods from the West Indies brought in much needed funds and helped kick start the colonies struggling agricultural ventures\(^41\).


Information addressing the role that cattle and cattle products played in the economy of colonial South Carolina can be found in *Archaeology at City Hall: Charleston’s Colonial Beef Market* by Martha Zierden and Elizabeth Reitz. This report details how beef products began as an important trade commodity and describes its role as a critical export to West Indies colonies. Along with being a valued export, the importance of cattle products as a source of food for people in Charleston is also discussed⁴².

Another direct economic benefit of the free ranging system noted by Otto is the fact that little labor was required to manage herds since the cattle were free to roam and thus not dependent on persons to provide fodder for the livestock. Under this system labor would have only been required twice a season to round up cattle and bring them back to the cowpens for branding and culling purposes. A few laborers, mostly enslaved Africans along with Native Americans, known as “cow hunters”, would have been all that was needed to manage a large herd. This reduction of labor required in cattle herding meant that startup costs were much lower than the capital needed to start a cash crop plantation.

Low initial investment costs were not only limited to the labor. Otto notes that the price of cattle themselves could be bought for one-pound sterling, a homestead of a couple hundred acres could be bought for a few pounds of sterling, and grazing lands for the cattle were free. This low initial investment paired with high demand for salted beef

and other cattle products resulted in large profits that were then used to fund large cash
crop plantations that brought in even more wealth43.

**Habitat and Landscape Features**

A final major topic of research as it relates to research addressing colonial
Charleston cattle activities are descriptions of the preferred habitat in which cattle were
known to have grazed. This section describes the physical features related to cattle
grazing such as general locations of cattle grazing activities and ideal habitat for cattle
including features like vegetation and soil.

While cattle grazing would eventually spread statewide, South Carolina’s coastal
plain was where most of the colonial grazing activity was taking place. The coastal plain
is defined as a low-lying area in terms of elevation and features a variety of habitats
including pine forests, savannas, hardwood forests, and marshes44. South Carolina’s
coastal plain is split into two major divisions, the outer and inner coastal plain. The outer
coastal plain is defined as the strip of land that runs from the coast line to about 50 miles
inland45. The inner coastal plain begins around 50 miles inland and continues to the
Sandhills region of the midlands46. Many researchers, including Jordan, believe that the

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43 Otto, “Livestock-Raising in Early South Carolina, 1670-1700: Prelude to the Rice Plantation
Smith, *Carolina's Golden Fields: Inland Rice Cultivation in the South Carolina Lowcountry, 1670-1860*.
19-20.

44 Otto, “Livestock-Raising in Early South Carolina, 1670-1700: Prelude to the Rice Plantation
Economy” 15; Reitsema, et al. “Provisioning An Urban Economy: Isotopic Perspectives On Landscape Use
And Animal Sourcing On The Atlantic Coastal Plain.”, 239.

45 Smith, *Carolina's Golden Fields: Inland Rice Cultivation in the South Carolina Lowcountry, 1670-1860*.
1670-1860. 5.

46 Otto, “Livestock-Raising in Early South Carolina, 1670-1700: Prelude to the Rice Plantation
outer coastal plain was the earliest location of cattle grazing in South Carolina. Within this area some of the highest concentrations of cattle were found just west of Orangeburg, between the forks of the Edisto River and between the Salkehatchie and Savannah Rivers. From the earliest cattle activities in the outer coastal plain, practices would move to the inner coastal plain as the population grew in the area of grazing activities.

The coastal plain was an ideal habitat for cattle as it consists of the four main habitats cattle preferred. These ecosystems include longleaf pine stands, small stream flood plains, savannas, and low-lying hardwood swamps. Considerable research has been done investigating the relationship between cattle grazing and the use of savannas. Savannas are pastoral lands within the coastal plain that are often described as low lying freshwater marshes. Jordan notes that these pasture landscapes were not only a favorite area for grazing but was also the ideal setting for establishing a homestead and cowpens. Ideal locations for savannas were areas that featured all of the desired habitat for cattle including pine stands and low-lying hardwood swamps. Soils of the savannas are described by Smith as a Lenoir fine sandy loam.

Since savannas were established as an ideal place for a homestead, savannas were cultural environments. Many researchers highlight that fire was used to clear underbrush.

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51 Smith, Carolina's Golden Fields: Inland Rice Cultivation in the South Carolina Lowcountry, 1670-1860. 29.
from savannas so that new growth could support cattle with fodder\textsuperscript{52}. Today, development of many areas that were once savannas have decreased the impact of natural fires. The absence of fire in pine savannas greatly impacts the natural plant regeneration and would alter how savannas look now compared to the past\textsuperscript{53}. While changes in plant life and understory appearance of savannas today has likely changed, geological features like soil type would not have changed much over time\textsuperscript{54}. The introduction of cattle to these landscapes to manage growth along with the introduction of structures further this idea of savannas being cultural environments.

Longleaf pine habitats served as the habitat for cattle during summer months. These ecosystems feature an understory of shrubs and grasses that cattle would use as fodder\textsuperscript{55}. Snitker et al. notes that within these pine forests, cattle were primarily eating bluestem (\textit{Andropogon scoparius}), switch cane (\textit{Arundinaria tecta}), Spanish moss (\textit{Tillandsia usneoides}), and wiregrass (\textit{Spartina patens} and \textit{Spartina alterniflora})\textsuperscript{56}. Reitsema et al. estimates that up to 90\% of the understory of a pine forest was composed of wire grass and thus served as a major food source for cattle. While the cattle chose to graze in the pine forests during summer months, the cattle would retreat into the low-

lying hardwood swamps during the winter. Smith makes it known that while these physical features are known as swamps they are not perpetually flooded with water. Smith defines these areas as “localized alluvial courses” that are situated with the floodplain of small streams. These features would flood during rain events and were able to drain after the storm. Vegetation found within these “dry swamps” were dominated by swamp trees like sweet gum, live oak, red maple and longleaf pine and full of cane breaks. Cane being a preferred food for cattle, especially during winter months57. These low-lying hardwood swamps were often found below the higher pine and savanna ecosystems.

Biological definitions for the term savannas are complex and difficult to determine. Modern interpretations of the term can be seen through biologist/botanist Porcher and Rayner’s description of long leaf pine savannas. They describe these landscapes as being woodlands with little to no undergrowth and primarily being located within the inner coastal plain and piedmont58. Savannas in this sense were often closely related to “wide prairies” or open woodlands. This definition of the term savanna differs from the landscapes suggested on historic plats and maps. Savannas in these locations suggest these landscapes to be flood plain or marsh like areas closely surrounding rivers and streams. Historic research, as shown above, suggest that savannas featured a combination of pine woodlands and low lying hardwood swamps existing within close proximity to one another. The various definitions for the term savanna suggest that there

58  Porcher and Rayner. A Guide to Wildflowers of South Carolina, 42.
has been a divergence in the interpretation of the term savanna from historic records to modern interpretation.

**Ecological Modeling**

While considerable research has been conducted on describing the locations and habitat known to support cattle activities, surprisingly little research has involved the use of modeling or spatial analytics to understand the distribution of these important landscape features. This section introduces past applications of predictive modeling as it relates to landscapes. These fall into two main fields of study: archaeology and environmental science/biology.

In the article “An Archaeology of Landscapes: Perspectives and Directions”, Kurt Anschuetz et al. provides a history of landscape modeling and how it is being used by archaeologists today. Anschuetz et al. argues that the theoretical foundations for modern landscape modeling date back to the 1920’s when the landscapes were absorbed into the larger archaeological study and served minor role in understanding archaeological sites. During this time landscapes were predominantly used as a way in which excavated features were plotted and evaluated. Since the 1920’s, the study of landscapes has evolved to serve a more important role in archaeology as researchers use them to describe both natural and cultural aspects of the human landscape. Examples of natural landscape features include ecological, geomorphological, and hydrological components. Cultural features include technological, organizational, and cosmological components of a society.
While Anschuetz et al. seeks to describe how the study of landscapes as it relates to the field of archaeology has changed over time, Maria Danese et al. provides a case study for how landscape modeling is applied to the field of archaeology by predicting Neolithic settlement sites in Southern Italy in their article “Predictive Modeling for Preventive Archaeology: Overview and Case Study.” The article notes that predictive modeling is a helpful tool that can save time and money, as well as provide critical information in setting up investigative boundaries for investigation. Another important application of predictive modeling is its contribution to the preservation of archaeological resources by highlighting likely areas of historic settlement and its potential to be damaged by anthropic and natural impacts\(^59\).

The case study within this report uses predictive modeling and GIS to find likely prehistoric settlement locations in the Apulia region of Italy. To begin the case study, the researchers state the importance of background research and the establishment of including and excluding factors to be used in the model. Determining the factors that are associated with prehistoric settlements in Southern Italy are critical to success of the model due to the archaeological idea that landscapes limit or develop cultural forms\(^60\). Some of the including factors that were included in this case study include values for distances between settlement sites, and values of geological and environmental characteristics of known settlement. These factors are what define the landscape that is to be modeled. GIS and remote sensing technologies were used to create the model. GIS

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60 Ibid
allowed the researchers to find and place the model parameters while remote sensing was
used to create data that alerted to archaeological features\textsuperscript{61}. The parameters used within
the case study were land use type, elevation and proximity to water. Danese et. al note
that these factors are the most important parameters used in archaeological investigations
while secondary parameters include environmental and social elements. Spatial analytics,
or the relationships between the parameters, were calculated through a process called
map algebra. This process uses one or more input raster files and creates an output raster
based on calculations of parameters done cell by cell across all input raster files within
GIS.

The article “Inferring Habitat-Suitability Areas with Ecological Modelling
Techniques and GIS: A Contribution to the Conservation Status of \textit{Vipera latastei}” by
Xavier Santos et al. provides another case study for how predictive modeling can be used
to find ideal habitat for an endangered species. Similar to the archaeological case study,
this model was used as a way to quickly and efficiently survey a large study area. To
perform their model, Santos et al. also used GIS and relevant habitat characteristics in
order to find habitat suitable areas. The parameters used within this study were also
similar to the parameters used in the archaeological study and included elevation, climate,
and land use parameters. Outputs from the model resulted in a raster-based map\textsuperscript{62}.

\textsuperscript{61} Maria Danese, Nicola Masini, Marilisa Biscione, and Rosa Lasaponara. “Predictive Modeling for
Preventive Archaeology: Overview and Case Study.” \textit{Open Geosciences} Vol. 6 No. 1 (January 1, 2014).

\textsuperscript{62} Xavier Santos, José C. Brito, Nefalí Sillero, Juan M. Pleguezuelos, Gustavo A. Llorente, Soumia
Fahd, and Xavier Parellada. “Inferring Habitat-Suitability Areas with Ecological Modelling Techniques and
130 No. 3 (July 2006): 416–25.
The literature on colonial South Carolina cattle grazing covers topics on the development and origins of the early cattle ranching system in South Carolina, the economic and cultural impacts associated with the cattle industry, descriptions of habitat and landform features associated with colonial cattle grazing sites, and the use of predictive modeling in various research fields. While there has been considerable research done on the impact and history of cattle in South Carolina the application of predictive modeling has not been applied to this study.

Information obtained through the review of literature assisted in three ways. First, determining datasets needed to populate a predictive model in order to accurately locate colonial cattle grazing sites. Second, to highlight the importance of predictive modeling and how this technology works. Third, to understand the environmental characteristics researchers have associated to cattle grazing sites through other research methods. These characteristics ultimately served as way to compare environmental values found within my study area.

Since modeling techniques have not been applied to the study of colonial cattle habitat in South Carolina, this thesis seeks to test if modeling techniques can be applied to this area of study and accurately locate colonial cattle grazing sites. To test this, a Boolean raster model was created using environmental data inputs that were obtained from a known area of cattle grazing. The output of the model was analyzed to determine if ideal cattle habitat was found in other areas of known cattle grazing across the state.
CHAPTER THREE

METHODOLOGY

This thesis seeks to use GIS to create a predictive model to test the applicability of modeling to the study of colonial cattle grazing site and to determine if these habitats can be accurately located using computer modeling techniques. To do this, environmental criteria like elevation, soils, and vegetation within known areas of cattle grazing lands were analyzed to find patterns and relationships among the variables. The model identified areas where all of these environmental characteristics exist together, and thus represent the most ideal habitat for cattle grazing lands.

Figure 3.1 Map of the study area situated in between Highway 61 and State Road 317. Yellow lines represent parcels shown on a 1715 plat of the area. Image made by the author.
The main study area of this thesis is the area now known as the Ashley River Road corridor (See Figure 3.1). Specifically, the sample area was focused on lands that are located on the west side of Highway 61, opposite of where Drayton Hall is located today. Many of the properties in this study area were historically owned by the Drayton family. The Ashley River Road Corridor was selected as it is a known area for colonial cattle grazing activity and features some of the earliest established properties in Charleston\textsuperscript{63}. Historic plats and maps of this area show features designated as “cow pens” or “savannas” which will provide a key boundary for the investigation of environmental factors for this model. While cattle grazing is no longer taking place in this location today, the environmental characteristics that will be evaluated can still provide insight as many environmental changes require long periods of time for drastic changes to occur\textsuperscript{64}.

The three main components to the model used in this thesis include environmental criteria, the GIS model, and georeferenced historic plats. The first component is the environmental criteria, which serve as the inputs upon which the model is based. The second component is the GIS model, or the software that computed and analyzed the presence and distribution of environmental criteria. Finally, georeferenced historic plats and maps served as the focus for the analysis of environmental characteristics and as a way to test the results of the model outside of the study area.

\textsuperscript{63} Diary, Charles Drayton I, 1784-1790, Drayton Papers, National Trust for Historic Preservation, housed at the College of Charleston Libraries, Charleston, SC.

Environmental Data

The environmental criteria chosen to be the inputs for this environmental model are elevation, geomorphology, soil type, and vegetation. These criteria were chosen as they represent known aspects of ideal habitat for cattle grazing based on historic research on the time period from 1670-1750 as well as being common criteria in both environmental and archaeological modeling. Since the time period related to this thesis is focused on the colonial period, the environmental data reflect common landforms and vegetation present within the Lowcountry of South Carolina as this was the dominant area of where colonial population of South Carolina were located.

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Figure 3.2 LiDAR mosaic showing elevations across the state of South Carolina. Image made by the author.

Elevation data used in this model is represented through LiDAR data provided by the United States Geological Survey (USGS) and downloaded using their application “The National Map Downloader”\textsuperscript{66}. LiDAR or Light Detection and Ranging is a form of remote sensing that uses light to calculate changes in elevation of the ground surface\textsuperscript{67}. The data provides a precise surface map as well as provides detailed elevation measurements for precise areas within the study area. To obtain statewide LiDAR data, a compilation of 1 arc second DEMS that were clipped to the shape of the state were


downloaded individually and stitched together in ESRI’s Arcmap using the *raster mosaic* tool. Research on colonial cowpens and savannas does not mention exact values for elevations at which cattle were known to graze. In order to obtain this value a range of elevations was created through looking at the georeferenced plats. The elevation values that either fell within or intersected with the georeferenced areas marked as “savanna” served as the ideal values for elevation within the model. Elevation values ranged from 1’ above sea level to 14’ above sea level.

Figure 3.3 Map showing the distribution of soil types across the state of South Carolina. Image made by the author.

Soil data was obtained through soil surveys from the United States Department of Agriculture (USDA) and downloaded from their database “Gridded Soil Survey...
Geographic Database” (gSSURGO)68. gSSURGO is downloaded as a geodatabase that features 147 separate data layers which describe characteristics of soil and its associated land use. Most of the data in this database is in tabular form. In order to use the data a series of joins was performed to link information stored in table formats to polygons, or vector files, that allow for spatial representation of the tabular data69. While these polygons are originally displayed as a vector file, the data was converted into a raster format using the polygon to raster tool within the ArcGIS toolbox. The specific files used for this model were soil components. Soil components, or soil types, refer to the levels of minerals, water, air, and organic and inorganic material that make up the soil70.

Historic and modern references to specific soil types for colonial cowpens was also difficult to find. Research did show that the best cowpens were situated on bottomland alluvium71. Generally, in these low lying areas, research suggested that soils like Lenoir and Wahee sandy loams were common soil types. The Lenoir soil type is a fine sandy soil found at higher elevations while the Wahee soil is a clay loam found in lower elevations72.

Geomorphology, as defined by the British Society for Geomorphology is “the study of landforms, their processes, form, and sediments at the surface of the Earth." The field of geomorphology looks at landscape features such as rivers, hills, plains, beaches, sand dunes, and other features and how they interact to shape the landscape that we see today. Geomorphology is an important environmental criterion as cattle grazing activities were heavily concentrated in first and second order flood plains. These flood...
plains were often low-lying areas that were prone to flooding during rain events and were locations where fodder for cattle were plentiful\textsuperscript{75}. Organizations like the USDA produce geomorphology datasets for research purposes, which are found in the gSSURGO database. The data from these geomorphic surveys will help establish what the ideal landscape of cattle grazing areas should be.

Vegetation data was hard to obtain, especially data that reflected the fodder species that were commonly used by cattle. In order to obtain this data a separate model was needed to be used to create this data layer. Using the program MaxEnt, a vegetation model was generated to show likely locations for the preferred fodder for cattle. The species of plants representing the fodder for cattle include bluestem (\textit{Andropogon scoparius}), switch cane (\textit{Arundinaria tecta}), Spanish moss (\textit{Tillandsia usneoides}) and cordgrasses (\textit{Spartina patens} and \textit{Spartina alterniflora}) as historical research identifies these as preferred food sources for cattle\textsuperscript{76}.

MaxEnt, short for Maximum Entropy, is a computer software program that predicts probabilities of species occurrence based on presence data. This means that the software analyzes a set of environmental criteria, or constraints, in locations where a particular species is known to inhabit. MaxEnt analyzes the widest distribution of these constraints and makes predictions based on this distribution of environmental data\textsuperscript{77}. The


result of the model is a probability that a species could be located in a given area based on the widest distribution of environmental characteristics associated with the known locations\textsuperscript{78}. Figures 3.5-3.8 show the results of the individual vegetation models.

\textbf{Figure 3.5} Results of the MaxEnt model showing the probability of suitable habitat for Bluestem (\textit{Andropogon scoparius}). Red cells represent the highest probability of the species in that location. Image by the author.

\textbf{Figure 3.6} Results of the MaxEnt model showing the probability of suitable habitat for Spanish Moss (\textit{Tillandsia usneoides}). Red cells represent the highest probability of the species in that location. Image by the author.

\textsuperscript{78} “Maxent.” Biodiversity and Climate Change Virtual Laboratory.
Figure 3.7 Results of the MaxEnt model showing the probability of suitable habitat for switch cane (*Arundinaria tecta*). Red cells represent the highest probability of the species in that location. Image by the author.

Figure 3.8 Results of the MaxEnt model showing the probability of suitable habitat for cordgrass (*Spartina*). Red cells represent the highest probability of the species in that location. Image by the author.
The set of environmental criteria used for the MaxEnt model includes climate data obtained from WorldClim.org. WorldClim.org’s data set is composed of 19 different climate factors including data related to temperature and precipitation. The 19 climate GeoTiffs were downloaded in 30 arc second resolution. Additional datasets in the model include elevation data (LiDAR), soil organic content to 30 cm depth (obtained from gSSURGO), and available water storage to 30 cm depth (obtained from gSSURGO). Before the model was run all of the data sets were brought into ArcMap and clipped to the shape of the state of South Carolina, as well as masked so that each layer had the same cell size (30 arc second) and extent. This step was critical to perform as the model will not run if all datasets do not have the extent same extent, projection, and raster cell size.

With all of the environmental data processed, each raster was converted into .asc files and loaded into MaxEnt program. Finally, species presence data for each plant species was downloaded from the USGS’s Biodiversity Information Serving Our Nation (BISON) data downloader. This data is downloaded in a .csv file format and features latitude and longitude of known locations of plant species. The .csv file was also uploaded into the MaxEnt program. With all of the data loaded into the program the model was run. After the model was run, data that contributed less than 5% to each individual model was removed and the model was rerun. Percent of contribution is calculated by MaxEnt and refers to the impact that a variable has on the fit of the model. By removing data layers that did not contribute much to the results, the model becomes
simplified leading to raster cells not being “penalized” for not representing a data layer that contributed a small percentage to the model\textsuperscript{79}.

**Modeling**

The principles behind modeling are fundamentally based on the ideas of spatial analysis, or the process of examining the locations, attributes, and relationships of features in spatial data through the use of overlaying various data layers\textsuperscript{80}. Results from this analysis of features with different data layers are used to answer questions relating to patterns and other scientific phenomena\textsuperscript{81}. While research related to colonial cattle grazing locations have provided insight into habitat qualities that are associated with cattle raising, no research has been conducted to determine the specific distribution of all of these criteria within the coastal plain. This model seeks to provide an answer to this question.

\textsuperscript{79} “Maxent,” Biodiversity and Climate Change Virtual Laboratory.
To complete this model, a collection of four maps and plats showing landownership in the 18th century for lands situated between modern day Highway 61 and State Road 317 were georeferenced using ESRI’s ArcMap (See Figure 3.9). Georeferencing refers to the process of aligning and fitting an image file within GIS by establishing correlations between individual points within the image and the modern day coordinates of those same points. To do this, landmarks like road intersections or bends in a river were found in the historic image and tied to these same landmarks on the aerial.

Figure 3.9 Two georeferenced plats that were used to analyze environmental criteria within the study area. The plat on the left shows “Bob’s Savanna”. The plat on the right shows the parcels around Horse, Jack, Long and Wampee savannas. Plats were provided by Drayton Hall82. Image made by the author.

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82 Copy of plat showing “Bob's Savanna,” Colleton County, surveyed 1771”. Drayton papers, Drayton Hall, National Trust for Historic Preservation, housed at the College of Charleston Libraries, Charleston, SC., Ink plat of 1085 acres in St. Paul's Parish, Colleton County, 1765 June 6, Drayton papers, Drayton Hall, National Trust for Historic Preservation, housed at the College of Charleston Libraries, Charleston, SC.,
imagery. This process assigns X and Y coordinate values to the landmarks on the historical imagery and orients the map to its real world location. These plats were chosen as they date to the time when cattle ranching was an active enterprise and the fact that the plats show annotations of areas clearly labeled “savannas”. Once the plats and maps were georeferenced, the parcels within the maps that intersected with the savannas were digitized. These digitized parcels served as the locations for which the ideal characteristics for locating colonial cowpens would be based.

The environmental data types chosen to investigate colonial cowpens within this model include elevation, geomorphology, soil type, and vegetation. To determine the values of the environmental criteria which fall within the digitized 18th century parcels, the “select by location tool” within ArcMap was used on each data layer to determine which values intersect with or fall within the digitized parcels. The values that resulted from this geospatial analysis were recorded. While most of the data representing these environmental criteria were originally downloaded in vector format, all were converted to raster data using the polygon to raster conversion tool in ArcToolbox. To perform the boolean overlay, the reclassify tool was used on each data layer to set the parameters for the ideal elevation, geomorphology, soil type and vegetation. Cells that feature the criteria that were determined to intersect with the 18th century parcels received a value of “1” while cells that did not intersect those parcels would receive a value of “0”. Locations where cells have a value of 1 for each criterion are the ideal cattle grazing habitat.

The model that was used to compute the overlaid environmental data in this study was a raster model. While there are several types of models used, raster models are
commonly used in environmental contexts as these models are best suited at representing continuous data, or data that can have any value\(^3\). An example of continuous data from this model is elevation as there are no limits to what the elevation for a certain point can be. Along with representing continuous data well, raster modeling is faster than vector modeling in the sense that multiple raster files can be considered at once and the fact that raster data can be reclassified or values associated with raster data can be changed easily\(^4\).

![Figure 3.10 Diagram showing how the boolean raster model works. Each cell within the raster data layer features a “1” or “0”. Cells with “1” mean the environmental layer is present in that location, while a “0” means that environmental layer is absent. The model adds the total number of “1s” present between all 7 overlaid data layers. The most suitable habitat would then be represented by a value of 7. The least suitable habitat would be represented by 0. Image made by the author.](image)

Raster models only work with raster data inputs. Raster data is a type of data that is represented through a continuous grid of uniformly sized cells\(^5\). The model works through cell by cell calculations of values between the individual overlaid data layers. In other words, the model analyzes what values are stacked up on top of each other. The cell by cell calculation performed by the model can be based on a variety of operators including mathematical functions, logical functions or boolean functions\(^6\). The model used for this study is a boolean overlay. Boolean overlays work based on two main

\(^3\)“Intermediate Spatial Analysis in GIS: Raster Data.” Lecture, n.d.
\(^4\)Lytle. “Intermediate Spatial Analysis.”
\(^5\)“Intermediate Spatial Analysis in GIS: Raster Data.”
\(^6\)Lytle. “Intermediate Spatial Analysis.”
values; 0 and 1. In this system each cell within a raster data layer will either receive a value of 0 or 1. The 0 value corresponds to the boolean expression being false, or in the case of this study, the environmental criteria being absent in the location the raster cell represents. The 1 value corresponds to the Boolean expression being true, or in this case, the environmental criteria is present in the location the raster cell represents\(^{87}\). Raster math was then performed using the raster calculator tool within ArcMap to add up the number of 1s present in each raster cell across the seven layers (See Figure 3.10). The resulting layer has values ranging from 0 to 7. Cells that had a value of 0 were least likely to support cattle grazing. Locations where all of the criteria exist represent the most ideal locations for cattle grazing to take place and would be represented with a value of 7.

**Analysis Methods**

The purpose of this model is to show the distribution of ideal cattle grazing habitat based on environmental characteristics within areas where historic cattle grazing was known to take place. The predictability of the model was then assessed by comparing the results to other known areas of cattle grazing throughout the state. Additional analysis was performed on the results of the model to understand patterns and distribution of certain environmental factors that compose the ideal cowpens sites.

To perform the analysis on the distribution of ideal habitat sites, results from the Boolean model were categorized into three categories: most suitable cattle habitat, moderately suitable habitat, and least suitable habitat. Most suitable cattle habitat is

represented by cells with 5, 6, or 7. Moderately suitable habitat is represented by cells with values of 3 or 4. Finally, low suitability is represented by values of 0, 1, or 2. By comparing results from each individual environmental data layer analysis of the environmental criteria which make up each location will be conducted.

In order to test if the model was able to predict locations of cattle grazing outside of my study area, three historic plats and maps that feature savannas were georeferenced. Results from the model within each georeferenced map will be analyzed and compared to the original study area. Results from the model are discussed in the next section.
CHAPTER FOUR

RESULTS

The output from the Boolean raster model described in the previous chapter resulted in an index of suitability. This means, the results from the Boolean model showed how many environmental characteristics constituting lands of known colonial cattle grazing are present in the same location. The analysis of this distribution of environmental characteristics allows for spatial analysis for the distribution of ideal cattle habitat, as well as, analysis of how individual environmental characteristics differ from location to location. By analyzing the distribution of ideal cattle habitats in relationship to other known cattle grazing locations the accuracy of the predictability of the model can be tested. Through this analysis conclusions can be drawn for why certain locations were chosen for cattle grazing sites as well as highlight the most likely areas where cattle grazing occurred; and thus in most need of preservation and research.

Analysis was conducted first within the Ashley River Road corridor to assess the environmental criteria which served as the inputs for which the model was based. The second area of analysis was on the output of the statewide model to highlight the most likely areas for cattle grazing. Next, detailed analysis of the environmental criteria within these locations designated by the model showed differences in the environmental criteria across the state. Finally, analysis of the savannas outside of my study area were analyzed to determine if the model was able to predict other sites of cattle grazing locations.
Analysis of Environmental Characteristics within the Ashley River Road Corridor

To determine environmental characteristics within the study area, the geospatial analysis tool “select by location” was used on each individual environmental layer to select all values that fell within or intersected with the parcels that form the study area. The values that were selected within this analysis were the inputs used to form the model. The study area encompassed just over 37,062 acres (See Figure 3.1).

Values for elevation within the study area ranged from 1 foot above sea level to 14 feet above sea level, with an average of 5.6 feet above sea level. As expected, this range of values corresponds to elevations often assigned to South Carolina’s coastal plain. The South Carolina coastal plain records ranges in elevation from around 300’ above sea level near its inland boundary with the Sandhills regions and gently slopes down to just above sea level near the boundary with the Coastal Zone of the state.  

Table 4.1 The top six most common soil types represented within the study area. Since the data layer describes a soil horizon, the total number of acres between the soil types exceeds the 37,000 acres within the study area. Table made by the author.

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Using the same geospatial analysis for elevation, values for soil type were obtained within the study location. In all, 47 different soil types were present within the study area. The most dominant soil series was Brookman, making up 20,842 acres (See Table 4.1). Brookman soil is a fine clay loam common in the lower coastal plain and found in areas that flood frequently. The soil is described as being a very poorly drained soil that is found in depressions and is often saturated in late winter and early spring. Being a poorly drained soil, the Brookman soil series would serve as the ideal soil to form seasonal floodplains in which cattle were known to graze.

Table 4.2

Table 4.2 The top five most common geomorphology types represented within the study area. The geomorphology data layer describes the landform associated with the soil type in the soil type layer. Given this close relationship to the soil type layer, the total number of acres between all of the geomorphology types exceeds the 37,000 acres within the study area. Table made by the author.

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90 Ibid
Like soil and elevation, the analysis of the geomorphic landforms within the study area were also analyzed. The dominant landform of the 17 that were represented within the study area, were coastal plains, depressions, and marine terraces (See Table 4.2). This dominant landform is referring to the general coastal plain landscape that is found along the eastern coast and stretches from New Jersey to Texas\textsuperscript{91}. As described before, this landscape is a broad plain that extends roughly 150 miles inland and gently slopes toward the ocean\textsuperscript{92}. Depressions within these landscapes refer to relatively low lying areas surrounded by areas of elevated ground. Typically, these depressions feature little to no way for surface draining of water to occur and often relate to swamp like landscapes\textsuperscript{93}. Marine terraces refer to flat alluvial plains typically above the 100 year flood stage and represents the former position of the sea shore\textsuperscript{94}.

Presence of vegetation within the study area varied from species to species. Bluestem (\textit{Andropogon scoparius}) featured the widest area of probable locations within the study area with 100\% of the study area having at least 50\% probability of the species being located within the study area. On the other hand, cord grasses (\textit{Spartina}) featured the lowest area of probable locations within the study area with 0\% of the study area having at least 50\% probability of the presence of this species. This is likely due to the fact that the grass is commonly found in marshes close to the coast and the study location...

\textsuperscript{93} Ibid
\textsuperscript{94} Ibid
is too far inland to support this species. The two other species, switchcane (*Arundinaria tecta*) and Spanish moss (*Tillandsia usneoides*) both showed areas of at least 50% probability of presence along with areas of low probability of presence. Switchcane reported approximately 98% of the study area had 50% or greater probability of presence while Spanish moss reported approximately 62% of the study area had 50% or greater probability of presence.

Research has shown that the South Carolina Outer Coastal plain featured a number of ideal characteristics for savannas and cowpens. The above values that were reported within this study reflect many of these environmental characteristics which help define this physiographic region. All of the values that were located within or intersected with the study area were the values that were reclassified with a value of “1” to use for the statewide raster model.

**Analysis of Statewide Boolean Raster Model**

Figure 4.1 depicts the results of the Boolean raster model. As mentioned previously, the areas of darkest green feature all seven environmental constraints and are the most ideal locations for cattle grazing. On the other hand, areas of red feature none of the environmental constraints and thus feature the least ideal locations for cattle grazing to occur.

With this information in mind, the most ideal cattle grazing sites are located within the outer coastal plain and specifically within the South Carolina coastal zone, a physiographic land region that stretches roughly 10 miles inland from the Atlantic Ocean.
and runs the entire length of the coastline\textsuperscript{95}. The most ideal locations, cells with values of 5, 6, or 7, are predominantly concentrated in the Sea Islands and Santee Delta regions of the state. Specific concentrations of this most ideal habitat include: areas along the Broad River near Beaufort, between the Edisto and Ashley Rivers, and between the Cooper and the Santee Rivers. The Grand Strand, the final coastal zone region, featured very few locations of ideal cattle grazing habitat. The patterns presented from this model coincide with the past research which suggest that the earliest locations for colonial cattle grazing occurred between Port Royal and the Santee River within the coastal zone\textsuperscript{96}.

\textbf{Figure 4.1} Results of the state wide Boolean model. The green cells represent the most suitable habitat, while the red squares represent the least suitable habitat. Note the concentration of green cells within the coastal zone. Image made by the author.

\textsuperscript{95} Kovacik and Winberry, \textit{South Carolina: the Making of a Landscape}.

\textsuperscript{96} Brooks, et al., \textit{Living on the Edge: The Archaeology of Cattle Raisers in the South Carolina Backcountry}, 43.
The most ideal habitat is limited outside of the coastal zone. There are two locations in the outer coastal plain which show concentrations of the most ideal habitat for cattle grazing lands. These two locations include the lands between the Ashley and Edisto Rivers, which served as the study location for this thesis, and the land between the Cooper and Santee Rivers (See Figures 4.2 and 4.3). The concentration of ideal habitat between the Ashley and Edisto Rivers extends approximately 35 miles inland while the eastern concentration ends approximately 25 miles inland. Since the coastal plain extends around 150 miles inland, these locations of the most ideal habitat are found in the lower portions of this physiographic region.

Figure 4.2 Results of Boolean model showing the area of most suitable habitat between the Ashley and Edisto Rivers. Note the concentration of green cells within the outer coastal plain. Image made by the author.
Figure 4.3 Results of Boolean model showing the area of most suitable habitat between the Santee and Cooper Rivers. Note the concentration of green cells within the outer coastal plain. Image made by the author.

Bordering the band of ideal habitat that extends across the coastal zone, is a band of moderately suitable habitat, or cells with values of 3 or 4. The highest concentration of the moderately suitable habitat is located within the lower portions of the coastal plain ending between 30 and 40 miles inland and extends across the state. A second area featuring a large concentration of moderately suited habitat is the Grand Strand region.

While the moderately suitable habitat is mostly concentrated in the lower portions of the outer coastal plain a less concentrated band of moderately suitable habitat does extend across the state in the inner coastal plain, or the region more commonly known as
the midlands. Within this band, higher concentrated areas exist just south of Augusta, along the Savannah River, and within Congaree National Park. This band of moderately suitable lands along the Savannah River does support the idea that this area features some similarities with the study area and could have been a likely spot for the spreading of cattle out of the coastal zone and even further west\textsuperscript{97}. Interestingly, these two higher concentrated areas of moderate suited habitat are located near the Catherine Brown cowpen, Mary Musgrove cowpen, and the Thomas Howell site, which are locations where livestock raisers were known to inhabit\textsuperscript{98}.

The model shows that the majority of the state contains lands that are least suitable for colonial cattle grazing locations. These lands are represented by values of 0,1, or 2. With the exception of a low concentrated band of moderately suitable habitat across the inner coastal plain, low suitable habitat is found from the middle of the outer coastal plain westward to the Blue Ridge region. This is due to the changes in environmental characteristics which occur moving west out of the coastal zone into different physiographic regions. Since the model is focused on the colonial period in South Carolina and the environmental variables chosen to populate the model were derived from historic and scientific accounts within the Lowcountry changes preferred fodder and landforms was not taken into account with this model. This means, that was cattle moved into the backcountry of South Carolina, the sources of fodder to support cattle changed.

\textsuperscript{97} Brooks, et al., \textit{Living on the Edge: The Archaeology of Cattle Raisers in the South Carolina Backcountry}, 43.

Analysis of Environmental Characteristics in Different Regions

Along with identifying statewide patterns of high, moderate, and low suitability areas, analysis was conducted in various locations to determine which of the seven major environmental characteristics contribute to these locations and how these criteria might change from location to location. Areas of investigation included the coastal zone where the most suitable habitat was located, specifically focusing on the area around the Broad River near Beaufort, land in between the Edisto and Ashley Rivers, land between the Cooper and Santee Rivers, and the Grand Strand region. Additional investigation was in locations in the lower coastal plain where moderate habitat was found. Finally, analysis of the environmental characteristics in locations that featured low suitability was conducted, primarily focusing on the Piedmont and Blue Ridge regions.

The Santee region is represented predominantly by cells of values of 5 or 6. The environmental characteristics that are different in this region compared to the study area are the absence of the vegetation layer cordgrass (Spartina) and the soil type (See Table 4.3). Analysis of the cordgrass data layer shows that distribution of this species is concentrated in the Sea Islands region. Lands north and east of Bulls Bays feature very few locations where cordgrass could be found. The limited distribution of cordgrass causes a large portion of the coastal zone to be represented by a value of 6 or less. Another explanation for the concentration of cordgrass is due to its preferred habitat being in salt marshes. Marsh landscapes typically occur along tidal inlets and barrier islands99. Given that the Sea Island region is predominantly made of barrier island, it

99 Porcher and Rayner, A Guide to Wildflowers in South Carolina, 63.
makes sense for the concentration of cordgrass to occur in this region. Along with cordgrass, the ideal soil types found in the study area were absent in the Santee region. Soils in the coastal zone north of Charleston largely feature soils that are very poorly drained, while south of Charleston better drained loamier soils are present\(^{100}\). While the study area featured clay loam soils like Brookman, soils in the Santee Region were dominated by Coxville soils. While this soil is still described as a poorly drained soil, its features more sand than clay and is classified as a sandy loam\(^{101}\).

Lands between the Ashley and Edisto Rivers featured the highest concentration of cordgrass, an environmental data layer that was largely absent in the Santee region. However, most of the cells represented by 6’s in this region were still due to cordgrass being absent. The presence of cordgrass ends near the transition of the coastal zone and the coastal plain leading to a concentration of cells with values of 6 in this transitional area. Cells with values of 6s are not only located near the transition between the coastal zone and coastal plain as a large presence of 6s can be found in the lower portion of this region (near the coast) due to the absence of bluestem (*Andropogon scoparius*). This would suggest that within this region, bluestem was not the dominant source of fodder and that cattle in this area were dependent on other vegetation like switchcane (*Arundinaria tecta*). Cells with values of 5s in the upper transitional region are due to the absence of cordgrass and Spanish moss (*Tillandsia usneoides*). Meanwhile, 5s in the lower section are due to the absence of bluestem and soil types. Soil types in this location

\(^{100}\) Kovacik and Winberry. *South Carolina: the Making of a Landscape.*
would differ from the study location as this landscape is so close to the Atlantic Ocean leaving the soil to have more sand dominant soil components. While variances in the habitat suitability in the Santee Region were heavily influenced by vegetation and soil type, the lands between the Ashley and Edisto Rivers are more heavily influenced by absence of vegetation.

Analysis of the lands around the Broad River section were divided into two locations, the west and east side of the Broad River. On the west side, 6s are because of the absence of cordgrass, a similar result with the Santee region. In this same location, 5s are related to the change in soil type along with absence of cordgrass. On the eastern side 6s are because of the absence of bluestem, a similarity with the Ashley and Edisto region. The 5s on the eastern side are due to a change in geomorphology and absence of bluestem. A sharp change in geomorphology can be seen in the ACE Basin area, a delta-like landform which separates the most suitable concentrations in the Broad River area from the most suitable concentrations between the Ashley and Edisto Rivers.

As stated previously, the highest concentrations of the most suitable cattle grazing lands were located in the Sea Islands and Santee Delta regions of the coastal zone, The Grand Strand region did feature some locations with cells with a value of 5. As with the Santee Delta and the west side of the Broad River, cordgrass was absent throughout the majority of this region. Presence of Spanish moss was also limited throughout the majority of the Grand Strand region. A final environmental characteristic in this region that differed from the study area is geomorphology. Landforms common in the study area for this thesis begin to change drastically in the Santee Delta region and continue to the
North Carolina border. The study area being located in the Sea Islands region of the coastal zone features landforms that are broken up by rivers and streams and barrier islands closer to the shore. On the other hand, above the Santee Delta the number of streams and barrier Islands are greatly diminished. While the dominant geomorphology in the study area was coastal plains, depressions, and marine terraces, the common geomorphology present in the Grand Strand was coastal plains, depressions, and flats. Flats refer to low relief poorly drained sandy loam soils common in the Southeastern coastal plain\(^{102}\). This continuous stretch of uninterrupted coastline gives this region the name the Grand Strand and provides a different landform than those common in Sea Islands region\(^ {103}\).

\[
\begin{array}{|c|c|c|c|c|c|c|}
\hline
\text{Environmental Constraint} & \text{West Side of the Broad River} & \text{East Side of the Broad River} & \text{Upper Portion Between the Ashley and Edisto} & \text{Lower Portion Between the Ashley and Edisto} & \text{Santee Delta} & \text{Grand Strand} \\
\hline
\text{Elevation} & \checkmark & \checkmark & \checkmark & \checkmark & \checkmark & \checkmark \\
\text{Soil Type} & X & \checkmark & \checkmark & X & X & \checkmark \\
\text{Geomorphology} & \checkmark & X & \checkmark & \checkmark & \checkmark & X \\
\text{Andropogon scoparius} & \checkmark & X & \checkmark & \checkmark & \checkmark & \checkmark \\
\text{Tillandsia usneoides} & \checkmark & \checkmark & X & X & \checkmark & X \\
\text{Spartina} & X & \checkmark & X & \checkmark & X & X \\
\text{Arundinaria tecta} & \checkmark & \checkmark & \checkmark & \checkmark & \checkmark & \checkmark \\
\hline
\end{array}
\]

*Table 4.3* This table shows the presence or absence of each environmental layer in each location within the coastal zone. Note the number of locations missing at least one vegetation layer. Table made by the author.

Moving out of the coastal zone, presence of the most suitable habitat is very low and limited to the lower portions of the outer coastal plain. In this area and directly to the west of the most suitable habitat is a stretch of moderately suitable habitat composed of a


\(^{103}\) Kovacik and Winberry. *South Carolina: the Making of a Landscape*
collection of 3s and 4s. Absence of cordgrass, Spanish moss, and changes in geomorphology were the main environmental characteristics that differed in the coastal plain across the state. The lack of presence of these environmental features make sense as the coastal plain is moving away from the study area located near the coast leading to expected changes in climate, environment, and elevation.

While there were some locations with moderately suitable habitat in the coastal plain region, the majority of this region is made up of low probability areas and are mostly represented by values of 1. Values of 1 in this region are mainly representing similar geomorphology or the presence of switchcane. The cells with a value of 2 in this region consist of geomorphology and switchcane in the same location. To the west of the coastal plain, the landscape is dominated by the absence of all values. This region, called the Piedmont, is almost entirely represented by cells with 0 values. A few cells with values of 1 are found throughout this region and are mostly represented by the same soil type as the study area.

The most northern region, the Blue Ridge, features a mix of cells with values of 0s and 1s. The ones in this region are representative of the presence of bluestem. The presence of bluestem in this location makes sense as it is a durable grass that can grow in a variety of soils and is known to appear across the state. Low representation of ideal cattle grazing sites was expected in this region to the drastic differences in climate and environment present in the upstate than those present in the Lowcountry.

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In this analysis, it can be seen that vegetation presence had the greatest influence on the ranking of habitat suitability. This is because vegetation was divided into four individual layers and thus was more heavily weighted compared to the other data layers. To help counteract the impact that the vegetation layers had on the results of the model, separate analysis was conducted using a single data layer for vegetation. This data layer was created by combining all the data layers from the four vegetation layers into a single data layer (See Figure 4.4).

![Figure 4.4](image_url)

*Figure 4.4* Results of the state wide Boolean model with all the vegetation data layers combined into a single layer. Note the projects of most suitable habitat into the outer coastal plain around the Savannah, Ashley, and Santee Rivers. Image made by the author.

Analysis of this map reflects a lot of the same trends that have already been discussed including a large concentration of the most suitable habitat being located within the coastal zone before ending in the lower portions of the coastal plain. Also, related is
that the highest levels of suitability are concentrated around the Broad River near Hilton Head, between the Ashley and Edisto Rivers, and between the Cooper and Santee Rivers. Similarities between the two models can also be seen outside of the coastal zone. The inner coastal plain is also represented mostly by cells with values of 1s and 2s and the Piedmont is predominantly 0s.

This map also shows areas of high suitability that extend further into the outer coastal plain. These areas exist along the Santee River, the Ashley River, and the Savannah River. These paths into the coastal plain could signal areas where the diffusion of cattle into the backcountry occurred.

Since the two models with differing weights for the vegetation data layers showed similar patterns, this suggests that other landscapes features like soil or geomorphology likely played a bigger role in determining ideal cattle grazing habitat.

**Savannas Outside of the Study Area**

In order to test the predictability of the model, savannas outside of my study area were needed to compare the environmental criteria within these locations to my study area. Three plats and maps were able to be located to serve as savannas outside of my study area. These plats are located in present day Berkeley, Orangeburg, and Dorchester Counties. As with the maps and plats within my study area these maps were chosen as they featured annotations of areas labeled “savanna” and could serve as a comparison to the savannas within the study area. While these maps feature savanna landscapes, it is unclear whether cattle were actually grazing in these location or if these landforms were
just labeled as savannas. Further research into the presence of cattle in these landscapes is still required.

*Figure 4.5* Map showing the location of the savannas outside of the study area. Image made by the author.
The first parcel outside of the study area that was analyzed belonged to Sr. Hoverdon Walker and referred to as Walker’s Barony is located near present day Lincolnville, South Carolina. Annotations on the plat designate two areas as “Flatland Cowwoods” hinting at the use of this parcel. When georeferenced, this plat is situated about 5 miles east of the study area and within the lower portion of the outer coastal plain. Results from the model show that the 820-acre parcel shows a combination of cells with values of 4s, 3s, and 2s (See Figure 4.6). Environmental features missing within this parcel are cordgrass (*Spartina*), Spanish moss (*Tillandsia usneoides*), elevation, geomorphology and soil type. These trends in presence of environmental characteristics align with trends found in the transition zone between the coastal plain and the coast zone. Given that the model predicted this landscape to have moderate and low suitability, the model was not successful in predicting the location of this cattle grazing site.

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A second comparison area was found approximately 33 miles to the northeast of the original study area. This parcel, known as Burnt Savanna is located just south of Pineville, South Carolina in present day Berkeley County. The map of this area shows annotations for “Burnt Savanna” as well as parcels surrounding the savanna. Results from the model show the area is represented by cells with values of 0s, 1s, and 2s (See Figure 4.7). The environmental characteristics that Burnt Savanna shared with the study area are soil types and geomorphology. The lack of similar environmental characteristics reflect trends found in the coastal plain. These results suggest that the model cannot accurately predict locations within the coastal plain due to changes in the climate and environment as locations get further west and inland from the study area.
A third and final study area was analyzed and compared to the study area. This location is situated approximately 30 miles north of the study area and is south of Eutaw Springs, South Carolina in present day Orangeburg County. The map of the area shows a designation for “Lightwood Savanna” as well as parcels surrounding the savanna. Results from the model within this study were very similar to those found in Burnt Savanna. The parcels in this area were represented by cells with values of 1s and 2s (See Figure 4.7). The values that were in common with this area and the original study area were soil types and geomorphology, the same values that were present in Burnt Savanna. These results further support the idea that this model cannot accurately predict locations within the coastal plain.
CHAPTER FIVE

CONCLUSION

The purpose of this thesis was to test the applicability of predictive modeling techniques to accurately locate colonial South Carolina cattle grazing sites and to gain an understanding of the distribution of environmental characteristics which constitute ideal grazing sites. Given the importance and close relationship of landform features like savannas to the early cattle grazing industry it was hypothesized that the ideal cattle grazing sites would be concentrated near the tracts of land between the Ashley and Edisto Rivers due to the high concentration of savannas in this area\textsuperscript{106}. As one moved further away from this location it was hypothesized that few locations would represent ideal cattle habitat due to changes in the environment in comparison to the study area.

In order to test this hypothesis extensive research was conducted on the topic of early cattle grazing in South Carolina to understand patterns and trends in research that describe the ideal habitat and early history of cattle in colonial South Carolina. The trends and patterns found and outlined in the literature review section served as a comparison to the results found through the computer modeling of colonial cowpens.

Analysis of the environmental characteristics that were found within the study area closely relate to the ideal landscapes that researchers have attributed to colonial cattle grazing sites. Research reported in the literature review section describes that the

ideal sites for cattle grazing were in savannas which are landscape features commonly found in first and second order flood plains, that feature low lying areas prone to flooding, and pine forest or low lying hardwood swamps. Specific research showed that within these savannas cattle were eating bluestem (*Andropogon scoparius*), Spanish moss (*Tillandsia usneoides*), switchcane (*Arundinaria tecta*) and cordgrass (*Spartina*).

Analysis of the environmental characteristics found within the study area feature all of the properties that reflect the characteristics reported for ideal habitat for cattle grazing including poorly draining soils, swamp like landforms, low lying elevation, and an abundance of desired fodder. Specifically, within the study area, the only environmental characteristic that was not present was cordgrass due to the study area being too far inland and thus out of the natural habitat for this species. Through the model, the presence of cordgrass was mostly limited to the lower portions of the coastal zone. Results from the model would suggest that the dominant source of fodder in the study area was bluestem and switchcane.

Review of the literature also showed extensive research on the general landforms in which cattle were known to graze. Most researchers agree that the outer coastal plain was the earliest site of cattle grazing in the state and that the majority of cattle grazing occurred between the Savannah and Santee Rivers. Results of the Boolean model mostly support this theory. The model shows that the highest concentration of most suitable lands were concentrated in the area between the Savannah and Santee Rivers. However, the model also shows that the concentration of most suitable locations is situated within the coastal zone, or the lowest portion of the coastal plain. The coastal zone is a narrow
strip of land that extends roughly 10 miles in land. The majority of the outer coastal plain is mostly representative of moderately suited or low suited habitat due to the absence of Spanish moss and cordgrass along with a change in geomorphology. These same changes in environmental characteristics limit the Grand Strand region to being represented as an area of moderately suited habitat. While there is a difference in geomorphology between the Grand Strand region and the other coastal zone regions, the landforms are very similar. This would suggest that the savanna landscapes of the Sea Island and Santee Delta regions feature a larger variety of desired fodder and could be a reason that these regions were the dominant locations for cattle grazing in colonial South Carolina.

The ability of the model to accurately predict other locations of cattle grazing sites had poor results. Within the coastal zone and lower portions of the coastal plain the model was not able to locate other savannas. In these locations the test savannas featured moderate and low suited habitat. Outside of the coastal zone the model was also not successful in determining savannas. These locations showed low suitability for known cattle grazing sites outside of the study area. This inability to predict these savannas are likely due to the changes in physiographic and climate region between the upper and middle portions of the coastal plain and the study area located closer to the coastal zone. Changes in geomorphology impacting suitability of habitat were found in the ACE basin region of South Carolina. This delta-like landform which separates the most suitable concentrations in the Broad River area from the most suitable concentrations between the Ashley and Edisto Rivers.
Due to difficulty finding savannas outside of my study area only one location was able to be found that was in the same physiographic region as the study area. Future research should be conducted to find savannas within the coastal zone and analyze the results of the model within these locations to better test the accuracy of the model.

The poor accuracy of the model also suggests that these sites where cattle grazing was taking place were chosen for other reasons. These other drivers of location could have been access to rivers as well as access to timber and other natural resources. Since cattle were free ranging and had the ability to move freely to find their desired habitat, it may have not been critical to establish cowpens directly adjacent to savannas.

While the model was unable to predict cattle sites, there are some factors which should be considered in future studies. One aspect of this model which should be explored is to return to the idea of weighted variables or data layers. In this thesis attempts to perform this was done by decreasing the weight of four vegetation data layers and combining them into one data layer. However, results from this can be misleading as it could suggest that a minor source of fodder like Spanish moss could support a herd of cattle. Instead each individual data layer should be weighted based on importance. Results from this model suggests that bluestem and switchcane should be weighted more than the other vegetation species based on its prevalence within the coastal zone and coastal plain. Another aspect of future research is the incorporation of other data layers such as distance to water and slope could also serve as important constraints to the distribution of cattle habitat. Along these lines, additional sources of fodder should be investigated. Since the model showed that the majority of the state featured an absence of
the modeled species, more research should be conducted and included in the model to show what types of fodder cattle were eating in the Piedmont and Blue Ridge regions.

Even though this model was not successful in predicting cattle sites, it still made contributions to the field of preservation. The creation of vegetation data layers can serve as an important tool for current research performing isotopic analysis on historic cattle bones in order to better understand what cattle were eating and where these sources of food were located in relationship to where the bones were found. The vegetation data layers can serve as an interesting comparison to this study by showing locations where fodder species could be located in relation to the results from their study.

This thesis also shows the scale at which historic landscapes exists across the state of South Carolina. While other researchers have studied colonial cowpens, their study has been localized to areas around structures or physical features such fencing. This thesis investigates the landscapes surrounding the built environment which are often overlooked. Results from the model illustrates the significant distribution of these landscapes and how preservationist should consider the impact of large scale historic landscapes and their relationship to localized features. In other words, these landscapes provide context for cowpen settlements and should be preserved and studied alongside features of the built environment.
APPENDICES
Appendix A

Plats and Maps

Figure A-1: Map of Burnt Savanna.
Figure A-2: Plat of Bob’s Savanna.
Figure A-3: Tracts of land in St. Pauls, St. Andrews, and St. George’s Parishes.
Figure A-4 Map of Ketelby's Barony.
Figure A-5: Map of Sr. Hoverdon Walker's Barony.
Figure A-6: Map of Lightwood Savanna.
Appendix B

Environmental Presence Data Layers

Figure B-1: GIS map of distribution of most ideal soil types for cattle grazing lands.
Figure B-2: Flow chart showing the steps taken to create the soil type data layer. First, the table named “component” in the gSSURGO database was joined to the shapefile called “MUPolygon”. The attribute named “Component Name” was mapped. Second, geoprocessing was performed to determine the soil values that fell within or intersected with the study area. In total 47 soil types were present. Next, these 47 soil values were reclassified with a value of 1.
Figure B-3: GIS map of distribution of elevation values present in the study area.
Figure B-4: Flow chart showing the steps taken to create the elevation data layer. First, a series of 1 arc second DEMs were mosaicked together to get elevation data for the entire state. Second, geoprocessing was performed to determine the range of elevation values that fell within or intersected with the study area. The range of values were 1’-6’ above sea level. Next, these elevation values were reclassified with a value of 1.
Figure B-5: GIS map of distribution of geomorphology values present in the study area.
Figure B-6: Flow chart showing the steps taken to create the geomorphic data layer. First, the table named “component” in the gSSURGO database was joined to the shapefile called “MUPolygon”. The attribute “Geomorphic Description” was mapped. Second, geoprocessing was performed to determine the geomorphic values that fell within or intersected with the study area. In total 17 geomorphic types were present. Next, these 17 geomorphic values were reclassified with a value of 1.
Figure B-7: GIS map of distribution of 50% probability of suitable habitat for Spanish moss (*Tillandsia usneoides*).
Figure B-8: Flow chart showing the development of the Bluestem (Andropogon scoparius). A series of environmental data layers and species presence data layers were used to power a MaxEnt model. Next, the results of the model were reclassified in GIS give raster cells with a habitat probability of .5 or greater a value of 1.
Figure B-9: GIS map of distribution of 50% probability of suitable habitat for Bluestem (*Andropogon scoparius*).
Figure B-10: Flow chart showing the development of the Bluestem (*Andropogon scoparius*) vegetation data layer. A series of environmental data layers and species presence data layers were used to power a MaxEnt model. Next, the results of the model were reclassified in GIS give raster cells with a habitat probability of .5 or greater a value of 1.
Figure B-11: GIS map of distribution of 50% probability of suitable habitat for Cordgrass (*Spartina*).
Figure B-12: Flow chart showing the development of the Cordgrass (Spartina) vegetation data layer. A series of environmental data layers and species presence data layers were used to power a MaxEnt model. Next, the results of the model were reclassified in GIS give raster cells with a habitat probability of .5 or greater a value of 1.
Figure B-13: GIS map of distribution of 50% probability of suitable habitat for Switchcane (*Arundinaria tecta*).
Figure B-14: Flow chart showing the development of the Switchcane (*Arundinaria tecta*) vegetation data layer. A series of environmental data layers and species presence data layers were used to power a MaxEnt model. Next, the results of the model were reclassified in GIS giving raster cells with a habitat probability of .5 or greater a value of 1.
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