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A Local Analysis of Early-Eighteenth-Century Cherokee Settlement

Results of an original analysis of Cherokee town placement and population c. 1721 are presented. Period and contemporary information were analyzed using local statistics to produce multivalued, mappable characterizations of the intensity of the processes of town placement and population. The analysis focuses on the scale and the space in which these processes took place among the Cherokee in order to open the way for examining the legacy of human-induced environmental change in southern Appalachia.

There are numerous eyewitness descriptions of the eighteenth-century Cherokee Indians of southern Appalachia by traders, missionaries, and military personnel (Chicken 1895; Timberlake 1948; Long 1969; Adair 1974 [1930]). From the wealth of primary information, subsequent interpreters have described the Cherokee social, political, legal, and ideological organization (Gilbert 1943; Reid 1970; Gearing 1974 [1962]; Goodwin 1977) or the political and economic changes that took place among them during the eighteenth century (Reid 1976; McLoughlin 1984; Hatley 1993; Fabel 2000; Oliphant 2001). However, the study of colonial Cherokee settlement can still be characterized as "drawing circles or 'jelly beans' around clusters of sites where archaeologists have found similar material remains" (Hudson 2002: xi).

This is surprising since the various events of the eighteenth century not only led to changes in the social structure of the Cherokee but reworked the geography of social relations within and beyond the region occupied by

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the Cherokee (Reid 1976; McLoughlin 1984; Oliphant 2001). The properties of how the Cherokee occupied the land are central to understanding why they underwent the cultural changes they did during the colonial and early American periods. Without a clear understanding of the regional social landscape of the eighteenth-century Cherokee, many historical claims about them are little better than conjectures.

We present results from our original analysis of Cherokee town placement and population c. 1721. This date represents the first point after the earliest contact between the Cherokee and the British for which there is substantial eyewitness evidence, but before the major social, economic, and political changes the Cherokee underwent during the late colonial and early American periods. Our objective is to dissect first-relative to second-order processes of settlement events in a regional context. With towns as the unit of analysis, we dissect global statistics into their local constituencies to map the differences in town placement, town population, and settlement intensity (Fotheringham et al. 2000; Healey and Stamp 2000; Abbott 2001). Global statistics are single-valued, aspatial characterizations of a whole region (i.e., mean). Local statistics disaggregate global statistics into multivalued, mappable characterizations of localities (i.e., intensity). While the first emphasizes similarities across space, the latter emphasizes differences.

For this analysis we use the first true census of the Cherokee (Varnod 1967 [1724]) and the first detailed English map of the southern frontier of North America (Barnevelt c. 1744). The census and map have been used independently by several previous authors to estimate total Cherokee population (Thornton 1990) or to produce lists of town names (Smith 1979) but have never been used in combination or complemented by other period information, as we do, to examine Cherokee town placement and population regionally. We believe that a regional analysis of Cherokee town placement and population makes it possible to build ever-richer syntheses of the forces that shaped North American Indians in the eighteenth century. It also opens the way for examining Cherokee effects on their surroundings to determine the legacy of human-induced environmental change in southern Appalachia (Gragson and Bolstad 2006).

The examination of such issues in southern history in general and southern Appalachia in particular has often relied on crude geographic determinism. The isolation and ruggedness of the southern Appalachian Mountains, for example, have been used to explain the personality and actions of its inhabitants (Philliber 1994). Alternatively, individuals have been portrayed as mere pawns in ever-expanding market relations over which they had little or no control (Dunaway 1996). Contemporary scholarship is moving away from such stereotypes toward process and explanation (Axtell 1997; Davis 2000; Oliphant 2001). In so doing, the long-standing parochialism of southern history is giving way to the recognition of internal variation of many kinds (Kolchin 2003). In this context we view our contribution from the present analysis as twofold.

Our first contribution is the development of the dataset itself. We used primary and secondary cartographic evidence complemented with narrative materials in a process comparable to the one Patricia Galloway (1995) used in her historical analysis of Choctaw ethnogenesis. The dataset we developed is rich enough to sustain several different types of inquiry into the situation of the Cherokee in the eighteenth century (Bolstad and Gragson forthcoming). There have been two previous attempts to reconstruct Cherokee town placement and population in the eighteenth century, but their distinct problems limit their utility for understanding this period.

Gary C. Goodwin (1977) developed three maps that collapsed town location across periods of several decades each to explain the condensing of ethnic space in the eighteenth century as a consequence of European contact. Portraying Cherokee towns as fixed in space for long periods of time, however, is contrary to dissecting the dynamics of this rapidly changing period. Betty Anderson Smith's (1979) reconstruction of eighteenth-century Cherokee settlement rendered as cartographic cartoons took the representation of Cherokee towns on dated maps as proof that towns existed on the date attributed to the map. This confused repetition with validation is a problem that cannot be overlooked for this time period. Most seventeenth- and eighteenth-century maps were based on a few "mother" maps, such as Barnwell c. 1721, and individually contain relatively little new information (Robinson and Petchenik 1976; Galloway 1995).

Our second contribution is to examine Cherokee settlement by holding time constant at c. 1721 to reveal the space in which social processes took place among them (Reid 1976; Oliphant 2001). Holding time constant is not ahistorical but, rather, the means for overcoming problems inherent to most previous discussions about eighteenth-century Cherokee settlement. The pre-1776 Cherokee literature has often relied on interpretations that outrun evidence, which compounds the difficulties of making sense of a sparse and often ambiguous record. Grand narrative and evocative imagery have been used to present global generalities that apply neither any*where* nor any*time*.

For example, the battle for empire among England, France, and Spain over which European power would control North America (Crane 1981) is a grand narrative that provides little room for the activities of the Cherokee or the other Native American groups on the southern frontier. Similarly, the description of the Cherokee as "employees of a trading system built around faraway demands of European society" (Corkran 1962: 6) is an evocative image that is economically questionable since it implies market principles in a situation that lacked critical aspects of a true market. Generality and imagery offer few insights for explaining the distribution of Cherokee towns or population at the scale social processes took place. Our analysis of Cherokee town placement and population c. 1721 reveals how the Cherokee, like other Native American nations, lived in a physical world that was both natural as well as historical.

A Regional Approach to the Colonial Cherokee

At the beginning of the eighteenth century, the Cherokee were the southern Indian "mountaineers" who laid claim to some 322,600 square kilometers (125,000 square miles) of the southern Appalachian Highlands (Royce 1975 [1883]; Mooney 1995 [1900]) (see figure 1). Royce recorded the boundaries of the land claim at the end of the nineteenth century after the Cherokee had borrowed European legal terminology to support a claim that their fathers had held these lands from time immemorial (Reid 1970; Royce 1975 [1883]; McLoughlin 1986). The nineteenth-century boundary, however, does correspond to the maximum geographic space used by the eighteenth-century Cherokee to satisfy various social, political, and economic needs based on eyewitness accounts, oral history, and modeling (Bolstad and Gragson forthcoming; Chicken 1895; Long 1969; Royce 1975 [1883]).

The region for the present analysis is the 30,400 square kilometers (11,700 square miles) of concentrated Cherokee settlement in the southeast corner of the land claim (see figure 1). This area is often referred to as the "heartland" or the "settlement core" and is the most commonly represented space in the Cherokee literature (Goodwin 1977; Smith 1979; Schroedl 2000). Throughout the eighteenth century, the heartland contained most day-to-day Cherokee economic and social activities with the exception of deer hunting (Bol-

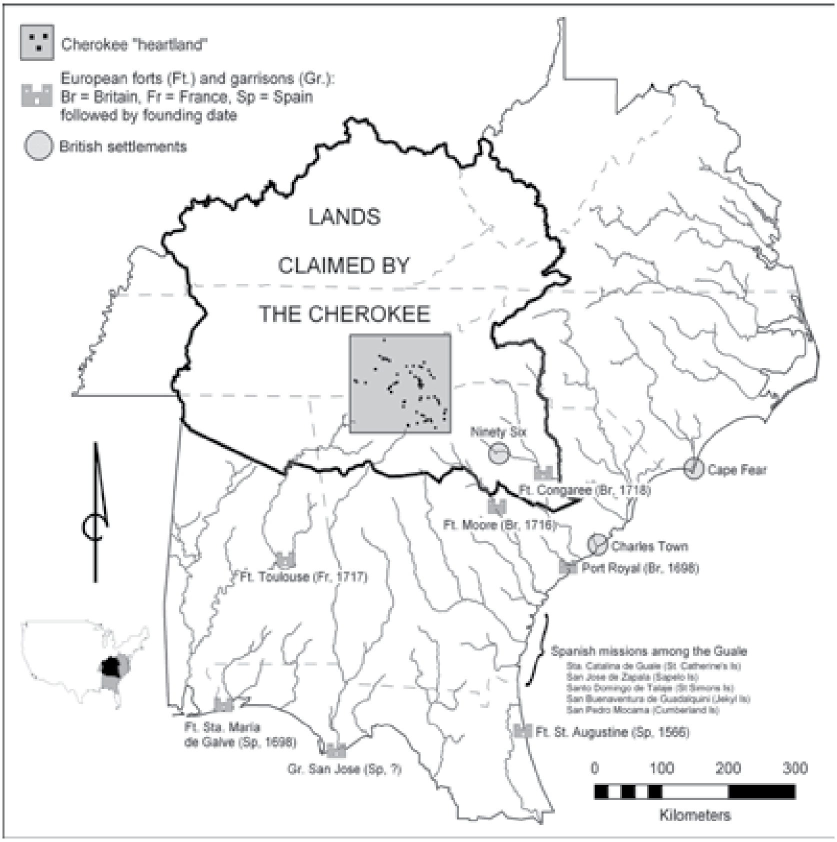

Figure 1 Cherokee land claim, c. 1721
Sources: Barnevelt c. 1744; Herbert and Hunter 1744; Boone and Barnwell 1955 [1720]: 68; Royce 1975 [1883]; Crane 1981.

stad and Gragson forthcoming). Excluding a small number of dubious claims based on unverifiable evidence (Mooney 1975 [1900]; Hoig 1998), the heartland also contained all known Cherokee settlements described by Europeans during the eighteenth century. As a region, the Cherokee heartland was a porous rather than a continuous surface that was spatially reworked during the eighteenth century (Allen et al. 1998; Fotheringham et al. 2000).

Our unit of analysis is the locality recorded on period maps and documents as a "town." There is historical and archaeological evidence that Cherokee towns in the eighteenth century were autonomous decision-making units that comprised a cluster of residential houses associated with a council house (*South Carolina Gazette* 1760; Chicken 1895; Dickens 1976; Goodwin 1977; Schroedl 2000). Fragmentation was the essence of Cherokee governance, and there was no Cherokee-wide council or ruler whose edicts were adhered to by all towns. At the town level every Cherokee had a voice in the council, and every Cherokee had a right to be heard (Reid 1970, 1976; Oliphant 2001). Decisions were reached by unanimous consent of council participants or not at all.

There are at least four grand theories in the literature explaining Cherokee settlement that can be given a spatial dimension by examining them in terms of first-, second-, and third-order processes (Fotheringham et al. 2000). First-order processes are a function of the physical setting of a town, or the likelihood of a place to receive a point, irrespective of the placement of other towns. Second-order processes reflect the interdependence or covariance between points that stem from social, political, or cultural ties between towns. Third-order processes reflect the relation between different regions irrespective of the internal placement or covariance between towns.

Production theories emphasize the placement and size of Cherokee towns as a function of the properties of the physical environment, most commonly of agriculture. These represent a first-order process of which the best known is James Adair's (1974 [1930]: 239) statement that Cherokee "towns are still scattered wide of each other, because the land will not admit any other settlement: it is a rare thing to see a level tract of four hundred acres." David H. Corkran (1962: 8) framed the issue in terms of hunting and stated unequivocally, although without any evidence, that the "Indian population bore a direct ratio to food resources" such that "a diminution of tribal hunting grounds by an invasion of aliens meant disaster."

Force-in-numbers theories emphasize the need for Cherokee towns to be militarily strong by having many able warriors and/or being close to another town that had many able warriors (Thornton 1990). Distance between towns is a second-order process, but force-in-numbers explanations are often conflated with a first-order process. Goodwin (1977: 47), for example, stated that "population aggregates were dispersed according to the carrying capacity of the land, as well as for security reasons."

Origin theories invoke second-order processes that are often abstract or indeterminate, such as mythology, clan and parentage, or language (Reid 1976; McLoughlin 1984; Oliphant 2001). Many authors describe settlement clusters among the early historical Cherokee. Frederick O. Gearing (1974

[1962]), however, states that semi-isolation of the residents of each cluster resulted in the development of mutually unintelligible Cherokee dialects that further perpetuated the isolation of clusters.

Finally, imperial theories emphasize Cherokee attraction to or involvement in trade with the British, French, or Spanish. They also typically reference imperial rivalries that originated in Europe and played out in America (Corkran 1962; Hatley 1993). This third-order process is about the relation between the Cherokee as a totality and some other ethnic, economic, or political other as a totality. We do not examine third-order processes in this article but refer to them in the conclusion as a direction to follow in future research.

Sources and Methods

We assembled the data for our regional analysis of the Cherokee c. 1721 by searching archival documents to obtain information on the location and population of Cherokee towns. This information was converted from its original paper format to a computer-compatible format (digitized), then was related to a real-world geographic coordinate system (georeferenced). The information was also compared to complementary historical information from authors with firsthand and extensive on-the-ground knowledge of the Cherokee as well as contemporary terrain information. The following section describes each source used and how we processed its information.

The Cherokee census of 1721, known as the "Varnod census," provides population information on 53 Cherokee towns and is in a letter from the Reverend Mr. Francis Varnod to the secretary of the Society for the Propagation of the Gospel in Foreign Parts (SPG) (Varnod 1967 [1724]). Varnod was an Anglican missionary of the SPG appointed to the Parish of Saint George (Charleston, South Carolina, area), where he arrived on October 23, 1723. The letter in question expresses Varnod's frustration with converting black slaves and suggests: "But there is a thing that seems to me more practicable, and that is the conversion of our Indians" (ibid.: 2). Because the Cherokee were one of the most populous Indian groups, Varnod argued that it would be good to "plant Christianity there first" (ibid.: 4). The letter ends with a table titled "A true and exact account of the number and names of all the towns belonging to the Cherrikee Nation, and the number of men, women and children inhabiting the same taken Anno 1721" (ibid.: 5).

Circumstantial evidence indicates that Varnod obtained the Cherokee census information from associates of Thomas Nairne, who was the political leader of the Dissident Anglicans from about 1702 until his death in 1715 (Sirmans 1966). This group had a particular interest in the SPG program to convert Indians during the first 20 years of the eighteenth century (Crane 1981). Nairne was also an accomplished explorer of interior Carolina and beyond (Sirmans 1966; Reid 1976; Galloway 1995) and attracted to himself a group of young men who thoroughly shaped South Carolina's Indian policy during the first half of the eighteenth century (Sirmans 1966; Reid 1976; Snapp 1996; Fabel 2000; Oliphant 2001). Three of these men left documents valuable to our study: John Barnwell, George Chicken, and John Herbert.

We used an original manuscript map known as Barnevelt c. 1744 that is a copy of the earlier manuscript map known as Barnwell c. 1721 (the copyist misspelled Barnwell's name on the 1744 map; see Cumming and De Vorsey 1998). Barnevelt c. 1744 follows the original in size, scale, and content and measures 53¼ by 31 inches with a scale of 1 inch to about 19½ miles. The main difference between the two maps is that the copy contains settlements and townships established after 1721. Barnwell c. 1721, and by extension its copy, is described as a "mother map of the first rank" (ibid.: 218) and "the first detailed English map of the southern frontier extant" (Crane 1981: 350).

John "Tuscarora Jack" Barnwell was a distinguished South Carolina Indian fighter with firsthand knowledge of the Indian and Spanish frontiers from Virginia to North Florida. He was born in Dublin, Ireland, and arrived in South Carolina about 1701 (Crane 1981). In 1720 Barnwell was sent to England by the South Carolina Assembly to justify to the king through the Privy Council the 1719 revolt against the Lords Proprietors (Sirmans 1966). During this trip he also argued before the British Board of Trade for a vigorous program of frontier defense against French expansion developed around ideas first advanced by Nairne (Salley 1947: 199). Barnwell's written plan was incorporated almost verbatim into the "Report on the State of Your Majesty's Plantations on the Continent of North America" (Great Britain, Board of Trade 1721). The Barnwell c. 1721 map was most likely a supporting document for Barnwell's plan and presentation to the British Board of Trade.

We used several narrative and cartographic documents based on eyewitness information from the years immediately before and after the date of the Varnod census and the Barnwell map. From these we obtained information on the placement and population of towns, distances between towns, and information about the context and geography of the Cherokee settlement area. The most important subsidiary sources we consulted were two journals by Colonel George Chicken, who recorded in two diaries separate expeditions he made to the Cherokee from November 1715 to February 1716 (Chicken 1895) and from June to October 1725 (Chicken 1916).[1] We used information from the original John Herbert–George Hunter 1725/1744 manuscript map (Herbert and Hunter 1744) and a diary by Herbert in which he recorded a trip from October 1727 to March 1728 (Herbert 1936).[2] We also used a photostatic reproduction of the 1730 pencil-and-ink manuscript map by Hunter (Hunter 1730; Cumming and De Vorsey 1998).[3]

Finally, we used 1:125,000 U.S. Geographical Survey (USGS) digital topographic maps to obtain elevation in meters above sea level that we then used to derive aspect and slope.[4] Aspect is the direction of maximum slope using azimuth designations (0–360 degrees) clockwise from north; slope is the percentage departure from the flat of the Earth's surface measured as the tangent of the angle multiplied by 100 (i.e., a 45-degree angle equals 100 percent). We assigned values for elevation, aspect, and slope to each Cherokee town based on the average value for an area of 7.3 hectares.[5] We chose this area because it approximates the surface covered by the public and private architecture of an eighteenth-century Cherokee town with a median population of 175 individuals (Goodwin 1977; Schroedl 1989, 2000).

Locating Cherokee Towns

It is commonly and vaguely stated in the Cherokee literature that there were some 60 simultaneously occupied Cherokee towns in the early eighteenth century (Reid 1970; Adair 1974 [1930]; Goodwin 1977). Towns are further stated to have contained between 100 and 600 individuals distributed into 10 to 60 households and covering 10 to 80 hectares (Long 1969; Schroedl 1989, 2000). A central difficulty in translating these statements onto the southern Appalachian landscape the Cherokee occupied is that there is no single historical list or map that either contains or places 60 towns. We first compiled separate lists of town names from our sources. After resolving name ambiguities attributable to language, transcription, and idiosyncratic spelling, we made sure every town was cited by at least two independent historical sources. Our tests of the content and independence of information across the separate lists indicates there is no systematic bias either within or between sources.[6] Condensing the information across sources yielded a final list of 62 simultaneously occupied Cherokee towns c. 1721. We relied on Mooney 1995 [1900] for the spelling of town names.

We used Barnevelt c. 1744, cross-checked and amplified with information from the Herbert-Hunter 1725/1744 and Hunter 1730 maps, to place Cherokee towns relative to major geographic features, such as rivers and mountain ranges, as well as other Cherokee towns. Euro-American mapmaking since the seventeenth century has been problem-oriented and directed at providing faithful representations of what a cartographer believes to exist in the world (Robinson and Petchenik 1976; Galloway 1995). This means the early-eighteenth-century cartographic sources we used were not merely expressive drawings but in fact maps showing the locations of features. Once we placed towns relative to each other according to the early maps, we adjusted their positions using information from historical sources from around the same period.

As an example of our method, we present the case of placing Dugilu′yĭ (Tugaloo). Dugilu′yĭ was an important crossroads between internal settlement divisions among the Cherokee that Chicken (1916: 145) characterized in 1725 as "the most Antient Town in these parts." The importance of Dugilu′yĭ increased in 1716, when it was designated the headquarters of British branded towns (trade houses) among the Cherokee (South Carolina 1955). Using the three historical maps, we located Dugilu′yĭ in the upstream vertex of the confluence of the Chauga River and a right-bank tributary, although at this point it was not certain which tributary it might be. Chicken (1895) reported in his 1715–16 account that Dugilu′yĭ was 4 miles from Tagwâ′hĭ, 25 miles from Ukwû′nĭ, 5 miles from Chagee, 14 miles from Sukehi (traveled twice), 26 miles from Itsă′tĭ (traveled twice), and 64 miles from Tlanui′yĭ (Quannissee, another branded town). (Before determining distances, we had placed these towns relative to geographic features and other towns as we had Dugilu′yĭ.) Using ancillary information as available on travel conditions and direction noted in the diaries by Chicken (1985, 1916) and Herbert (1936), we then triangulated the position of Dugilu′yĭ as to the most likely vertex between the Chauga River and a right-bank tributary relative to the towns in its vicinity.

Once satisfied that we had placed all Cherokee towns by this method according to the available historical information, we finalized their placement using contemporary sources and a set of criteria based on historical, ethnohistorical, and archaeological evidence. For example, it is generally stated that towns were placed close to a river or creek to provide ready access to rich alluvial soils that were easily worked with simple agricultural tools. Nearby woodlands provided wild fruits, vegetables, nuts, seeds, and herbs as well as hunting opportunities, building materials, and fuel (Long 1969; Adair 1974 [1930]; Goodwin 1977; Schroedl 1989, 2000; Greene 1996). From this information we developed criteria applicable in a geographic information system using contemporary terrain information about where Cherokee towns were typically located (Bolstad and Gragson forthcoming).[7] The key criterion was that a town had to be near a river on relatively flat land rather than far from a river on a steep slope. The application of this criterion is possible because stream courses and land forms in southern Appalachia have been lightly altered during the past 300 years. River meander displacement has changed less than floodplain width (Wilson and Gallant 2000; Bolstad 2005). We judge the nominal horizontal accuracy of the final map of Cherokee town placement to be approximately 52 meters.[8] In practical terms, this means that we expect the true position of each Cherokee town to fall within a circle with a radius of 52 meters.

As a partial assessment of the accuracy of our map, we obtained from the North Carolina Office of State Archaeology the geographic location of all recorded historical Amerindian sites in the so-called Middle Town Cherokee area (discussed below). We overlaid our Cherokee town locations c. 1721 onto the archaeologically recorded sites and verified multiple instances where our town locations were within 0.0 to 2.0 kilometers of archaeologically recorded sites. The areas of concentrated occupation in both cases were also comparable. While this indicates that our map is reasonable, the comparison cannot be quantified for several reasons, although it could serve as the basis for a future archaeological test. The dating of archaeological sites in the state record is coarse, as sites are assigned to the period c. 1650–1838. This means, in practical terms, that there are absolutely more archaeological than historical sites since the information, respectively, represents a settlement record for approximately 188 years versus a record for approximately 1 year. More important, the c. 1650–1838 period collapses the distribution of sites pre– and post–American Revolution—an event known to have dramatically affected the number, location, and distribution of Cherokee towns (Goodwin 1977; Crane 1981). Finally, there is no way to know from the state record whether a recorded archaeological site is absent from a certain location because there was never a settlement there or because the location has not been surveyed.

Population Size

The 1721 Varnod census provides population information on 53 Cherokee towns, although we have cartographic and documentary evidence for 62 Cherokee towns in that year. The total Cherokee population in 1721 according to the Varnod census was 10,436. A report by South Carolina governor Robert C. Johnson (1955 [1719]) with native population figures for 1715 prior to the Yamassee War reports a total Cherokee population of 11,210. Both the count and the manner in which it is divided by settlement areas is identical to the presentation of this information in a small cartouche on the Barnwell c. 1721 map.[9] Both counts almost certainly underestimate the true Cherokee population around this time. The questions are by how much and whether we should adjust the town population values in the present analysis.

From our assessment of changes in Cherokee population size between 1650 and 1809, we believe the total Cherokee population in 1721 was around 16,487.[10] The discrepancy between the Varnod census, the Johnson-Barnwell count, and our estimate is most likely the result of the eyewitnesses who provided the original town population records undercounting individuals younger than about 15 years. In the present analysis, it would be possible to estimate the population for the 9 missing towns and compensate for the undercount of individuals to develop a dataset with locations and populations for all 62 towns. However, there are statistical issues in confounding inputted missing values with adjusted values (Allison 2002) that we judged were better avoided in the present analysis, although we discuss them in depth elsewhere (Bolstad and Gragson forthcoming). Therefore the results on the location of Cherokee towns are based on the distribution of all 62 towns occupied c. 1721, while the results on the population of Cherokee towns and the combined results about location and population are based on information for the 53 towns recorded in the Varnod census.

Analytic Procedure

Our objective is to dissect first-relative to second-order processes of Cherokee town placement and town population c. 1721. The study region, R, for this analysis is the 30,400-square-kilometer Cherokee heartland. The point pattern of Cherokee towns or *events* in the study region R constitutes a dataset X composed of a series of points $\{x_1, x_2, \ldots\}$. Each x_i or point is a two-dimensional vector $(x_{i1}, x_{i2})^T$ that we evaluate for placement or population. We begin by comparing the pattern of Cherokee town placement relative to a model of complete spatial randomness to identify the effect of first-order processes.

The conventional approach to establishing a relationship between human settlement and physical environmental factors is ordinary least squares (OLS) regression. We calibrate a model using OLS but also analyze the dataset using geographically weighted regression (GWR). The inherent weaknesses of an OLS for final explanations are that the parameter surface is assumed to be constant across space and observations have a weight of unity (i.e., it is a global statistic). OLS, however, is a special case of GWR that has the following model form:

$$y_i = \$_0(u_i, v_i) + \sum_k \$_k(u_i, v_i)x_{ik} + g \qquad \text{(Eq. 1)}$$

In this equation, (u_i, v_i) denotes the coordinates of the ith point in space, and observation $\beta_k(u_i, v_i)$ is a realization of the continuous function $\beta_k(u, v)$ at point i (Fotheringham et al. 2000, 2002). Each $\beta_k(u_i, v_i)$ is weighted according to its proximity to point i using a distance-decay curve derived from a spatial kernel controlled by a fixed bandwidth or adapted to the density of data points. A spatial kernel weighs each data point by its distance from the regression point, which in this case is a Cherokee town. We use an adaptive bandwidth to control the spatial kernel because it is a better choice given the variation in density of Cherokee towns across the settlement area. To derive the adaptive bandwidth, we minimize the Akaike information criterion (AIC), which provides a trade-off between goodness of fit and degrees of freedom.

We then evaluate covariation progressively between towns to identify the effect of second-order processes. We begin by using two-dimensional descriptive statistics—mean center and standard distance—to provide a sense of the scale and distribution of towns and then examine the interaction between points in two ways. We use nearest neighbor analysis, then use size-class interval analysis of the distribution of towns in clusters. Nearest neighbor analysis is a parsimonious test that ignores all potentially confounding factors influencing placement by focusing only on the distance between any two points.

We conclude with an analysis of settlement intensity of town placement and population to assess the effect of first-relative to second-order processes. The number of Cherokee towns and their associated population occurring in one year, 1721, in the heartland depended on the size and shape of this area. Intensity of either the placement or the population process at a given point is a useful way to convert presence/absence information to a surface so the entire area, rather than just the point, can be evaluated. We estimate settlement intensity using a kernel density function, $\lambda(x)$, equal to the expected number of events per unit area. The height of the function centered over each point event represents the contribution of all point events to the point-count estimate, $\hat{\lambda}(x)$. Summing individual density functions at a given point and dividing by their n yields a kernel probability density function, $\hat{f}(\mathbf{x})$, which normalizes the continuous variable $\hat{\lambda}(\mathbf{x})$. The kernel probability density function has the following form:

$$\hat{f}(\mathbf{x}) = \frac{\sum_{i=l}^{i=n} \frac{1}{h^2} k\left(\frac{x - x_p}{h}\right)}{n} \qquad \text{(Eq. 2)}$$

The spread and smoothing of the function is controlled by a bandwidth h. We estimate h by generalizing a formula in Fotheringham et al. 2002 with

$$\mathrm{h}_{\mathrm{opt}} = \left[\frac{2}{3n}\right]^{1/4} v \qquad \text{(Eq. 3)}$$

where n is the number of point events, and v is some measure of variation in their distribution.

The measure of the dependence between two points x_1 and x_2 is a second-order intensity function $\gamma(x_1, x_2)$ that we characterize using K functions of distance d (Fotheringham et al. 2000) as

$$\hat{K}(d) = \frac{|\mathrm{A}|}{n^2} \sum_{i=l}^{i=n} \mathbf{N}(\mathbf{C}(\mathbf{x}_{\mathrm{i}}, d)) \qquad \text{(Eq. 4)}$$

In this equation $|\mathrm{A}|$ is the area of the study region, n is the number of events in the sample, and $\mathbf{N}(\mathbf{C}(\mathbf{x}_{\mathrm{i}}, d))$ is the sample mean estimate. The K function for a distance d is the average number of events found in a circle of radius d around an event divided by the mean intensity of the process.

Different values of d can be used to determine if the clustering of Cherokee towns and population is constant or constrained with respect to scale. The existing Cherokee literature provides no explicit rationale for choosing a particular value for d at which towns might cluster. We thus analyze the effect of distance as a function of $l(d)$, which takes on the value zero when equal to the observed $\hat{K}$ function and has either a + or a − sign when it differs from $\hat{K}$. A positive value indicates that towns had more towns near them than would be expected at random, while a negative value indicates that towns had fewer towns near them than would be expected at random. We use the following formula to estimate $l(d)$:

$$\hat{l}(d) = \frac{1}{2}\log\left(\frac{\hat{K}(d)}{\pi}\right) - \log(d) \qquad \text{(Eq. 5)}$$

We use bootstrap and permutation resampling methods (Chernick 1999; Good 2001; Simon and Bruce 2001) with 10,000 iterations and exact p-values to test significance. The bootstrap is based on the interval estimates of parameters. The empirical distribution is repeatedly resampled with replacement, and the test statistic (e.g., median, difference, sum, etc.) is recomputed each time under the assumption that the empirical values are independent. The permutation test is based on the equivalence of distributions. A test distribution is derived by rearranging the empirical observations, computing the test statistic for each new arrangement, and comparing this value to the original. The assumption is that the values are independent and have a symmetrical distribution.

Results

Town Placement

Table 1 presents three physical factors explicitly or implicitly referenced in general statements about where Cherokee towns *should* be located in the heartland. Did the Cherokee locate their towns preferentially with respect to these terrain characteristics? Using the locations of the 62 Cherokee towns and 62 random points from the settlement region R generated by Monte Carlo sampling, we calibrated an OLS model for Cherokee town placement. Of the three factors identified in table 1, only elevation and slope proved significant. Although both are strongly negatively related to town placement,

Table 1 Terrain factors of Cherokee town placement compared to a set of random points

	Towns		
	Elevation[a]	Aspect[b]	Slope[c]
Minimum	200	0	0.0
First quartile	257	74	2.2
Median	493	126	4.1
Third quartile	606	198	9.4
Maximum	734	311	12.5
Average	446	140	5.5
Standard deviation	176	81	4.3
	Random points		
	Elevation	Aspect	Slope
Minimum	71	0	0.0
First quartile	304	94	3.7
Median	518	158	10.0
Third quartile	777	234	20.2
Maximum	1,788	353	100.0
Average	587	164	13.4
Standard deviation	319	89	12.8

[a] Meters above sea level.

[b] Direction of maximum slope measured in degrees clockwise from north, 0–360.

[c] Percentage departure from the flat of the Earth's surface.

the r^2 of approximately 0.20 (table 2) indicates that the OLS model accounts for only some 20 percent of the observed variability in town placement. This result is in line with general statements by numerous authors (Adair 1974 [1930]; Goodwin 1977) that in mountainous southern Appalachia, the Cherokee placed towns in areas of lower elevation and lower slope. However, the failure of elevation and slope to explain most of the variability in Cherokee town placement indicates that they were not limiting or perhaps particularly important to the Cherokee decision of where to place a town.

Using the calibrated OLS model, we then developed a GWR model and compared results from the analyses of three similarly configured datasets. Each set consists of the 62 town locations and 62 random points across R (three different random point sets were generated). A GWR model using an adaptive kernel with an AIC-minimized bandwidth provided a signifi-

Table 2 OLS and GWR results of Cherokee town placement compared

		AIC[a]	Adj. r^2	F-test[b]	Test of nonstationarity: Elevation	Test of nonstationarity: Slope
Test 1	OLS	148	0.2663			
	GWR	133	0.4555	3.9	n/s	n/s
Test 2	OLS	162	0.1800			
	GWR	140	0.3627	5.5	n/s	n/s
Test 3	OLS	157	0.2108			
	GWR	147	0.4256	3.3	n/s	n/s

Note: n/s = nonsignificant, $p > 0.05$.

[a]Akaike information criterion: a gain equal to or greater than 3 is considered significant.

[b]Likelihood ratio test of the ability of each model to replicate the observed dataset obtained by dividing OLS residual sum of squares by GWR residual sum of squares.

cant improvement over the OLS model (table 2), since the adjusted r^2 now explains around 40 percent of the total variance. The Monte Carlo test for nonstationarity indicates that elevation and slope are nonsignificant, however. This is further support for the preceding conclusion that the availability of lower-elevation and lower-slope sites suitable for town placement did not constrain Cherokee town placement. Thus the oft-repeated statement by Adair (1974 [1930]: 239) that "their towns are still scattered wide of each other, because the land will not admit any other settlement," is simply not the case.

These results imply that terrain was perhaps secondary to the effect of another force, for example, the proximity of one town to another. Many authors make a point of stating that Cherokee towns were grouped into two, three, most commonly four, and sometimes five settlement clusters (Corkran 1962; Gearing 1974 [1962]; Goodwin 1977). Authors back at least as far as Johnson (1955 [1719]) grouped Cherokee towns into clusters, but John Hammerer, who traveled through Cherokee country in 1765, was one of the first to offer an explanation for clustering. He noted: "The whole nation of the Cherokees is divided into four settlements; namely, the Upper or Over Hills, the Middle, the Lower settlements, and the Valley, which lie in a kind of cross. These settlements are separated from one another by such craggy mountains and bad roads that it will ever be impracticable to make any communication by wagon-roads from one to another" (Williams 1928: 246). Despite the pervasive reference to clustering in the Cherokee literature, there is no definitive

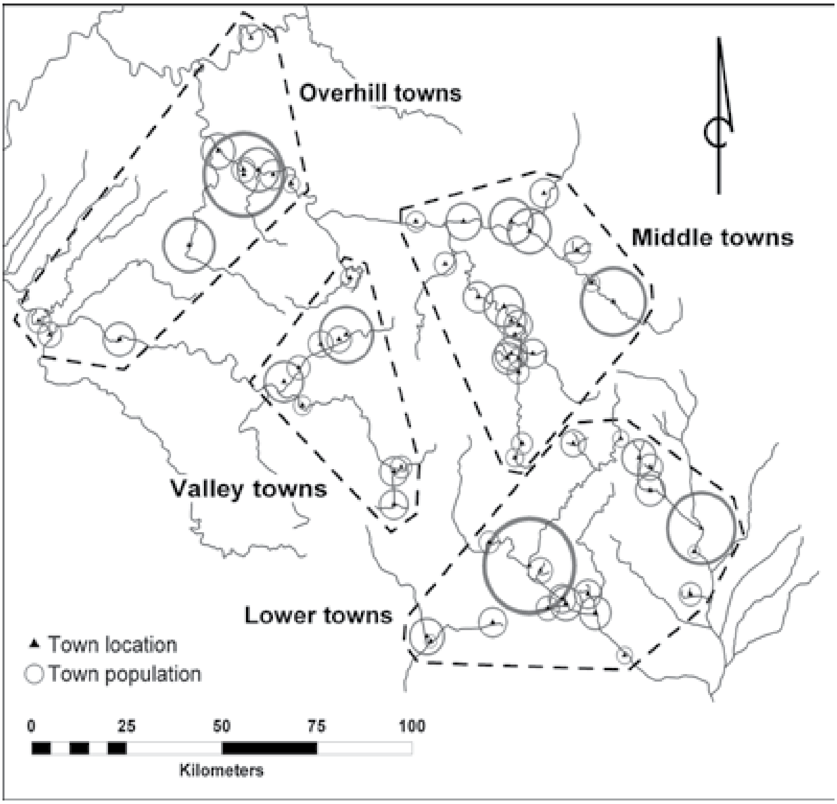

Figure 2 Cherokee settlement clusters relative to major rivers with town locations weighted by population

list of town-cluster affiliation (figure 2). Early sources typically summarized the number of towns by cluster but did not list the member towns. Early cartographic sources typically listed towns by drainage rather than cluster. Contemporary sources usually list towns by cluster but disagree on the membership of towns or the boundaries for each cluster.

Town-to-town placement overall is described by the two-dimensional mean and standard distance for the series of (x, y) points representing the geographic coordinates of each town. The mean center for Cherokee towns was on the high plateau separating the valleys formed by the Little Tennessee River (Middle Towns) and the Hiawassee River (Valley Towns). Individual towns were 15 to 104 kilometers distant from the mean center, and the first and second standard distances were, respectively, 53 and 105 kilometers. Thirty-seven towns (60 percent) fell within one standard distance of the

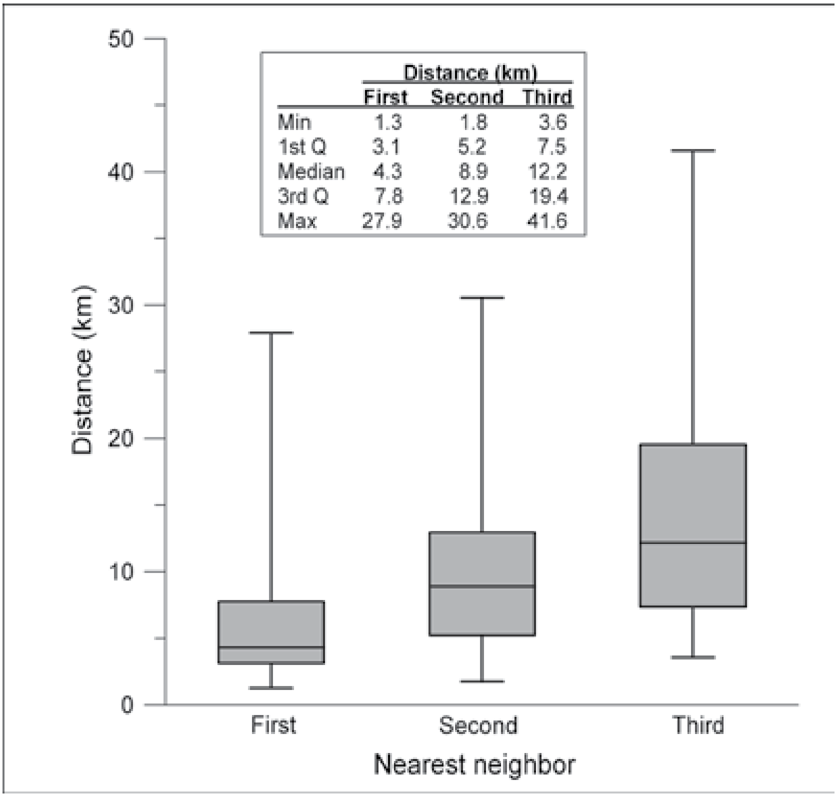

Figure 3 Nearest neighbor distances between Cherokee towns

mean center and consist of all Valley Towns and Middle Towns; the remaining 26 towns (40 percent) fell within two standard distances of the mean center and consist of Lower Towns and Overhill (or Upper) Towns. Since "craggy mountains and bad roads" were just as challenging for pedestrians as they were for wagons, it is important to go beyond these basic measures of clustering to ask about the placement of individual towns relative to each other.

Nearest neighbor distances (we use Euclidean or as-the-crow-flies distances) among all possible town pairs provide a basic measure of town clustering. The closest first-nearest neighbor town pair is 1.3 kilometers, and the most distant is 27.9 kilometers. The median distance of 4.3 kilometers and third quartile of 7.8 kilometers indicate the strong tendency for Cherokee towns to be one to two hours' foot travel from a neighboring town (see figure 3).[11] This tendency for proximity carries through to second- and third-nearest neighbors located at median distances of 8.8 kilometers and 12.2 kilometers, respectively. Seventy-five percent (n = 47) of all Cherokee towns c. 1721 were less than 14 kilometers distant from one to three other towns. This result indicates that the neighborhood of Cherokee towns was much tighter and more selective in terms of membership than the vaguely defined Overhill, Middle, Valley, and Lower town clusters commonly used in the literature. We further disentangle the elements of town clustering in the following section on town population.

Town Population

The average population of Cherokee towns in 1721 based on the Varnod census was 197 individuals. However, there was significant variation in town size as indicated by the standard deviation of 117 and the range of 62 to 622 (see table 3), raising the question of whether there is a difference between the observed and expected distribution of town sizes. Using Fisher's exact test indicated no difference either in the overall distribution of town sizes or in the distribution of town sizes in the four commonly identified settlement clusters. However, town size is a heterogeneous measure that ranges from 62 to 622—an order of magnitude—on a universe of 62 events, making it more appropriate to examine the distribution of town-size classes.

The distribution of town sizes is multimodal with four size classes (see figure 4): small towns (37 percent), medium towns (44 percent), large towns (11 percent), and what we call primate towns (8 percent).[12] We define a primate Cherokee town as one that is two times the average size of the next largest town-size class in its vicinity. The question, however, is whether town-size class is purely random or reflects an underlying process across the region. The answer is important since by choosing certain documents (e.g., French 1977), emphasizing cultural atavism (e.g., Greene 1996), or underscoring the political power of certain areas (e.g., Hoig 1998), it is possible to reach an a priori conclusion that some Cherokee town clusters will be characterized by only certain town-size classes. We therefore tested for this possibility by using the sum of the absolute deviations between the population mean of each town cluster and the overall town population mean.

The null hypothesis is that settlement cluster makes no difference in the sum of rank scores across the four commonly identified clusters. This would mean that the observed differences in the distribution of town-size

Table 3 Population of Cherokee towns from the Varnod census, 1721

	Town population	Men (number)	Men (%)	Women (number)	Women (%)	Children (number)	Children (%)	Adults (number)	Adults (%)	Ratio of children to adults
Minimum	62	12	19.4	11	12.2	7	7.8	42	54.8	0.08
First quartile	125	43	29.4	42	31.8	38	27.6	88	65.3	0.38
Median	174	59	33.5	58	33.8	49	31.0	110	68.3	0.45
Third quartile	215	71	36.5	71	36.9	65	34.4	144	72.4	0.53
Maximum	622	160	80.0	193	50.8	281	45.2	353	92.2	0.82
Average	197	66	34.7	69	34.8	62	30.4	135	69.6	0.45
Standard deviation	117	106	30.0	34	33.3	35	36.0	73	60.9	35.10
Total	10,436	3,510	—	3,643	—	3,283	—	7,153	—	—

Source: Varnod 1967 [1724].

Notes: Town population and number of men, women, and children per town are original. Percentages of men, women, and children per town are derived. Number of adults per town is the sum of men and women, derived. Percentage of adults per town is the sum of men and women, derived. The ratio of children to adults per town includes the sum of men and women, derived.

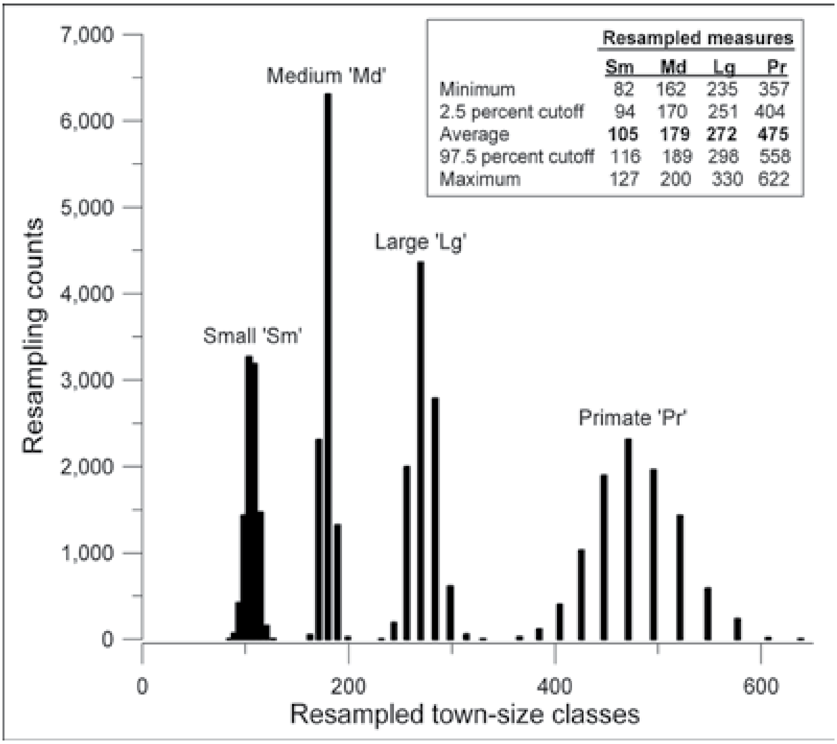

Figure 4 Theoretical distribution of Cherokee town-size classes (2.5 percent and 97.5 percent cutoffs)

classes are attributable to chance alone. To test this hypothesis, we combined all observations and shuffled them into groups of 14, 23, 8, and 8 that are, respectively, the empirically recorded number of towns in the Lower, Middle, Overhill, and Valley areas. We then calculated an absolute mean difference statistic of 12.4 and determined that the sum of absolute differences for the shuffled data exceeds this value in 52.8 percent of all trials. We conclude that the observed variation in the distribution of town-size classes across the four traditionally identified settlement clusters is due to chance alone. The interpretation is that Cherokee town clustering was more nuanced than the literature suggests.

When the observed number of towns by class in each settlement cluster is compared to the overall distribution, there are several significant differences. In the Lower Town area there were more medium-size and fewer large-size towns than expected. The exact probabilities of observing eight or more medium-size or zero large-size towns is, respectively, $p = .0121$ and $p = .0012$. (Eight and zero are the empirically recorded number of towns, respectively, in the medium- and large-size classes in the Lower Town area.) In the Overhill Town area there were fewer small-size and more large-size towns than expected. The exact probabilities are, respectively, $p = .0001$ for observing one or fewer small-size towns and $p = .0066$ for observing two or more large-size towns. Finally, in the Valley Town area there were more small-size and fewer medium-size towns than expected. The exact probabilities are, respectively, $p = .0076$ of observing four or more small-size towns and $p = .0056$ of observing two or fewer medium-size towns. There were no significant differences in the observed versus expected occurrences of towns by size in the Middle Town area. In the final section we examine town placement and population as two dimensions of the overall settlement process using results from the two previous sections.

Settlement Intensity

The number of towns and the number of individuals per unit area are different dimensions of settlement intensity. In order to compare the relative spatial distribution of these two dimensions of settlement, we normalized raw intensity (the expected number of settlement events per unit area) to a probability density function (raw intensity divided by R). There is no evidence in the Cherokee literature that would suggest the shape of the density function, so we assume that $\hat{f}(x)$, the kernel probability density function of equation 2, has a Gaussian (normal) distribution. The strong southeast to northwest distribution of Cherokee towns in the heartland (see figure 1) means that standard distance would be a poor estimator of v (equation 3). Our nearest neighbor results, however, place 75 percent of all towns at fewer than 14 kilometers from one to three other towns. By substituting the exact value of this distance for v (13.7 kilometers), h_{opt} (equation 3) takes on the value 33.3, and we obtain the probability density surfaces for placement and population shown in figure 5.

These surfaces represent the response of placement and population to first-order processes and show that both settlement dimensions were most heavily concentrated at the same two locales: the middle portions of the Little Tennessee River (Middle Towns) and the Hiawassee River (Val-

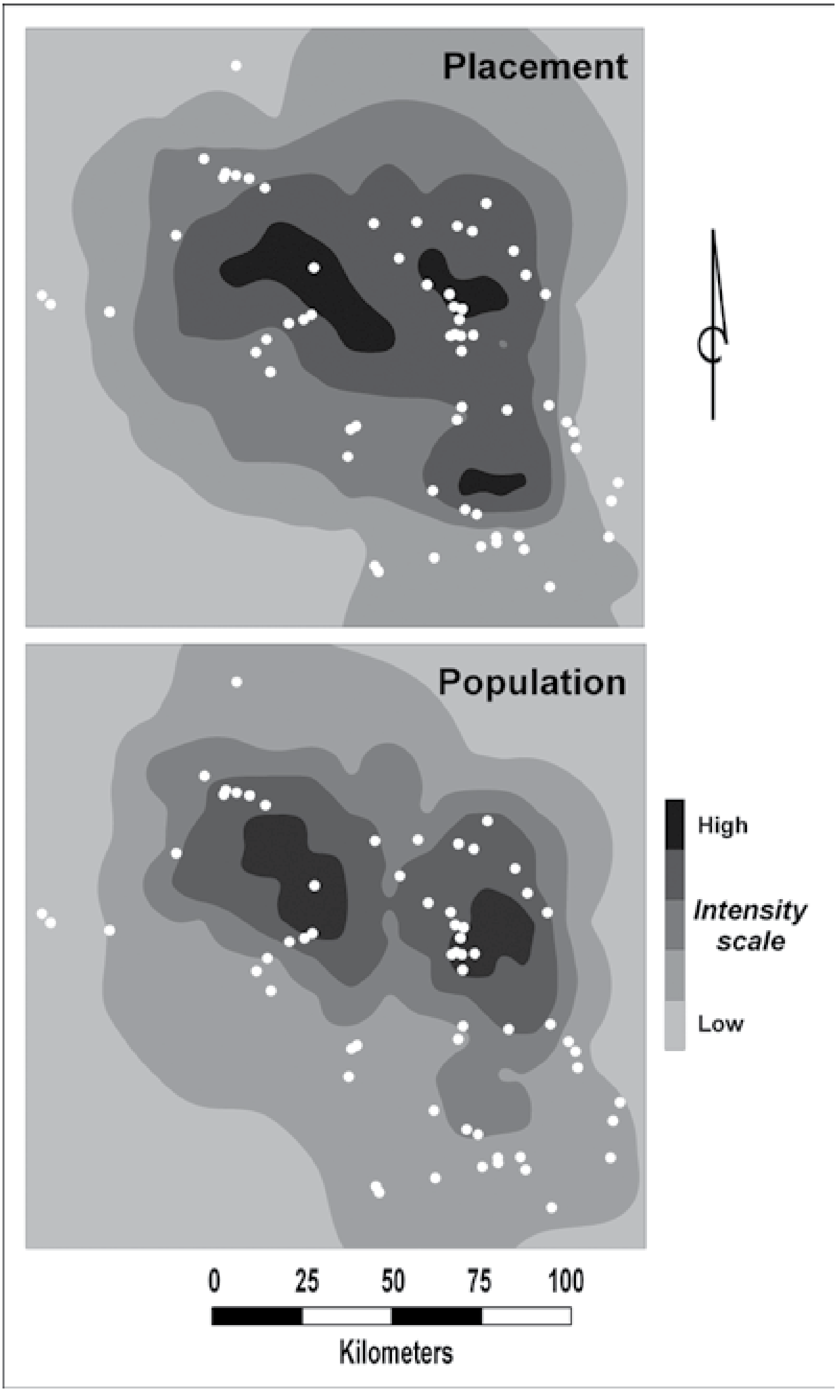

Figure 5 Probability density functions of town placement and town population

ley Towns). Placement was also highly concentrated in the headwaters of the Savanna River (Lower Towns), but the concentration was less notable in this area for population. The relative intensity of the process responsible for town placement was higher, on average, than the relative intensity of the process responsible for town population. (Darker colors indicative of higher intensities cover a larger absolute area on the placement side of the figure than they do on the population side of the figure.) Quantitatively, for any 100 random sample points taken from both probability density surfaces, the average relative intensity value for placement is 15 percent larger than it is for population.

The only first-order process consistently identified in the literature that might account for the density of placement and population relates to what we term *production theories*. We approximated the importance of production by examining elevation and slope, but OLS and GWR results both indicate that physical parameters account for only a small proportion of the observed variation in the distribution of towns. This emphasizes the need to consider not only first-order processes relevant to dispersion but also second-order processes relevant to clustering. How much influence do points have on the location of nearby points? Our nearest neighbor results lead us to predict that clustering will produce a positive correlation between the number of points close to each other when the population size of towns and the spatial dimensions of the clustering process are taken into consideration. While our prediction does not identify a specific process, it does make it possible to distinguish between likely and unlikely process scenarios.

We first tested a null hypothesis of uniformity that all distances between towns will be of comparable magnitude in R. We determined $\hat{K}$ (the measure of dependency between two points from equation 4) for the distribution of towns irrespective of their populations at d = 13.7 kilometers, the distance at which 75 percent of all Cherokee towns were located from one to three additional towns. The expected value of $\hat{K}$ under the uniformity scenario is approximately 586 ($\pi * d^2$). The observed value is 37,789, or some 64 times larger than expected at the spatial scale of the Cherokee settlement region. It is thus clear that Cherokee towns were tightly clustered rather than uniformly distributed.

The degree to which Cherokee towns were clustered can be expressed as the average number of towns one would expect to find within 13.7 kilometers of another town, given R = 30,400 square kilometers. This number is

1.7, which means that Cherokee towns were distributed across the heartland in clusters of at least three towns no more than 14 kilometers apart. Given 62 simultaneously occupied towns, there are a maximum of about 20 town clusters of at least three towns in a settlement region of this size. Twenty clusters is thus the upper bound on the likely number of clusters given the empirical distribution of Cherokee towns. Alternatively, Cherokee towns occupy approximately 1 percent of the space available for their placement. This further confirms the previous finding that while the Cherokee placed towns in lower-elevation and lower-slope areas, the availability of suitable lands was not limiting on this choice.

The four grand theories identified above offer global explanations about the constraints that might be exerted by the mountainous southern Appalachian terrain on town placement, but the explanations are locally aspatial. This is because they do not recognize an effect of town population size on town placement, since they do not incorporate knowledge about the distribution of forces acting locally. In figure 6 we show the effect of distinct clustering processes on the various town-size class intervals using $\hat{l}(d)$ (equation 5). Small, medium, and large towns were all significantly clustered as a function of a second-order process operating at a scale of less than 10 kilometers that loses force at a distance of approximately 20 kilometers. (That is the distance at which the three curves approach the zero line.) The bootstrapped confidence intervals on the three distributions (not shown in figure 6) indicate that the differences in the scale-dependent clustering process are not significant. This result indicates that Cherokee towns were tightly clustered into small nodules selectively distributed across the landscape subject to local forces that had an effective reach no greater than the distance at which any one town was located relative to another town.

Primate towns, however, displayed no second-order clustering process between 0 and 50 kilometers; the curve for this size class is negative over this range of distances. This means that primate towns at this scale were subject only to first-order (physical) rather than second-order (social) processes. It is unreasonable and contrary to social science evidence of widely divergent origins to assume that a human activity such as the placement of a town was subject only to physical forces. The results suggest, rather, that primate towns were subject to a fundamentally different second-order process operating at a different spatial scale from that which affected small, medium, and large towns.

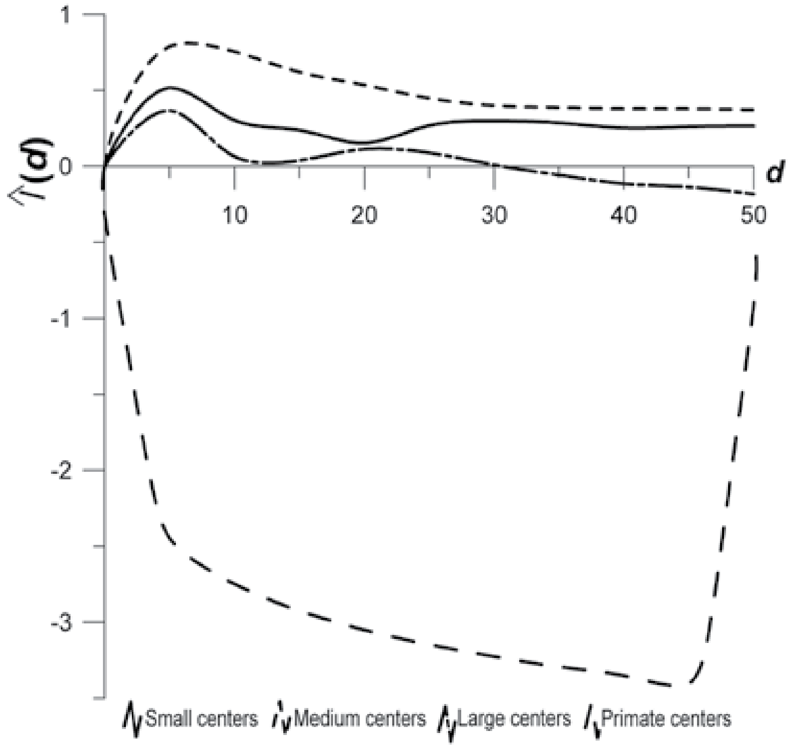

Figure 6 Distribution of $\hat{K}$ functions for Cherokee town-size classes
Notes: $\hat{l}(d)$ is a function of $\hat{K}$ (equation 5). The distance between any two towns is collapsed to 5-kilometer intervals for $0 \leq d \geq 50$ kilometers. The 50-kilometer cutoff includes the value of h_{opt} (equation 3) used to calculate the probability density functions.

Conclusion

Our analysis holds time constant to dissect the spatial properties of the relation between Cherokee town placement and population. In this way we have laid the foundation for an analysis of the relation between space and time that can reveal the landscape of communication and negotiation on which the social and political dynamics of the eighteenth century were based (Rodning 2002). Through this analysis our particular interest has been to make a contribution to ethnohistory that avoids the extremes of global generalities of overly evocative language. Local analysis treats settlement as a social process and uncovers aspects of location that global statistics are incapable of revealing. This is important because social processes are not stationary and depend intimately on the context of both when and where measurements were made. In the case of the Cherokee, it was not merely decisions made in Paris, London, Charles Town, or Philadelphia that determined the Cherokee lifeway of the eighteenth century or the course of history in the Southeast. The activities of identifiable individuals at particular locales with little or no relation to either imperial or subsequent American federal ambitions were also significant (Snapp 1996; Oliphant 2001).

We view the next step in this analysis as geographically demonstrating the effect of third-order processes. Our identification of primate towns offers one of the more compelling insights for how to proceed. It is not possible to know at this time whether primate towns predated the beginnings of intense contact with the British, but they could reflect the various Cherokee experiments in social, economic, and political organization that are currently being suggested in the ethnohistorical literature (Reid 1976; McLoughlin 1984; Fabel 2000; Oliphant 2001). Based on this literature and our finding that medium-size towns had a lower than expected occurrence c. 1721, we suggest that primate towns suppressed the occurrence of medium-size towns. This type of distortion in the size-class distribution of towns is common to noncompetitive, agrarian-based economies subject to or formerly subject to colonialism (Smith 1976a, 1976b).

This insight suggests several possible ways to examine the effect of third-order processes among the Cherokee. We are particularly interested in how the effects of family-level production and the trade in deerskins cascaded through the political and economic system to threaten the stability of the Cherokee nation (Bolstad and Gragson forthcoming). Such an inquiry would entail assessing the clustering of Cherokee towns relative to the branded towns established in 1716–17 that served as the first trade depots in Cherokee country (South Carolina 1955) and possibly relative to the so-called mother towns (Drake 1872), the purpose of which remains unclear. It will also be important to examine the position of Cherokee towns relative to the location of trade routes throughout the region and determine the travel cost of moving products across this landscape via the means available to them according to the ethnohistorical literature (Gragson 2006). Examining the effect of third-order processes among the Cherokee in a space-time framework will help position ethnohistorians to answer the question "What shaped the Indians of the eighteenth-century South?" (Hudson 2002: xii).

Notes

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1 Colonel Chicken served under Colonel Maurice Moore in 1715–16 during his march into Cherokee country and later served as South Carolina Indian commissioner for trade from 1724 to 1727 (Crane 1981).

2 Herbert was a practiced Indian fighter who served with Chicken under Moore in 1715–16 and served as South Carolina Indian commissioner for trade from 1727 to 1733. The Herbert-Hunter map is either a copy made in 1744 by Hunter of a 1725 map by Herbert that no longer exists or the 1725 map with annotations made in 1744 (Cumming and De Vorsey 1998).

3 Hunter was surveyor general of South Carolina (Sirmans 1966; Crane 1981).

4 We used the DEM series files Chattanooga-E, Rome-E, Greenville-E and -W, and Knoxville-E and -W. A DEM is a digital elevation model consisting of elevations recorded in square cells arranged in rows and columns. The 1:125,000 DEM series has cells that are 90 meters on a side, so each cell covers 8,100 square meters.

5 To compute the average, we used the values of the nine cells surrounding the cell containing the Cherokee town.

6 We performed a one-sample permutation test for the mean and standard deviation of the number of town matches across sources and a rank-sum test with a bootstrap sampled sum of ranks across all sources that we split in half for the test. Neither test was significant using $p < .05$ as the criterion.

7 Our two principal contemporary sources were the USGS 30-meter DEM series and the 1:100,000 DLG river series. A DLG is a digital line graph consisting of a set of lines, e.g., a vector file, representing the course of all first- through fifth-order rivers.

8 Our Cherokee town map and its analysis were based on cartographic information projected into UTM Zone 17 using the 1927 North American Datum. See the 1947 revision of the USGS *United States National Map Accuracy Standard* (U.S. Geological Survey 1947) for a full technical discussion of mapping standards and Bolstad 2005 for the importance of using projected digital information for the spatial analysis we carry out in this article.

9 This is probably no accident as a note on the table in the report by Johnson (1955 [1719]: 238) states that the sources for the information were the journals of Nairne, John Wright, and Price Hughes as "compared & corrected by the journals and obser-

vations made by John Barnwell while he was employed by the Governmt Amongst them."

10 We obtained Cherokee population values from Herbert and Hunter 1744; Haig and Hunter 1751; Stuart 1761; Drayton 1821; Stevens 1847; Rivers 1856; Logan 1859; North Carolina 1886–1907; Chicken 1895; Owl 1929; Gipson 1939; Timberlake 1948; Englund 1973; Adair 1974 [1930]; Mooney 1975 [1900]; Goodwin 1977; Crane 1981; and Thornton 1990.

11 The third quartile is the point below which 75 percent of the ranked data values lie.

12 Primate towns are a unique size class not previously discussed in the literature. We identify five primate towns: Kuwăhi′yĭ and Estatoe in the Lower Town area; Tsĭksi′tsĭ in the Middle Town area; Tănăsĭ′ in the Overhill Town area; and Tama'lĭ in the Valley Town area.

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