Characterization of Archaic and Woodland Period Prehistoric Coastal Plain Archaeologic Sites in Gloucester County, Virginia: A Geospatial Analysis

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Abstract

The Virginia Coastal Plain province, containing Gloucester County, is an important historical region of the United States. This project examined physical attributes of Archaic and Woodland Period prehistoric archaeological sites of Gloucester County, Virginia using geospatial techniques. Site elevation, slope, distance to rivers, and distance to wetlands were calculated and compared, and models incorporating those attributes were constructed to identify factors associated with prehistoric sites. The analysis found no significant differences between Archaic and Woodland Period site elevation, slope, or distance to water. The Kvamme's Gain statistic, a test of model performance based on accuracy and precision, identified distance to rivers as an important determinant for site location. While this analysis has value, its scope is limited by the narrow range of attributes included in the study. In addition, it is likely that difficult-to-measure socio-cultural factors of importance in prehistoric site selection are not accounted for in these models.

Introduction

Overview

This project analyzed Archaic and Woodland Period Native American archaeological sites located in Gloucester County, Virginia. Differences in the site locations, geospatial attributes, and time periods of occupation were analyzed to gain insight into lifeways evolving over the course of ten millennia of inhabitance of the area.

Rationale

While understanding Virginia's past is essential to understanding Virginia today, there are important differences between prehistoric and historic investigations. Studies of the Commonwealth and its immigrant inhabitants during historic times depend on written documents which do not exist for the prehistoric period (Egloff and Woodward, 2000; Hume, 1970). Prehistoric material culture consists of artifacts, often restricted to lithic or ceramic, which have escaped destruction by climatic and environmental conditions (Ewen, 2003).

While the physical attributes of an artifact provide important information, understanding that artifact's full significance requires placing it in its temporal, geographical, and cultural context. Variations in form, manufacturing technique, and methods of use help locate artifacts in time and space (Gardner, 1994; Geier, 1990; McLearen, 1991; Turner, 1992). Their number and distribution pattern across an archaeological site lead to testable hypotheses regarding lifeways, subsistence patterns, and social norms of prehistoric

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peoples (Ewen, 2003; Gardner, 1994). Locally collected artifacts often yield information with broader geographical implications, touching on prehistoric migratory patterns, ethnography, and evolution of cultural practices (Gardner, 1994; Gibbon, 2012).

Background

Physiographic Context

Virginia is divided into five physiographic provinces (Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and Appalachian Plateau), based on their geological and hydrological attributes (Egghart, 2020b). The Coastal Plain physiographic province encompasses approximately 950 square miles, measures approximately 100 miles from east to west, and 160 miles from north to south. It lies between the Atlantic Ocean to the east and the Fall Line, an abrupt transition in elevation marking the border of the Piedmont physiographic province, to the west (Egghart, 2020b) (Figure 1). It borders on North Carolina to the south, and Maryland to the north. The hydrology of the Virginia Coastal Plain province is dominated by the Chesapeake Bay, into which the tidal James, York, Rappahannock and Potomac Rivers drain (Egghart, 2020b).

Archaic Period Context

While Virginia has been inhabited by humans since the Paleoindian Period dating from 12,000 BC to 8000 BC, no Paleoindian sites have yet been identified in Gloucester County.

The Archaic Period followed the Paleoindian Period, and lasted from 8000 BC to 1200 BC (Custer, 1990; McLearen, 1991). Climatologically this period transitioned from a cold, wet, late-glacial environment where spruce, fir, and hemlock forests predominated, to a warmer, drier setting associated with an expanding hardwood forest of oak and hickory (Egghart, 2020a).

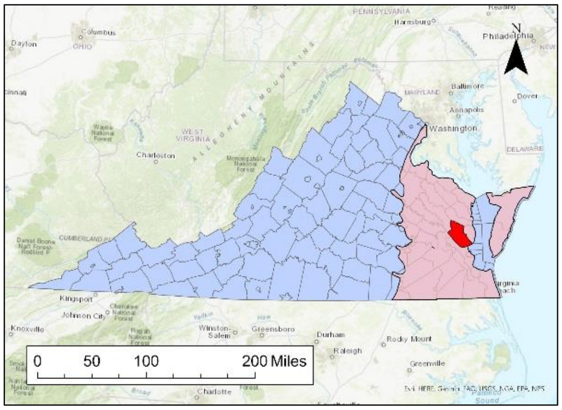

Figure 1. Virginia, USA. Counties map (blue) showing Coastal Plain province, measuring approximately 950 square miles (rose), and Gloucester County, measuring approximately 300 square miles (red).

Surviving Archaic Period material culture is limited to lithic artifacts, since biodegradable objects made of bone, animal skin, wood and other materials have not survived the passage of time (Egghart, 2020e; Geier, 1990). Archaic Period lithic artifacts include a variety of corner-, side-notched and stemmed projectile points, scrapers, choppers and other stone tools (Geier, 1990) (Figure 2). The lithic toolkit expanded over time to include bifurcated projectile points, chipped stone tools such as choppers and axes, ground stone mortars, manos and nutting stones (Egghart, 2020e). By the end of the Archaic Period tool production had evolved to include the temporally diagnostic Savannah River broadspear as well as large, heavy ground stone grooved axes and metates (McLearen, 1991).

Early Archaic hunter-gatherers likely gathered in microbands of 25-50 foragers who seasonally came together to form larger groups, following a “fission/fusion” model (Barber, 2020). Freshwater wetlands and bogs resulting from glacier melt-induced sea level rise were common sites of Archaic Period settlements in the Coastal Plain province (Custer, 1990).

By the end of the Archaic Period climatic warming had produced an essentially modern environment (Egghart, 2020d). While the hunter-gatherer lifeway persisted, population migration to the floodplains along rivers was underway (Egloff and Woodward, 2000). Native plants such as *Chenopodium*, sumpweed, sunflower, and amaranth were exploited, foreshadowing the beginning of horticulture (Egghart, 2020d). Riverine resources such as shellfish and anadromous fish served as rich sources of food. Heavy, not easily-transported bowls carved of steatite (soapstone), a soft stone that is easily worked and which does not break when heated, hint at a more sedentary lifeway (Barber, 1991).

Figure 2. Prehistoric projectile points. Top row: Archaic Period points, left to right: Kirk Corner-notched, St. Albans bifurcated, Morrow Mountain, Savannah River. Bottom row: Woodland Period points, left to right: Calvert, Piscataway, Potts, Yadkin. (Photo adapted from photos by Chris Egghart, with permission).

Woodland Period Context

The Woodland Period is temporally bounded by the end of the Archaic Period in 1200 BC and the arrival of European colonists in 1607, marking the start of the Historic Period (Egloff and Woodward, 2000).

Dendrochronologic studies and data obtained from Greenland ice cores suggest that by the start of the Woodland Period the warm, dry climate of the late Archaic Period had transitioned to a cooler, moister environment such that climate and vegetation characteristics in Virginia were similar to the current day (Egghart, 2020a; Nash, 2020). The Chesapeake Bay had reached its modern extent, providing a ready supply of food resources (Egghart, 2020c).

Characteristics of Woodland Period culture include an increasingly sedentary settlement strategy based on semipermanent coastal base camps and hamlets from which small groups made forays to the uplands to harvest terrestrial resources (Stewart, 1992). Large numbers of what appear to have been seasonally occupied base camps have been identified in the Coastal Plain province (Nash, 2020). Territoriality associated with population growth and competition between groups increased, reflected in the rise of palisaded villages (Turner, 1992). Another defining characteristic of the late Woodland Period is the beginning of horticulture, initially based on maize at approximately 1100 AD, followed by the addition of squash and legumes by 1300 AD (Nash, 2020).

The material culture of the Woodland Period differs from that of the preceding Archaic Period. Small stemmed, notched and lanceolate projectile points made of quartz, quartzite, and chert corresponding to the introduction of the bow and arrow replaced large broadspear forms

(McLearen, 1991; Nash, 2020) (Figure 2). Chipped- and ground-stone axes and grubbers reflect an increasingly plant-based economy (Egghart, 2020c).

Ceramics manufacture and use is another defining characteristic of the Woodland Period (Egloff and Woodward, 2000). While initially slab-constructed and flat bottomed like the soapstone bowls of the Archaic Period, Woodland Period ceramics rapidly evolved to a coil-constructed, round-bottomed form suited to cooking on an open fire (McLearen, 1991) (Figure 3).

Figure 3. Archaic and Woodland Period ceramics. Top row: Late Archaic Period steatite bowl fragment, Woodland Period Ware Plain. Bottom row: Woodland Period Potomac Creek Ware, Woodland Period Accokeek Ware (photo adapted from Chris Egghart, with permission).

Study Area

This project targeted prehistoric sites located in Gloucester County, Virginia, measuring approximately 26 miles from north to south, 14 miles from east to west, and encompassing approximately 300 square miles (Figure 4). It borders King and Queen and Middlesex Counties to the north, Matthews County to the east, James City County to the west, and York County to the south. Gloucester County occupies the southeast extremity of the Middle Peninsula of Virginia, bounded by the Rappahannock River to the north and the York River to the south.

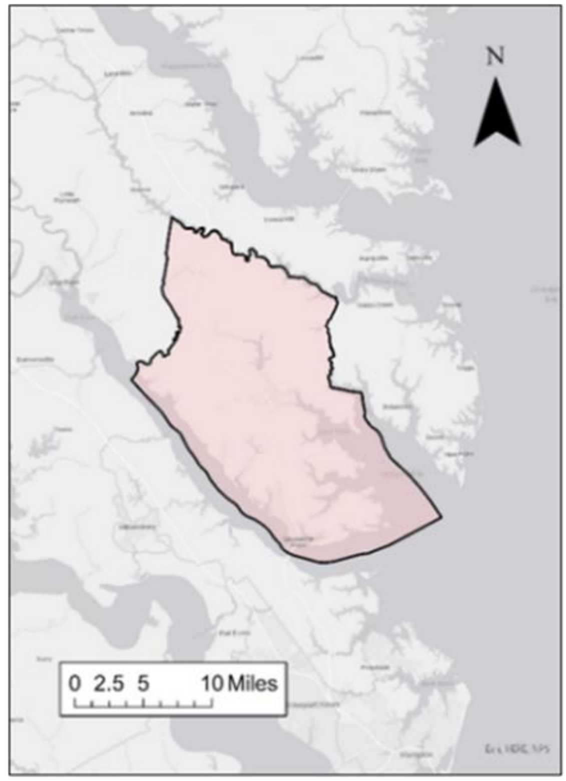

Figure 4. Gloucester County boundary (rose) located on the southeast extremity of the Middle Peninsula of Virginia.

Introduction Summary

The current project used geospatial techniques to study Archaic and Woodland Period Native American archaeological sites registered with the Virginia Department of Historic Resources (VDHR). Site locations and attributes (elevation, slope, and distance to water) were analyzed and compared, and used to generate location models identifying geographic areas with high probabilities of containing yet-to-be identified prehistoric archaeological sites located on the Virginia Coastal Plain.

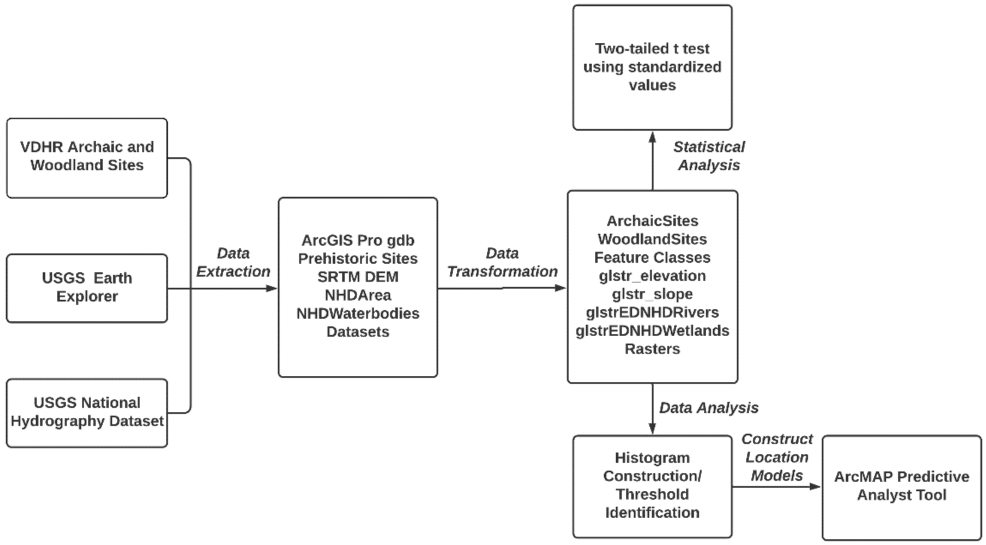

Figure 5. Data Flow Diagram illustrating the project workflow. Data extracted from project data sources were entered into an ArcGIS Pro® geodatabase and then transformed into rasters comprised of elevation, slope, distance to rivers/streams and distance to wetlands attributes and feature classes for Archaic and Woodland Periods archaeological sites. Attributes were tested statistically for differences between Archaic and Woodland Period sites. Data thresholds identified using the Geographic Analysis Histogram tool were used to construct archaeological location models using the ArcMAP® Predictive Analyst tool.

Methods

Introduction

The approach to this project is shown in the workflow diagram presented in Figure 5. Data were extracted from multiple databases. Geospatial attributes of Archaic and Woodland Period sites were analyzed and compared, location models were constructed, and their performance assessed.

Data Sources

Data for this investigation were obtained from three sources. First, data regarding prehistoric Native American sites were obtained from VDHR, including the registration number of each site, the temporal period of the site occupation, (Archaic vs. Woodland), and geospatial data (latitude and longitude). In order to confirm the accuracy of the temporal period assignment, the VDHR registry data was compared to the original archaeological site report submitted by the investigating archaeologist at the time of registration. Discrepancies were identified and corrected in 15 of 137 sites (11%).

Second, a Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM, 1 Arc-Second resolution, Global Coverage) encompassing the area of investigation was downloaded from the United States Geological Survey (USGS) dataset accessed through the USGS EarthExplorer website (Figure 6).

Third, the National Hydrography Dataset (NHD) was the source of data regarding waterbodies, rivers and streams used in this investigation. The NHD FCodes, comprised of a five-digit integer defining the feature type, characteristics, attributes, and values of the water features analyzed in this investigation are shown in Table 1.

Data Extraction, Transformation, and Display

The NAD 1983 (2011) StatePlane Virginia

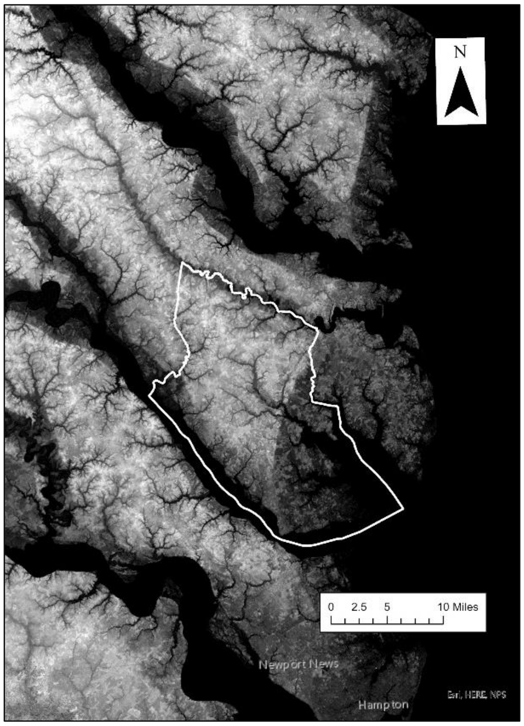

Figure 6. Virginia Coastal Plain province. Gloucester County, VA is shown in white outline. SRTM DEM (Entity ID: SRTM1N37W077V3, 1 Arc-Second resolution, Global Coverage, published 2014-09-23, coordinates 37, -77). Resolution: X and Y cell size 92.2 feet.

South FIPS 4502 (US Feet) projected coordinate system with the Lambert Conformal Conic projection was chosen for the analysis.

Archaic and Woodland Period sites data from the VDHR and the USGS SRTM DEM map (Figure 6) were entered into an ESRI ArcGIS Pro® geodatabase, and feature classes for Archaic and Woodland Period sites generated (Figures 7 and 8). The SRTM DEM map was masked to limit it to Gloucester County and then used to construct elevation (Figure 9) and slope (Figure 10) rasters.

The National Hydrography Dataset Area (Figure 11) and Waterbody (Figure 12) shapefiles were used to create distance to rivers and streams (Figure 13) and wetlands, (Figure 14) rasters.

Data Interpretation

Zonal statistics were used to calculate four geospatial attributes of Archaic and Woodland Period sites, including elevation, slope, distance to rivers, and distance to wetlands. The Geostatistical Analyst tool was used to calculate the means and standard deviations of each of the four attribute values and to create histograms showing the distribution of Archaic and Woodland Period sites in relation to them. These histograms were examined to identify "thresholds", defined as attribute values where site frequency abruptly changed. Thresholds for elevation, slope, distance to rivers, and distance to wetlands provided the basis for creating location models using the

Table 1. National Hydrography Dataset (NHD) water feature shapefile name, FCode with description and attributes of water features analyzed in the current investigation.

NHD Source Shapefile	FCode	NHD Description	Attributes
NHDArea	46006	Stream/River	Perennial
	36400	Foreshore	No attributes
NHDWaterbody	39000	Lake/Pond	No attributes
	39004	Lake/Pond	Perennial
	43600	Reservoir	No attributes
	43613	Reservoir	Water Storage
	46600	Swamp	No attributes
	49300	Estuary	No attributes

ArcMAP® Predictive Analyst add-in tool. The output of the analysis was a map showing the location of prehistoric sites (Archaic or Woodland Period) superimposed upon a composite raster created from Boolean overlays of elevation, slope, distance to rivers, and distance to wetlands rasters (Figures 15-18). In each of the four individual component rasters, pixels in which a criterion selected by the user (chosen based on threshold values) was fulfilled was scored as “1”, while non-fulfilled pixels were scored as “0”. The tool allows the user to gradually refine a location model by selectively altering attribute values in an iterative fashion, eventually yielding a raster classified by the number of criteria fulfilled, ranging from “0” to “3.” This score was then used to classify the area of investigation as having a very low (no criteria met), low (1 criterion), intermediate (two criteria), or high (three criteria

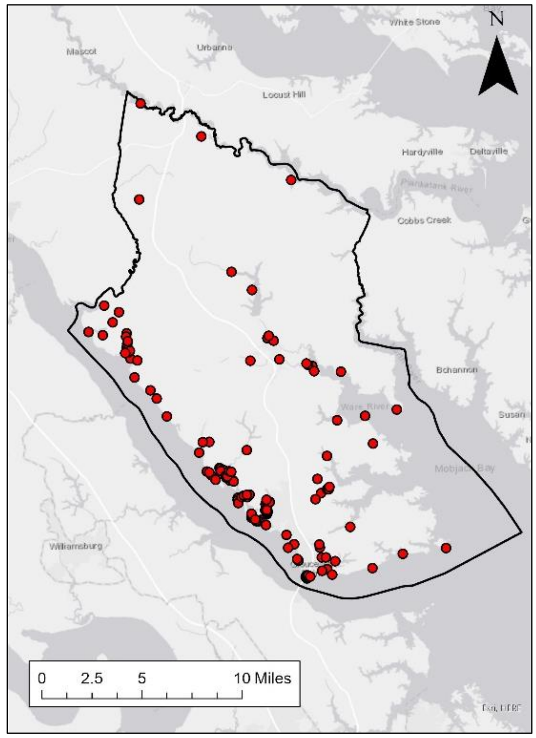

Figure 8. One hundred twenty seven Woodland Period sites (red circles) located in Gloucester County, Virginia (black outline) registered with the VDHR.

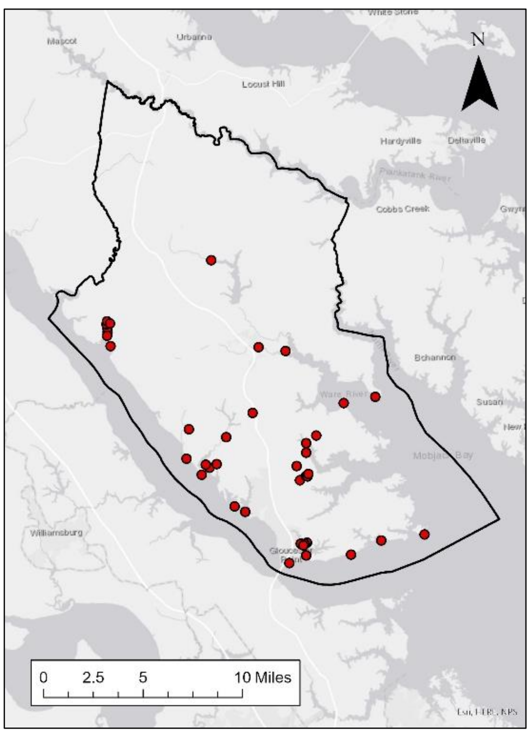

Figure 7. Thirty-nine Archaic Period sites (red circles) located in Gloucester County, Virginia (black outline) registered with the VDHR.

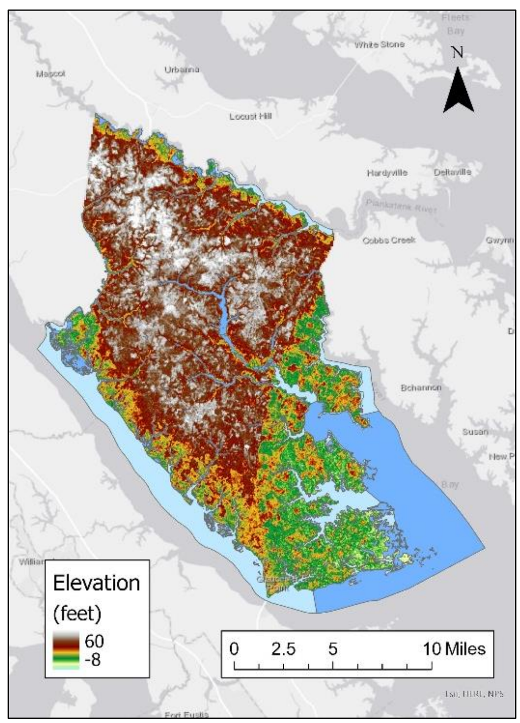

Figure 9. Elevation of terrain in Gloucester County, Virginia. The NHD Rivers (light blue) and NHD Wetlands (dark blue) feature classes are also displayed. Source data: USGS SRTM DEM.

Figure 10. Slope of the terrain in Gloucester County, Virginia. The NHDArea (light blue) and NHDWaterbody (dark blue) feature classes are also displayed. Source data: USGS SRTM DEM.

Figure 11. NHD Rivers with extent limited to Gloucester County, Virginia. Water features comprised of rivers and streams (shown in light blue). Source data: NHDArea shapefile.

Figure 12. NHD Wetlands, with extent limited to Gloucester County, Virginia. Water features comprised of estuaries, swamps, reservoirs, lakes, and ponds (shown in dark blue). Source data: NHDWaterbody shapefile.

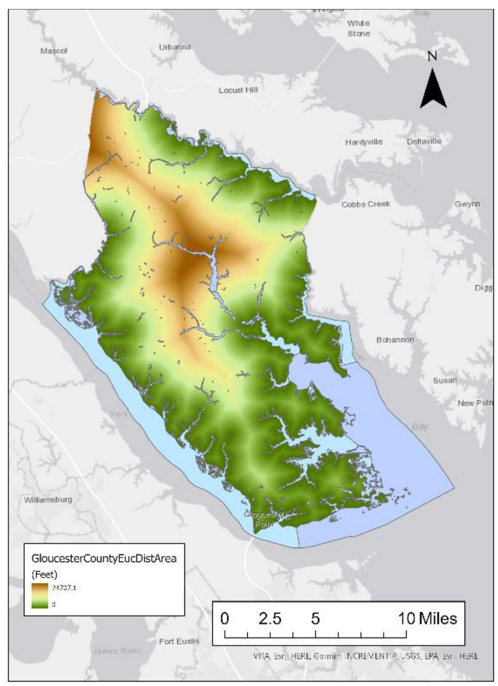

Figure 13. Euclidean Distance to Rivers and Streams in Gloucester County, Virginia. The NHD Rivers (light blue) and NHD Wetlands (dark blue) feature classes are also displayed.

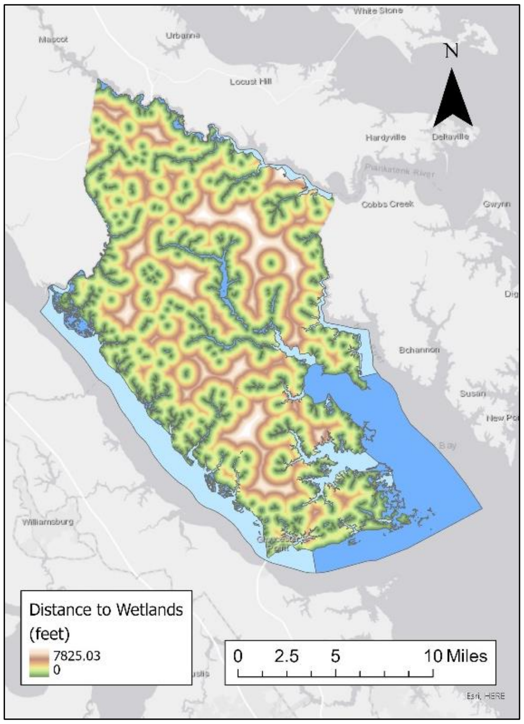

Figure 14. Euclidean Distance to Wetlands in Gloucester County, Virginia. The NHD Rivers (light blue) and NHD Wetlands (dark blue) feature classes are also displayed.

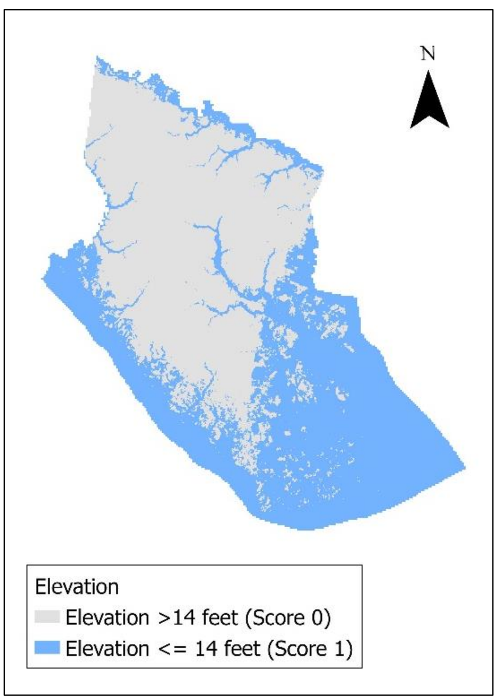

Figure 15. Boolean raster showing portion of the area of interest (Gloucester County) having an elevation ≤ 14 feet above sea level (blue, scored as 1) and that portion with elevation > 14 feet (gray, scored as having a value of 0).

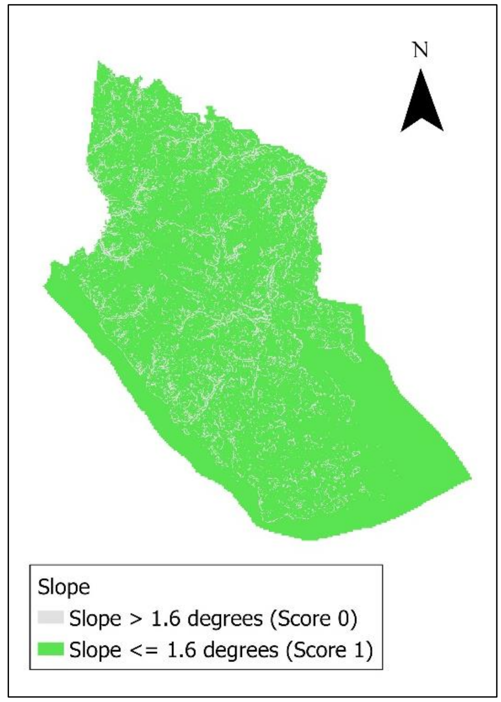

Figure 16. Boolean raster showing area of interest having slope ≤ 1.6 degrees (green, scored as 1) and areas with slope > 1.6 degrees (gray, scored as 0).

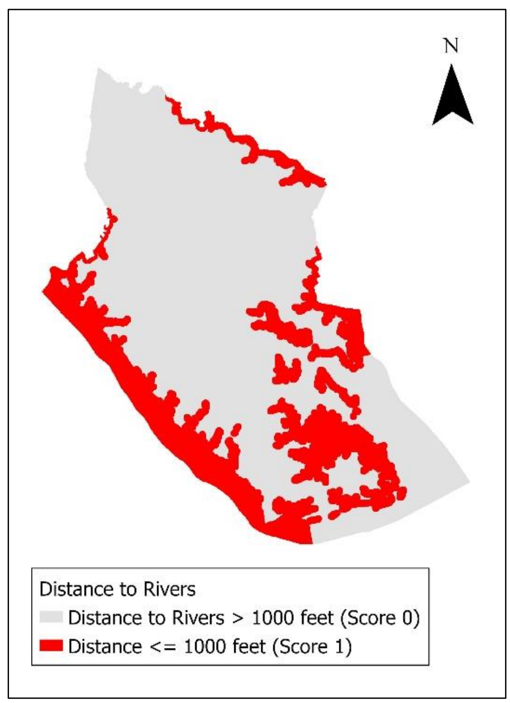

Figure 17. Boolean raster showing area of interest having a distance to rivers ≤ 1000 feet (red, scored as 1) and areas with distance to rivers > 1000 feet (gray, scored as 0).

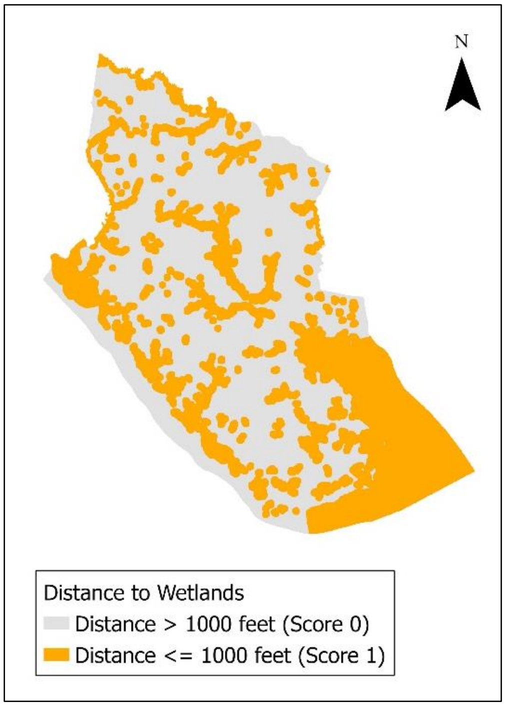

Figure 18. Boolean raster showing area of interest having a distance to wetlands ≤ 1000 feet (orange, scored as 1) and areas with distance to wetlands > 1000 feet (gray, scored as 0).

fulfilled) probability of containing a prehistoric site.

Statistical Analysis

Statistical Comparison of Archaic and Woodland Sites

The continuous variables (elevation, slope, distance to rivers and distance to wetlands) for Archaic sites were compared with the same variables for Woodland sites using Student's two-tailed t test. Since the values of those variables were skewed, and the study populations were relatively small (39 Archaic and 127 Woodland sites), values were standardized prior to comparison, using the formula:

$$Z = (X-\mu)/\sigma$$

where Z = standardized values,
X = observed values,
μ = mean of all observed values, and σ = standard deviation of all observed values.

Comparison of Location Models

The output of the Predictive Analyst tool consisted of models constructed with various combinations of the elevation, slope, distance to rivers and distance to wetlands values and their relationship to Archaic and Woodland sites. The performance of those models was assessed based on two qualities. First, the accuracy of the model, defined as the proportion of the total number of sites found to be located in areas predicted to contain sites was calculated. Second, the precision of the model, defined as the proportion of the total area of investigation classified as highly likely to contain a site, was calculated. An effective model combines high accuracy and high precision. In the current investigation, models in which a high proportion of the total number of sites are located in high probability areas were considered to be accurate. Models in which high probability areas comprised a small proportion of the total area of investigation were considered to have good precision.

In this analysis, the Kvamme's Gain statistic was used to determine the performance of the location models produced by the Predictive Analyst tool (Kvamme, 1988b). This statistic, described by Kvamme (1988a), scores an archaeological location model relative to chance. The formula for the Kvamme's Gain (KG) statistic is:

KG = 1 – (percentage of total area covered by model / percentage of total sites within model area).

The output measures what the model gains over random chance and considers both accuracy and precision. A score of 0.5 is equal to chance, while models with scores exceeding 0.65 are considered to have good performance.

Results

Introduction

The results of this project consist of two components. First, a statistical comparison of elevation, slope, and distance to either rivers or wetlands values was performed, seeking to identify differences in the site characteristics for the two temporal periods (Table 2). The second component of the analysis consisted of a series of location models characterizing the geospatial attributes of Archaic and Woodland Period sites, whose performance was assessed with the Kvamme's Gain statistic (Tables 3 and 4).

Archaic and Woodland Period Attributes

Archaic and Woodland Period sites were compared (Table 2). After standardizing variables, the two-tailed t test found no difference in elevation, slope, distance to rivers, or distance to wetlands between Archaic and Woodland Period sites.

Archaic Period Site Models

A series of Archaic Period site models (shown in Table 3) were constructed using mean plus one standard deviation as the attribute value for elevation and slope, (14 feet and 1.6 degrees, respectively). These values were chosen based on the histograms identifying thresholds at 14 feet elevation and 1.6 degrees slope in the distribution of Archaic sites (Figures 19 and 20). The models were performed using 500-, 1000-, 1500-, and 2000-foot distances to rivers or wetlands. Models incorporating distance to wetlands performed poorly, with KG scores typically less than 0.5. In contrast, the models incorporating the distance to rivers were highly predictive, with scores ranging from 0.64-0.65. An Archaic Site location model based on elevation ≤ 14 feet, slope ≤ 1.6 degrees, and distance to river ≤ 1000 feet yielding a high performance KG score of 0.66 is shown in Figure 21. This model captured 25/39 (64%) of Archaic sites in an area comprising 23% of the total area of investigation.

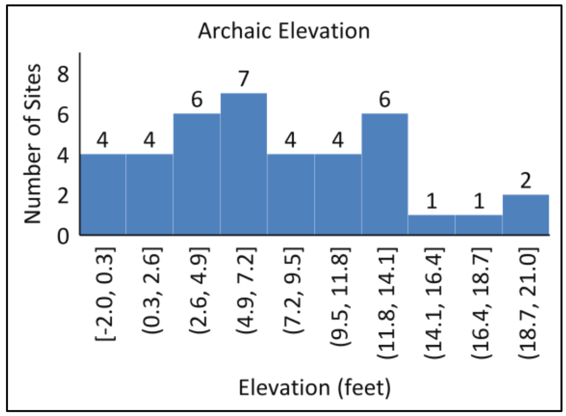

Figure 19. Histogram showing distribution of Archaic Period sites in relation to elevation. Ninety-seven percent (35/39) of the sites are located on terrain ≤ 14 feet above sea level. Data extracted from elevation raster and the Archaic Sites feature class.

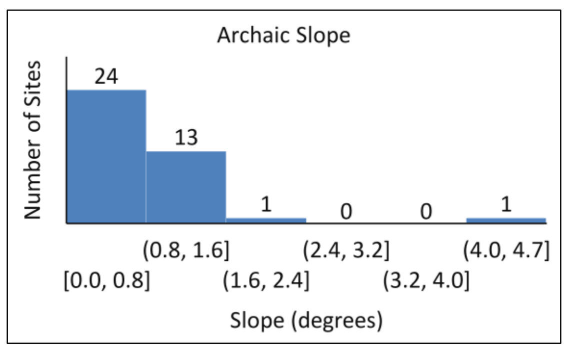

Figure 20. Histogram showing distribution of Archaic sites in relation to slope. Ninety-five percent (37/39) of the sites are located on terrain with slope ≤ 1.6 degrees. Data extracted from slope raster and Archaic Sites feature class.

Table 2. Comparison of Archaic and Woodland Period site attributes (Elevation = feet, Slope = degrees, Distance Rivers = feet, and Distance Wetlands = feet). Two-tailed t test for Elevation, Slope, Distance Rivers and Distance Wetlands performed after standardization of data shows no significant difference between attribute values for Archaic and Woodland Period sites.

Site Class	Elevation	Slope	Distance Rivers	Distance Wetlands
Archaic (Mean)	7.5	0.9	1566	864
SD	5.5	0.7	3952	845
Woodland (Mean)	9.7	0.9	1286	676
SD	5.2	0.7	3372	676
p	0.83	0.40	0.32	0.32

Table 3. Archaic Time Period models based on site elevation in feet (E), slope in degrees (S), Distance to Wetland or Distance to River in feet. Values for elevation and slope represent the mean plus one standard deviation. Total pixel count of entire area of investigation (Gloucester County, Virginia) = 936877 pixels.

Model Attributes Selected	Sites Captured	Proportion Sites Captured	Pixel Count of Area Captured	Proportion of Total Pixels	KG
E 14, S 1.6, Wetland 500	14/39	0.36	210449	0.22	0.39
E 14, S 1.6, Wetland 1000	21/39	0.54	260914	0.28	0.48
E 14, S 1.6, Wetland 1500	26/39	0.67	302879	0.32	0.52
E 14, S 1.6, Wetland 2000	31/39	0.80	336813	0.36	0.55
E 14, S 1.6, River 500	20/39	0.51	169897	0.18	0.65
E 14, S 1.6, River 1000	25/39	0.64	212514	0.23	0.64
E 14, S 1.6, River 1500	29/39	0.74	246256	0.26	0.65
E 14, S 1.6, River 2000	31/39	0.80	275149	0.29	0.64

Table 4. Woodland Time Period models based on site elevation in feet (E), slope in degrees (S), Distance to Wetland or Distance to River in feet. Total pixel count of entire area of investigation = 936877 pixels.

Model Attributes Selected	Sites Captured	Proportion of Sites Captured	Pixel Count of Area Captured	Proportion of Total Pixels	KG
E15, S 1.6, Wetland 500	54/127	0.43	213723	0.23	0.47
E 15, S 1.6, Wetland 1000	81/127	0.64	267051	0.29	0.55
E 15, S 1.6, Wetland 1500	89/127	0.70	311542	0.33	0.53
E 15, S 1.6, Wetland 2000	97/127	0.76	347416	0.37	0.51
E 15, S 1.6, River 500	68/127	0.54	170967	0.18	0.67
E 15, S 1.6, River 1000	89/127	0.70	215434	0.23	0.67
E 15, S 1.6, River 1500	95/127	0.75	250895	0.27	0.64
E 15, S 1.6, River 2000	98/127	0.77	281572	0.30	0.61

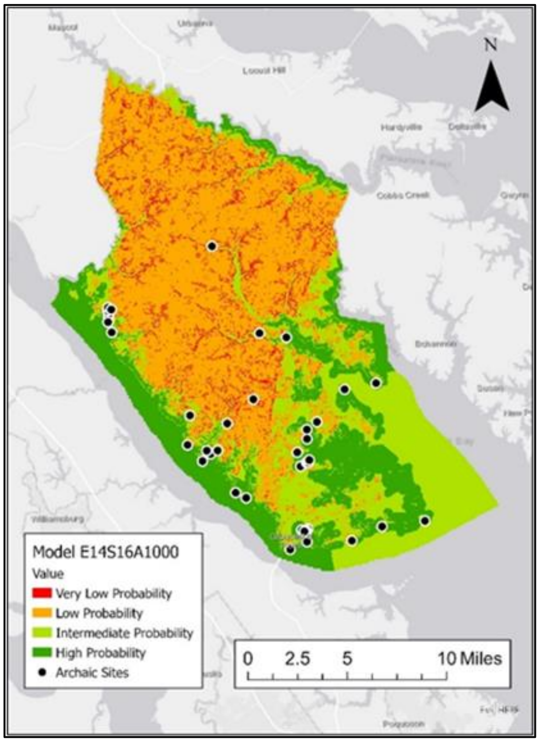

Figure 21. Archaic site location model, Gloucester County, Virginia. Criteria used to calculate model assessing probability of site location included elevation ≤ 14 feet, slope ≤ 1.6 degrees, and distance to river ≤ 1000 feet. Classification score: Very low probability of site location (red) = 0 criteria fulfilled; Low probability of site location (orange) = 1 criterion fulfilled; Intermediate probability of site location (light green) = 2 criteria fulfilled; High probability of site location (dark green) = 3 criteria fulfilled. The model captures 25/39 (64%) of the sites in a high probability area. Proportion of the study area predicted to have a high probability of containing an Archaic site was 0.23, yielding a Kvamme's Gain = 0.65.

Woodland Period Site Models

Woodland Period models using the mean plus one standard deviation values for elevation and slope (15 feet and 1.6 degrees, respectively (Table 4) and based on a review of histograms (Figures 22 and 23) yielded results similar to those seen in the Archaic Period models. Distance to wetlands in all models gave only marginally predictive results (KG 0.47-0.55), while models incorporating distance to rivers performed well (KG 0.61-0.67). Figure 24 shows a Woodland Period Site Model using elevation ≤ 15 feet, slope ≤ 1.6 degrees, and distance to river ≤ 1000 feet. In this model 85/127 (67%) Woodland Period sites were located in high probability areas, which comprised 23% of the total area, yielding a KG score of 0.66.

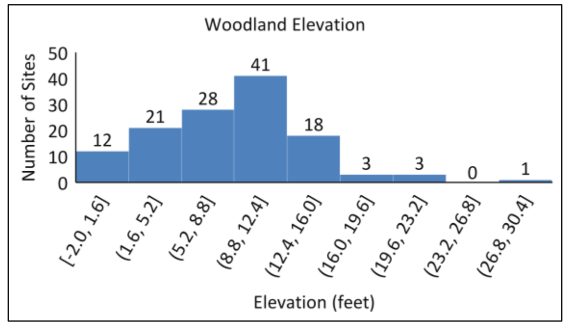

Figure 22. Histogram of distribution of Woodland sites in relation to elevation. Eighty-five percent (108/127) sites are located on terrain ≤ 15 feet above sea level.

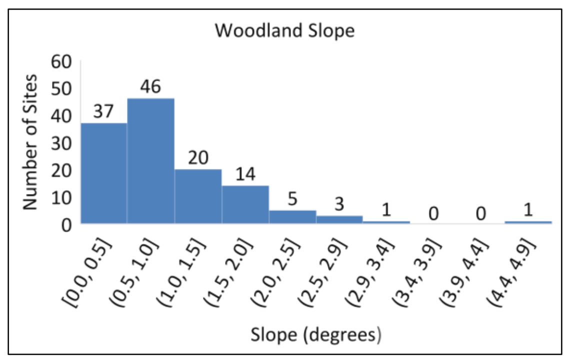

Figure 23. Histogram of distribution of Woodland sites in relation to slope. Eighty-one percent (103/127) sites are located on terrain with slope ≤ 1.6 degrees.

Discussion

While GIS has been employed to address archaeological questions since the 1970's, early capabilities were limited (Kvamme, 1995). Archaeological site analysis required direct measurement of attributes of interest. Statistical associations based on probabilistic selection and interpolation from geophysical surveys required complex mathematical modeling (Altschul and Nagle, 1988). The availability of satellite-recorded digital elevation models of regional surfaces marked a major step forward in archaeological science, facilitating spatial analysis, regional spatial database mapping, and serving as a primary tool for constructing location models. Improved platforms for creating surface generalizing models of artifact distribution, digital elevation, computer simulations, and predictive modelling have advanced to the point that archaeology without GIS analysis has become nearly inconceivable (Kvamme, 1995).

The current project examined the distribution of prehistoric archaeological sites in Gloucester County, Virginia, and analyzed a variety of geophysical attributes. Substantial differences in lifeways between those periods in the Virginia Coastal Plain province are well documented (Means and Moore, 2020). The needs of Archaic Period hunter-gatherers foraging in upland regions differed from those of the more sedentary, riverine-focused Woodland Period, and these differences are often reflected in the attributes of their settlement sites (Klein and Klatka, 1991; Parker, 1990; Turner, 1992). Attributes analyzed in this project included elevation, slope, distance to rivers, and distance to other wetlands. Interestingly, no statistical difference between Archaic and Woodland Period sites was identified for any of these four attributes, although a closer examination of the study population provides a more nuanced interpretation. One hundred thirty seven prehistoric sites were studied. Thirty-nine of these sites were classified as Archaic, based on artifacts recovered from those sites having been dated to the Archaic Period (8000 to 1200 BC). One hundred twenty seven sites were classified as dating to the Woodland Period (1200 BC to 1607 AD). Importantly, however, 29 of the total 39 (74%) Archaic Period sites were also classified as Woodland Period sites, based on the recovered artifacts. Given the large proportion of combined Archaic and Woodland Period sites it is not surprising to find a lack of significant differences between the groups in terms of the site elevation, slope, or distance to either rivers or other wetlands (Table 2). Notably, both Archaic and Woodland sites were clustered in proximity to rivers and streams, as seen in Figures 21 and 24.

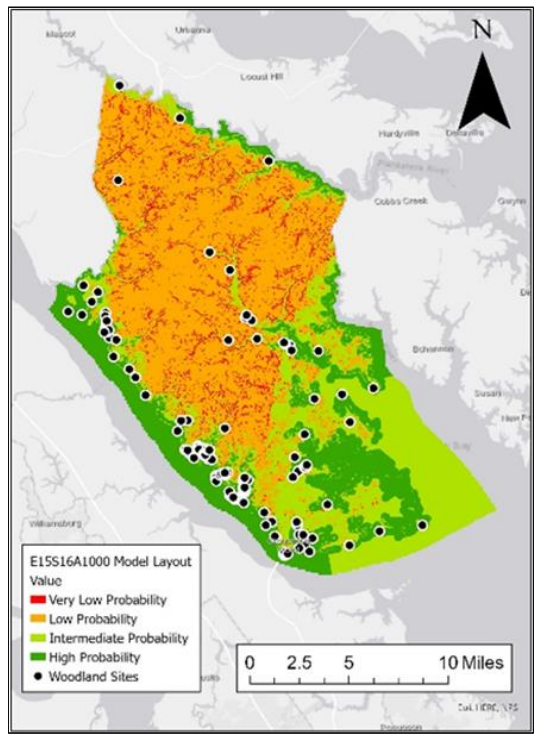

Figure 24. Woodland site location model, Gloucester County, Virginia. Criteria used to calculate model for site probability included elevation ≤ 15 feet, slope ≤ 1.6 degrees, and distance to rivers ≤ 1000 feet. Classification score: Very Low probability of site location (red) = 0 criteria fulfilled; Low probability of site location (orange) = 1 criterion fulfilled; Intermediate probability of site location (light green) = 2 criteria fulfilled; High probability of site location (dark green) = 3 criteria fulfilled. The model captures 85/127 (67%) of the sites in high probability areas. Proportion of study area predicted to have high probability of containing a Woodland site was 0.23, yielding a Kvamme's Gain = 0.66.

Location models for prehistoric sites were generated, based on a composite raster created by overlaying Boolean rasters displaying individual site attributes in relation to each Archaic or Woodland Period site. As seen in Tables 3 and 4, different combinations of attributes produced similar KG scores. For example, both the Woodland and Archaic models showed good performance (KG scores 0.64-0.67) at distance to rivers ranging from 500 to 2000 feet (Tables 3 and 4). An inverse relationship exists between the proportion of sites captured and the area classified by the model as highly likely to contain sites. Models based on greater distance to rivers captured a high proportion of sites, although at the expense of increasing the study area (more accurate but less precise). Alternatively, models in which the distance from water is minimized capture a smaller proportion of sites (more precise but less accurate). While the two models differ in precision and accuracy, their overall model performance (assessed by the KG score) is the same.

The inverse relationship existing between accuracy and precision permits investigators to choose a model best addressing their research question. For example, in an investigation of the Woodland Period in which capturing the largest proportion of sites takes priority over area, an investigator might choose the model using the 2000 foot distance to river option, in which 98 of 127 (77%) sites are captured, at the expense of accepting a high-probability area comprising 30% of the total area of investigation. This model yields a well-performing KG score of 0.61 (Table 4). Alternatively, models in which minimizing the area classified as high-probability can be chosen, although at the expense of decreasing the percent of captured sites. In Table 4, the model for Woodland sites in which the distance to rivers is ≤ 500 feet classifies 18% of the total area of investigation as high-probability, while capturing 68 of 127 (54%) of sites. This model yields a KG score of 0.67, indicating good performance.

The current investigation is based on data obtained from the VDHR database. While using existing databases to create location models is common and appropriate, the approach is subject to several potential sources of bias (Kvamme, 1988b). Several individually registered sites in close proximity to each other may in fact represent a single larger site (Kvamme, 1988a). Archaeological methods used in prior fieldwork may vary from site to site, potentially resulting in incomplete or conflicting data. In the field, more readily noticed artifacts are more likely to be discovered, while less obtrusive material culture may not be recognized. In addition, the definition of a “prehistoric site” may be different for different investigators. A small, diffuse lithic scatter may be recorded as a site by one researcher, while being disregarded by another. Moreover, difficult access to an area may lead to undersampling. Finally, discrepancies between field notes and final registration data may occur. For example, in the current project, 11% of VDHR records were found to have significant differences from the original field notes, which were corrected prior to performing the analysis.

An important limitation of this project is that the actual significance of the attributes used in the analysis may be overestimated. Elevation and slope are commonly analyzed variables in location modeling studies and were two major components of this analysis. A closer look at the elevation map shows that Gloucester County terrain is relatively flat (Figure 9). While the elevation values range from sea level to 60 feet above sea level, this variation is misleading. Gloucester County appears to have two elevation levels, one corresponding to the northwest half, whose mean elevation is greater than 30 feet, separated from the southeast half whose mean elevation is less than 14 feet above sea level. One result of this relative uniformity of elevation is that slopes are low, ranging from 0 to 7.6 degrees (Figure 10). In addition, the uniform terrain eliminates aspect, another commonly used attribute in location models, as a useful factor for analysis. Since all the prehistoric sites in this project are located in areas with slope values less than 5 degrees and elevation below 60 feet above mean sea level, the impact of these attributes on the analysis is reduced, strongly suggesting that other factors played significant roles in site selection. Incorporating other attributes into the model criteria, such as soil type obtainable through the United States Department of Agriculture, might yield significant insights, particularly in Woodland Period sites where horticulture was an important lifeway component.

It is important to recognize a potentially more fundamental limitation of this study. While location models are useful in identifying associations between sites and geospatial attributes, key socio-cultural variables, which are difficult to quantify in spatially measurable terms, are excluded from consideration (Whitley, 2003). Separate from our ability to measure such variables, it is expected that cognitive and socio-cultural factors with probable profound impact on Archaic and Woodland Period site selection are likely unsuspected at such a distance in time and milieu.

While this project focused on Gloucester County archaeological concerns, location modeling has other potential stakeholders, both in Virginia and elsewhere. As an example, locating, recording, and characterizing prehistoric sites in other Virginia counties by other archaeological groups could produce important information. In addition, broadening location modeling beyond the binary attribute classification system employed in the current project, to include more nuanced, multiple category classification criteria, could yield more granular insights into factors that led to site location, as well as providing another means of site discovery.

Conclusions

This project has identified several characteristics of Archaic and Woodland Period archaeological sites. First, no significant difference was identified between Archaic and Woodland Period sites for elevation, slope, distance to rivers or distance to wetlands. This may be due to the fact that 74% of the Archaic Period sites in this study were also classified as Woodland. Second, elevation and slope likely played a minor role in site selection due to the uniformity of terrain in Gloucester County. Third, while distance to wetlands such as estuaries, swamps, and marshes was not strongly associated with site locations, distance to rivers was highly important, with a demonstrable effect on location models at distances ranging from 500 to 2000 feet. Finally, the analysis was limited to geophysical attributes, and therefore the impact of important cognitive and socio-cultural factors could not be assessed.

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