INTRA-SITE AND REGIONAL SPATIAL ANALYSIS

The past 40 years of research have demonstrated the existence of gross structure at multi-component, repeatedly occupied sites, and studies have identified relatively discrete occupation loci and activity areas at small, interfluvial sites that were once dismissed as indecipherable. For example, the investigations at the Lums Pond Site (7NC-F-18) documented the presence of overlapping, yet analytically definable, occupation areas (Petraglia et al. 1998; cf. also Blanton and Pullins 1991; Blanton and Robinson 1990; House and Wogaman 1978). Ethnoarchaeological data and computer modeling also point to the persistence of structure that provides a basis for the interpretation of small, upland sites.

Ethnographic research conducted among living hunter-gatherers by archaeologists has produced detailed analyses of the formation and use of small archaeological sites (e.g., Binford 1978; O'Connell 1987; Yellen 1977). The ensuing awareness of the spatial organization of activities and disposal patters, as well as the identification of the behaviors that occurred at camps and extractive sites, form the basis for current models of site structure. The ethnographic studies demonstrate that:

> (1) Concentrations of functionally associated artifacts or tool kits were not regularly discarded where they were used in single-purpose activity areas; (2) hearths commonly represent a focal point for a variety of domestic, maintenance, and special purpose activities; (3) size sorting of refuse can be an important means for distinguishing locations where refuse-producing activities actually occurred; and (4) a variety of natural processes can reorder the refuse generated by human activities (Kroll and Price 1991:304).

Ethnographic observations of the effects of post-depositional disturbance of site structure by natural and cultural processes have been augmented through experimentation and computer modeling. Studies have demonstrated both the resilience of archaeological patterns (e.g., Ammerman et al. 1978; Gorecki 1985; Gregg et al. 1991; Odell and Cowan 1987) and the disruption of original patterns by taphanomic and pedological processes (e.g., Gifford 1981; Gifford-Gonzalez et al. 1985; Wood and Johnson 1982). Computer-simulation of disturbance of Yellen's (1977) ethnographic data on the spatial distribution of materials at a !Kung San camp by Gregg et al. (1991:188) indicated "a substantial degree of overall similarity in the assemblage composition of clusters" defined by analysis of data exhibiting various degrees of disturbance. Nevertheless, as the simulated assemblage underwent artifact loss due to differing preservation of materials and random movement of artifacts across space, resolution was lost. As a result, estimation of the precise number and composition of families and extended families present and the identification of the types of activities undertaken in the camp became increasingly difficult as disturbance increased (Gregg et al. 1991:183-195). Despite the degradation of archaeological resolution over time, Gregg et al. (1991:195) believe that quantitative analysis of artifact distributions "provides a rigorous description of data structure."

Intra-Site Spatial Analysis of the Warwick Site

The limited range of temporally diagnostic artifacts recovered from the Warwick Site points to a limited span of occupation; of course, at an archaeological scale limited span may refer to hundreds of years. Spatial analysis of artifacts provides a basis for evaluating the duration and intensity of the occupation(s). Ethnographic, ethnoarchaeological, and simulation studies indicate that:

> 1) single, short-term, special purpose occupations typically produce a homogeneous artifact assemblage with few functionally distinct clusters of artifacts;
>
> 2) repeated short-term occupations, with the site regularly used for a single purpose, result in a higher density of a limited range of artifacts;
>
> 3) repeated short-term occupations for varied activities create overall diversity with clinal variation between activity areas;
>
> 4) assemblages from repeated short- and long-term occupations over millennia, typical of persistent places, consist of dense, highly diverse assemblages that contain a broad range of temporally diagnostic artifacts.
>
> 5) distinct functionally, depositionally, and spatially discrete assemblages result from the organization of space characteristic of single long-term occupations. Artifact diversity tends to correlate with the length of the occupation.

Given the expected changes in an upland environment in response to climatic events on ethnographic or generational time scales, short-term Late Archaic occupations should be relatively brief rather than spanning the circa 2500-long interval.

Calculation of variance-to-mean ratios for each artifact category indicated that only debitage, fire-cracked rock, and total artifacts varied significantly at the one-meter scale of the excavation blocks. Points and other tools occurred in 28 of the 59 test units, with no more than two in any single unit. Tools were recovered throughout the excavation block, with only the southernmost and northernmost test units and a band near the center of the site lacking tools (Figure 41, p. 73). Given variation in only three functional categories of artifacts, cluster analysis appeared unlikely to provide significant information on site structure. Intra-site spatial analysis, therefore, relied on variance-to-mean ratios and visual inspection of Surfer maps.

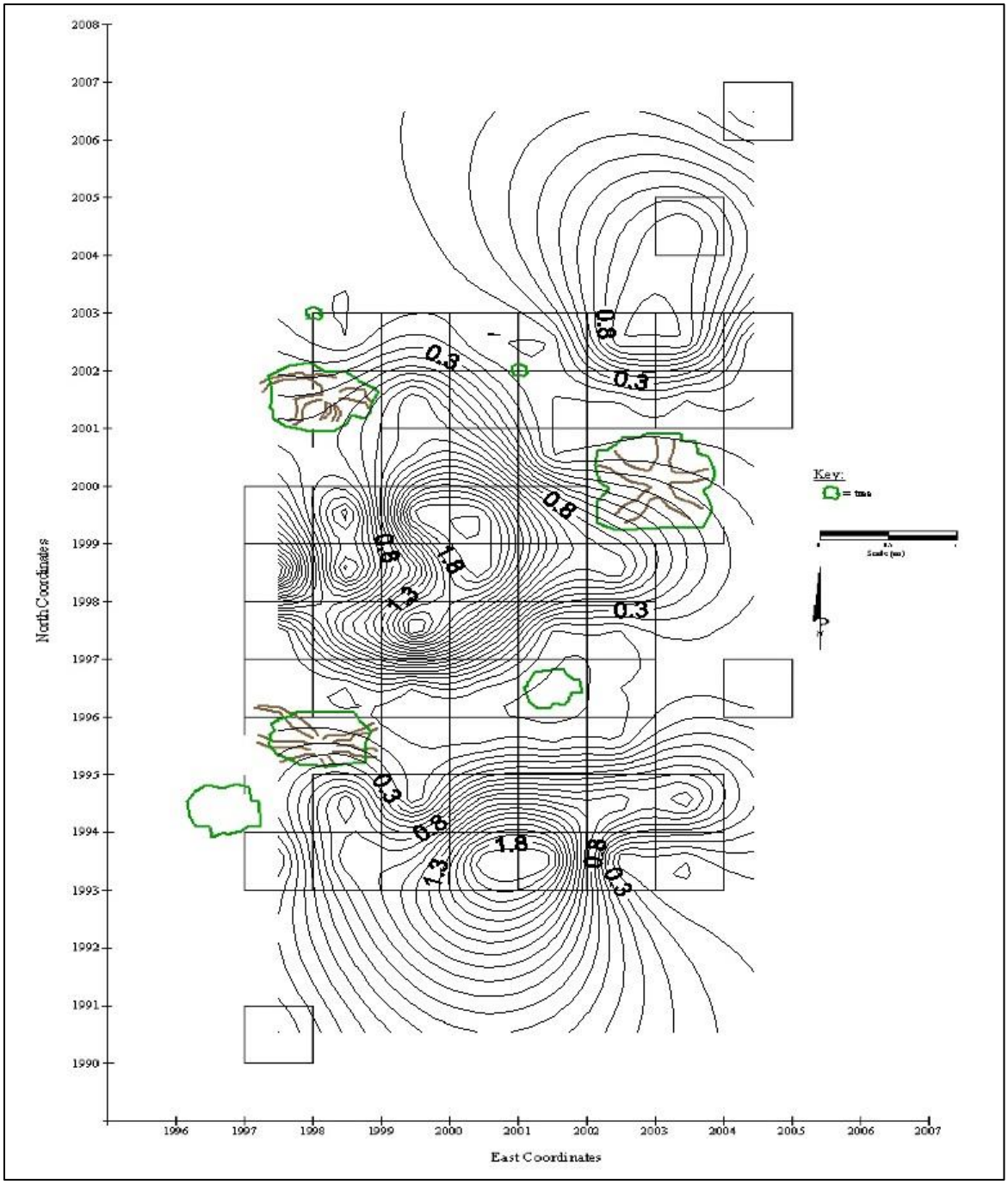

Figure 41: Contour Map Depicting the Distribution of Projectile Points and Other Tools Recovered from Test Units.

Artifact Density

Artifacts cluster along a southwest to northeast axis extending from approximately N1997/E1999 to N2001/E2004 (Figure 42, p. 74). The distribution is left-skewed, with ten or fewer artifacts in most test units, and 30 or more artifacts occurring in only six units (Figure 43, p. 75). Peak values appear in TU 54 (N1999/E2001), with 67 artifacts,

TU 16 (N1999/E2002), with 60 artifacts, and TU 43 (N1999/E2003), with 56 artifacts, TU 12 (N1998/E2001), with 47 artifacts, TU 39 (N1997/E2000), with 38 artifacts, TU 40 (N1998/E2000), with 33 artifacts. Twenty-nine prehistoric artifacts occurred in TU 17 (N2000/E2001). The distribution of debitage, representing approximately three-forths of the assemblage, approximates that of the overall assemblage.

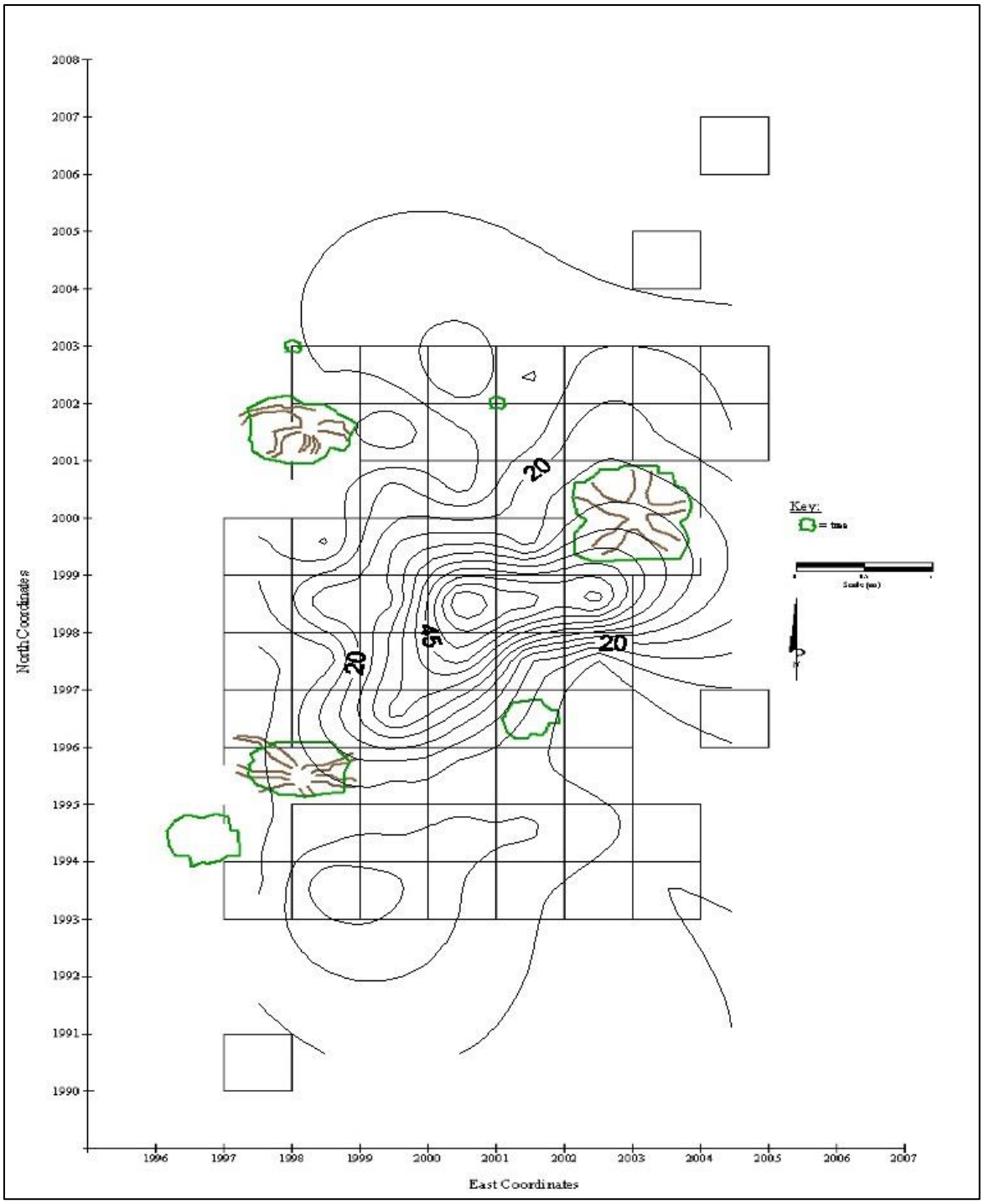

Figure 42: Contour Map of Artifact Distribution Recovered from Test Units.

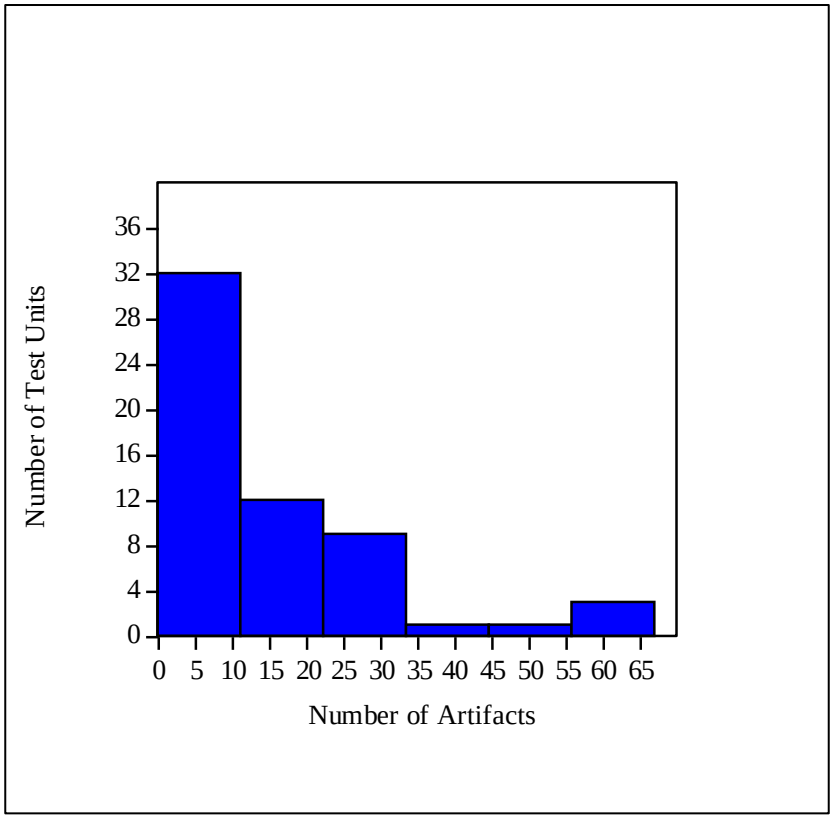

Figure 43: Histogram of Artifact Density byTest Unit.

Debitage

The combination of stone tools and debris implies on-site knapping, whether to manufacture, repurpose, or sharpen the tools. Knapping and sharpening result in the accumulation of large amounts of chipping debris. Moreover, as the edge damage identified on one large flake suggests, unaltered and minimally altered flakes and other debitage potentially represent expedient tools (e.g., Gould 1980:12–19). In addition, unlike formal tools, which were often curated, debitage tends to remain on the landform when a camp was abandoned. The sheer quantity of debitage typically recovered from archaeological sites makes it particularly useful for the identification of site structure.

Debitage clusters near the core of the site identified in the analysis of all artifacts, the southwest to northeast axis extending from approximately N1997/E1999 to N2001/E2004 (Figure 44, p. 76). Not surprisingly, since debitage constitutes 76 percent of the assemblage, the distribution of debitage by test unit also closely parallels that of total artifacts (Figure 45, p. 77). Ranked by the abundance of debitage, the top seven test units were TU 54 (N=59), TU 16 (N=55), TU 43 (N=53), TU 12 (N=45), TU 39 (N=37), TU 40 (N=28), and TU 17 (N=26), the same test units that produced the most total artifacts. Microdebitage peaked near the core of the distribution of macroscopic debitage, implying a primary, probably abandonment-phase, knapping area. A peak in phosphorus values in the eastern portion of the site core suggests organics were deposited as well, perhaps indexing a secondary deposit of toss-zone refuse (Binford 1983b:153).

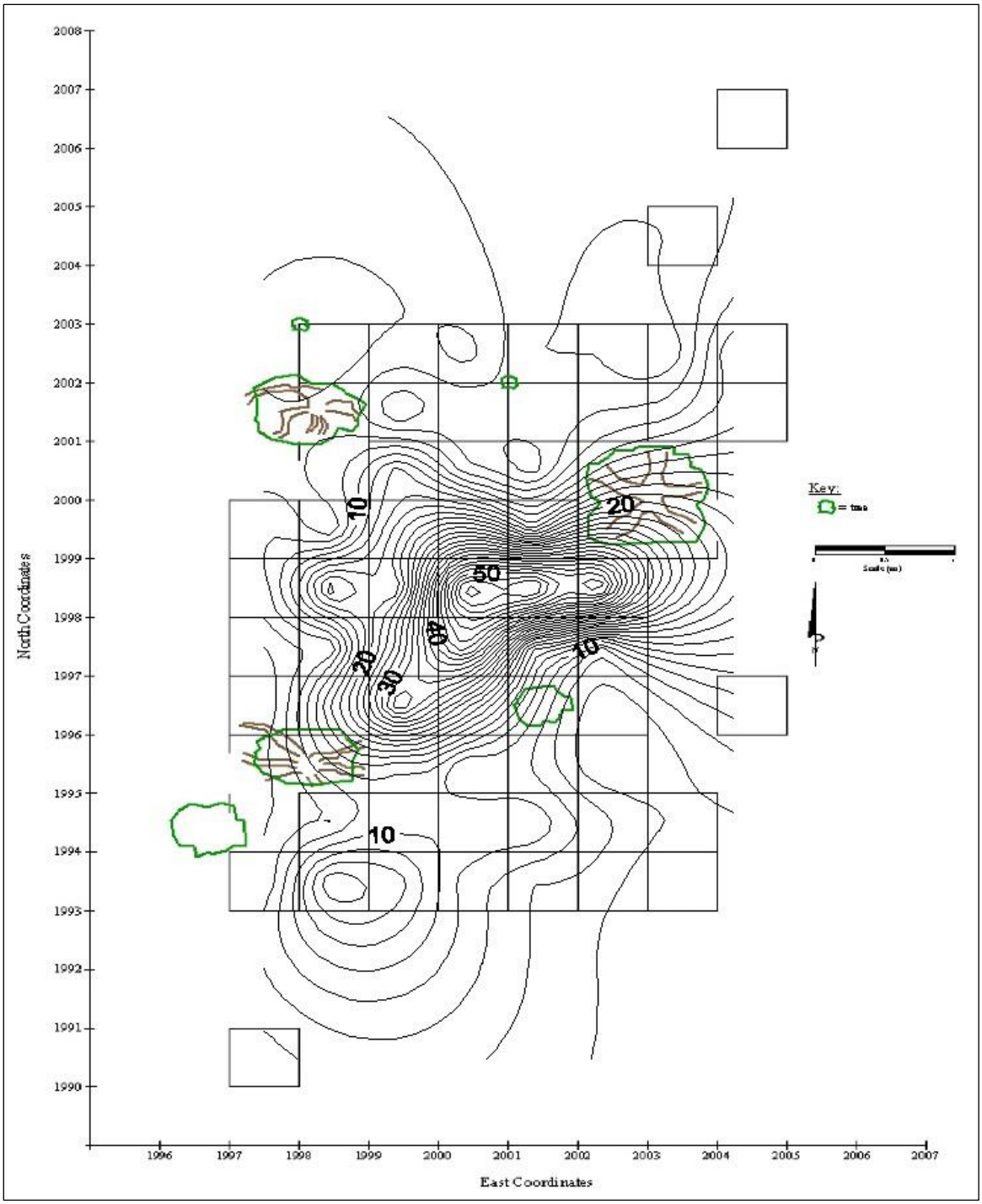

Figure 44: Contour Map of the Distribution of Debitage Recovered from Test Units.

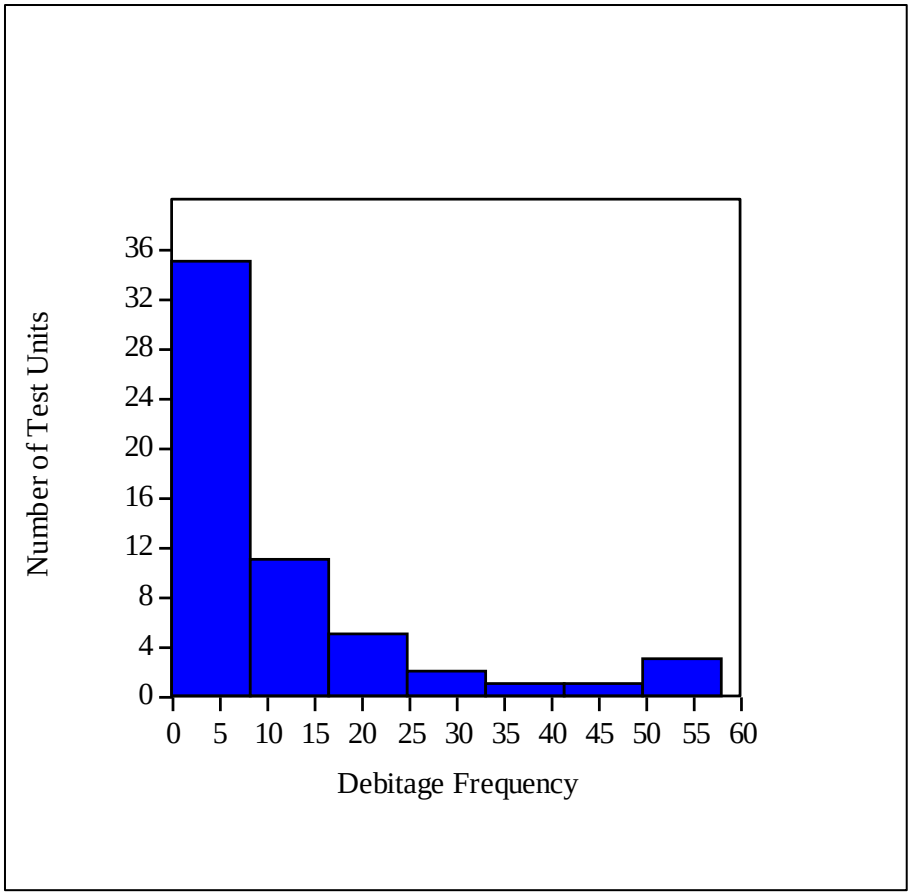

Figure 45: Histogram of Debitage Density for Test Units.

Jasper represents a significant majority of the assemblage, followed by chert; the distribution of cryptocrystalline artifacts, which represent the overwhelming majority of the debitage, mirror that of the overall assemblage. Quartz and Quartzite debitage cluster along the western edge of the overall debitage core, perhaps indicating a somewhat distinct occupation or, more likely, one or more distinct knapping episodes (Figure 46, p. 78).

Microdebitage

Site maintenance may remove material that impedes other activities from the main living area to the fringes of a given site (e.g., O'Connell et al. 1991:66−68). Therefore, the recovery of microdebitage (extremely small fragments of chipping debris associated with tool production or resharpening) may be crucial for the identification of areas where particular types of activities took place, as well as for determining the length of time a site was occupied (Fladmark 1982; Hull 1987; O'Connell 1987; Simms and Heath 1990). This follows from the ethnographic observation that site maintenance requires the removal of larger pieces that would have been underfoot and impeded use of particular areas during long periods of occupation (Binford 1983a; Nielsen 1991).

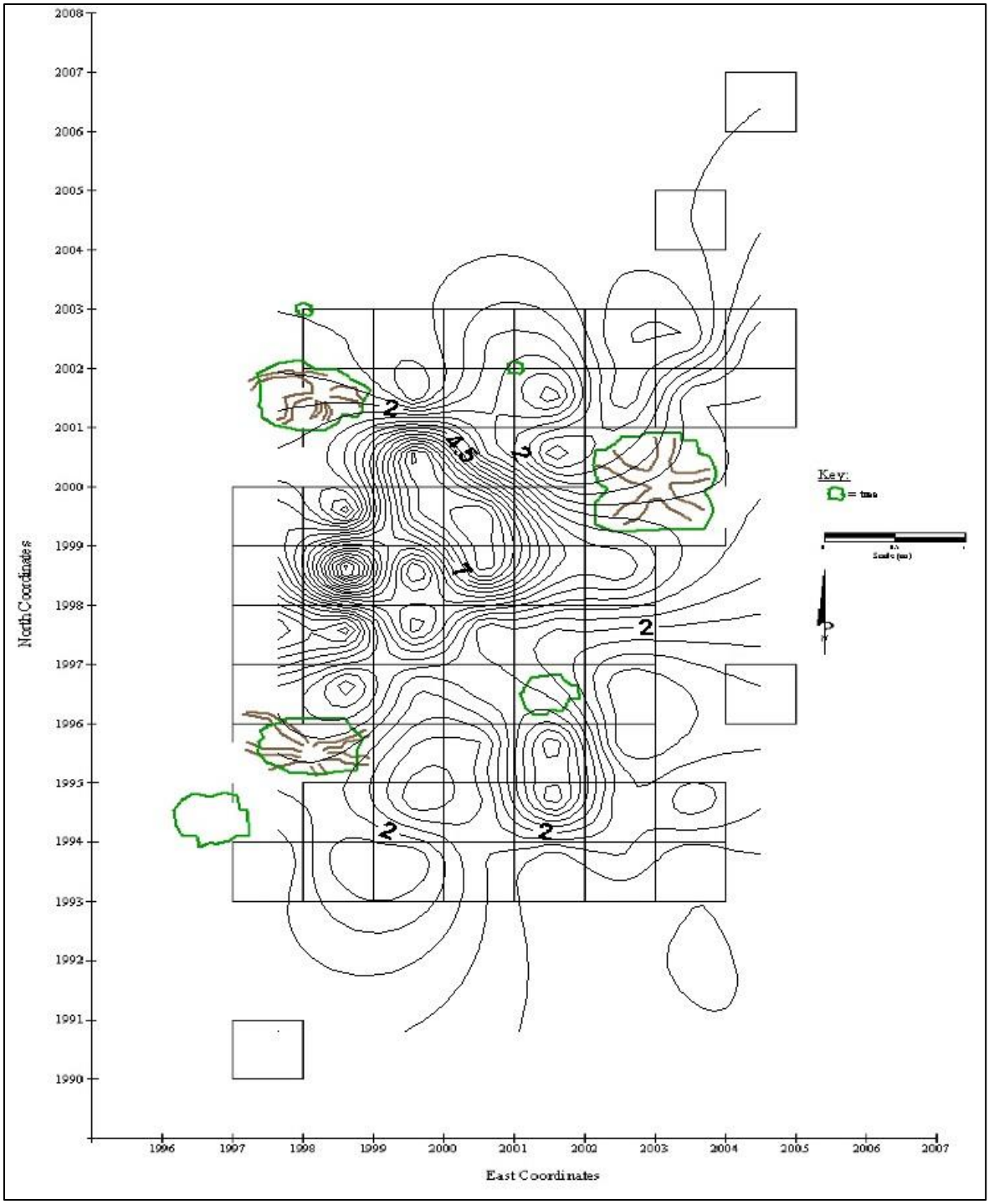

Figure 46: Contour Map of the Distribution of Quartz and Quartzite Debitage Recovered from the Test Units.

Hull (1987:773) suggests that "correspondence or noncorrespondence of microdebitage and macrodebitage distributions can be interpreted" based on ethnoarchaeological studies of formation processes:

> (1) *Primary refuse* is identified by a cluster of macrodebitage corresponding to a cluster of microdebitage.
> (2) *Secondary refuse* consists of macrodebitage with no corresponding cluster of microdebitage;
> (3) *De facto refuse*, although difficult to distinguish from primary refuse, should correspond to a microdebitage high density area while containing relatively large macroflakes and, possibly, more tools or tool fragments (italics in original).

De facto refuse refers to items intentionally left behind, like cached points. A fourth possibility, though somewhat remote, consists of microdebitage with no associated macrodebitage, representing a well-maintained activity area unaffected by refuse deposited when the site was abandoned (Stevenson 1991:279).

Soil samples of at least 2 liters (0.25 gallons) were collected from a designated corner of the Phase III test units, and submitted to Justine McKnight for flotation. The precise corner was selected to minimize disturbance within the area sampled. Soil samples were collected from the Stratum II, the Ap horizon, and the upper 10 centimeters (4.0 in) of Stratum III, the B1 horizon. Slivers of cryptocrystalline microdebitage contrasted with the rounded to subangular pebbles in the matrix, which consisted primarily of quartz (Table 16, p. 80). Variation in sample size does not correlate with the amount of debitage recovered per sample (Figure 47, p. 81).

A weak, yet definable correlation links the distribution of microdebitage with overall debitage density (Figure 48, p. 81). Microdebitage density peaks in TU 54, located near the core of the overall density distribution (Figure 49, p. 82; see Figure 44, p. 76). Knapping, therefore, likely produced the distribution of the macroscopic fraction of debitage, rather than cleaning and site maintenance.

Fire-Cracked Rock

The major concentration of FCR was north and east of the debitage concentration, though the two distributions overlapped. More than 200 grams (70 oz) of FCR was unearthed from eight test units located between N1998 and N2003 and E2001 and E2005 (Figure 50−Figure 51, pp.83–84). In only one of the test units were more than 200 grams (70 oz) and more than 30 pieces of debitage recovered, TU 54 (N1999/E2001; 236.0 g; 82.6 oz). TU 54 was located southwest of TU 41, the test unit that contained the highest density of FCR by weight.

Table 16: Phase III Data Used in the Microdebitage Analyses.

Test Unit	North	East	Debitage Count	Microdebitage Count	Soil Volume (l)
30	1994	2003	3	1	8.3
31	1995	2003	4	1	7.5
32	1996	2003	0	0	8.2
33	1997	2003	1	2	9
34	1994	2001	7	0	7.8
35	1994	2000	15	1	5.75
36	1996	2002	6	2	5.5
37	1995	2000	9	2	7.3
38	1996	2000	12	4	4.8
39	1997	2000	37	4	6.8
40	1998	2000	28	7	6.8
41	2002	2004	5	1	8.8
42	1998	2003	5	3	6.5
43	1999	2003	53	1	5.5
44	2002	2005	10	1	7.3
45	1995	1999	6	2	6.8
46	1995	2004	2	0	8
47	1994	2004	0	0	6.5
48	2003	2005	11	2	8
49	2000	2002	16	10	10.3
50	2001	2000	2	2	7.5
51	1997	1999	17	1	6.3
52	2001	2002	2	3	10.5
53	2003	2001	7	1	7
54	1999	2001	59	29	10
55	1997	1998	3	3	6.8
56	2002	2002	4	0	9.8
57	1999	1999	26	8	8
58	2002	2004	3	2	8.5
59	2000	1999	4	2	11.3
60	2003	2002	2	0	6.5
61	2000	1998	9	8	10.8
62	2003	1999	8	3	10.5
Total	NA	NA	376	106	258.95

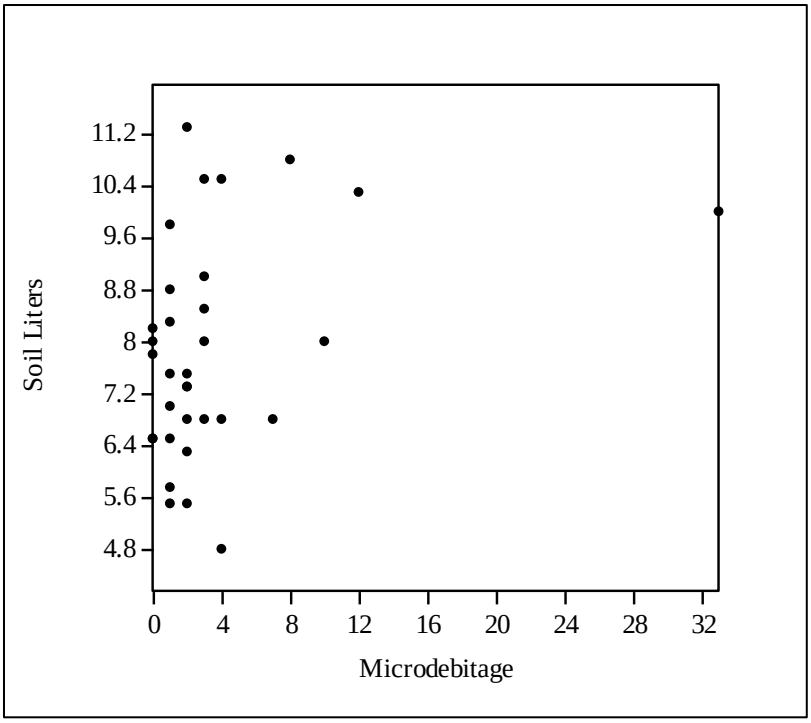

Figure 47: Microdebitage Count by Soil Sample Size in Liters.

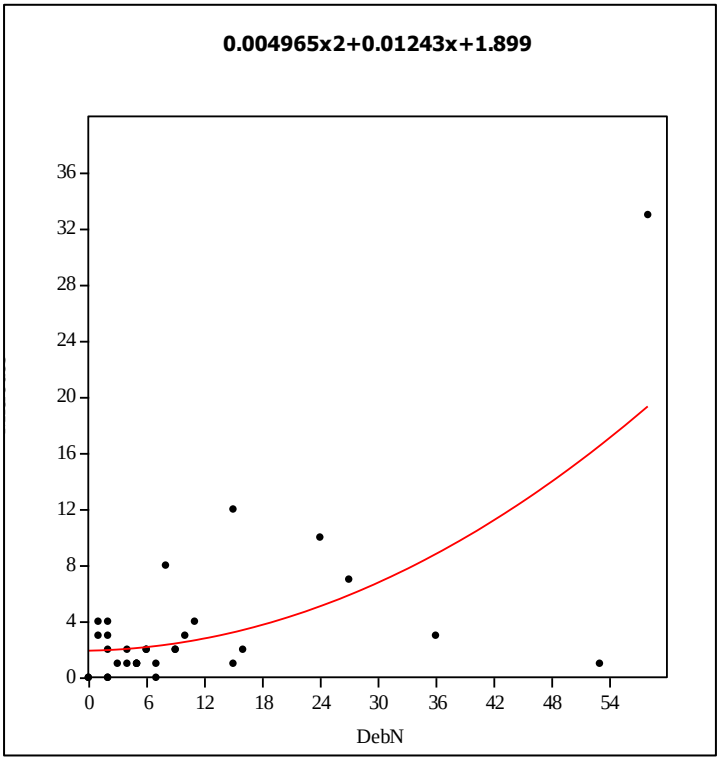

Figure 48: Second-Order Polynomial (i.e., X^2) Regression of Microdebitage Abundance by Macrodebitage Abundance (R^2=0.4383; p. 0.0002).

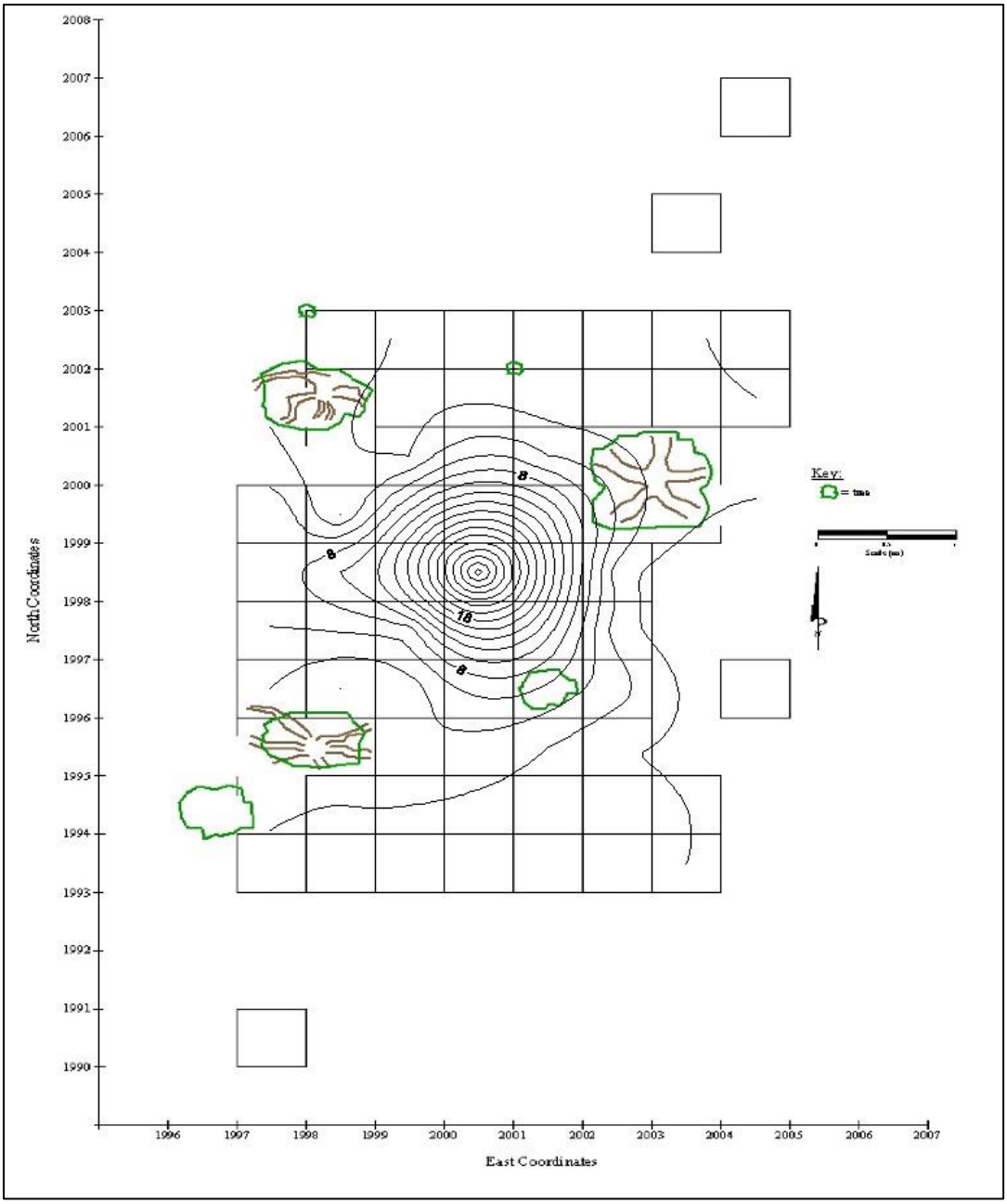

Figure 49: Contour Map of the Distribution of Microdebitage Recoverd from the Phase III Test Units.

The 893.3 grams (312.7 oz) of FCR in TU 41 exceeded all others; in addition, three FCR, perhaps the least disturbed remnant of the original concentration of FCR on the site, appeared at the surface of the subsoil in TU 41. No soil stains or reddening, charcoal, or other indications of an intact feature, however, existed in TU 41. The remaining six test units, by weight, produced 786.0 grams (275.1 oz; TU 52), 618.7 grams (216.5 oz; TU 21), 323.3 grams (113.2 oz; TU 53), 267.7 grams (93.7 oz; TU 22), 249.0 grams (87.2 oz; TU 49), and 226.0 grams (79.1 oz; TU 56). Six of eight units (TU 21, 22, 41, 49, 52, and

56) surround a large tree at the northeastern edge of the excavation block. The maximum dimensions of the concentration equal 4.0 by 3.0 meters (13.1 by 9.8 ft).

The presence of three test units that far exceed all others in FCR density by weight and 54 percent of all FCR by weight within 11 percent of the excavated area suggests the presence of at least one latent feature. Latent patterns result from the alteration of former activity loci, in this case a hearth or heated-rock dump and work area, by post-depositional processes. In contrast to evident features, which retain a distinctive form long after the use and abandonment of the site, latent features lack unambiguous structure. Nevertheless, latent features manifest as distinctive statistical and distributional patterns (Petragulia 2002).

Binford (1983b:160) suggests that "the size and basic mechanics of the human body affect patterning in the archaeological record" by creating minimum dimensions for work spaces and associated refuse deposits. As a consequence, cross-cultural patterns in the size of work and living spaces exist (Binford 1983b:173–192). It follows that a single seated person consumes at least a square meter (10.8 ft^2) of space, and probably more, meaning even undisturbed activity areas encompass at least 2 square meters (21.5 ft^2). Both fire-cracked rock and microdebitage extend across at least 2-square meter (21.5- ft^2) areas; macrodebitage clusters within a larger portion of the site core. While plowing and other actions and natural processes undoubtedly blurred the original pattern, the overall distribution of the debitage, microdebitage, and fire-cracked rock likely identifies work areas for several individuals.

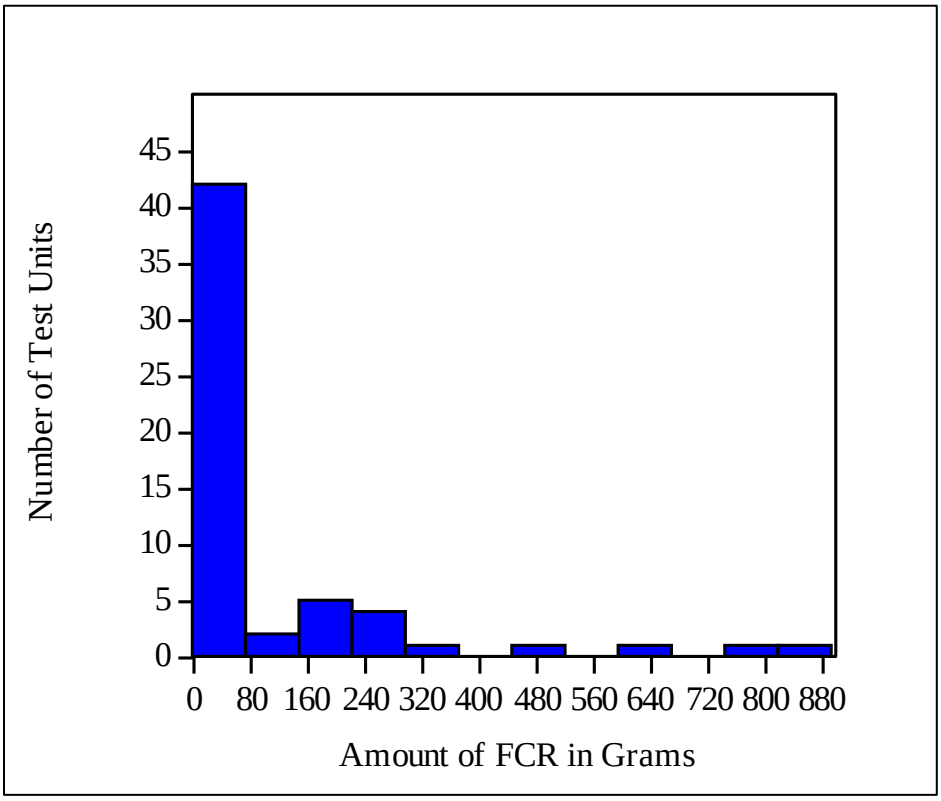

Figure 50: Histogram of Fire-Cracked Rock Weight in Grams by Test Unit.

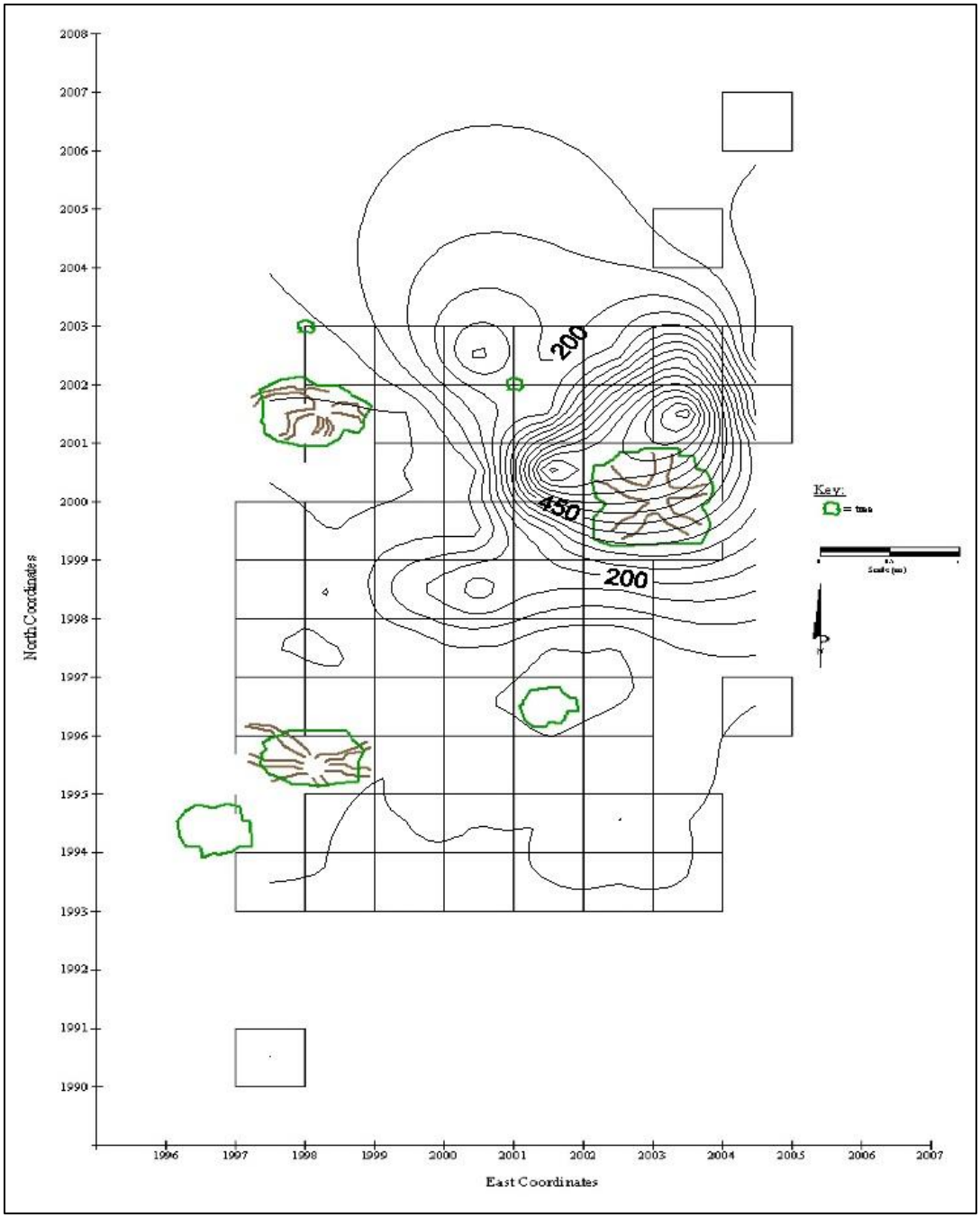

Figure 51: Contour Map Depicting Variation in the Weight in Grams of Fire-Cracked Rock by Test Unit.

Soil Chemistry

Eighty-eight soil chemistry samples were collected during Phase III excavations at the Warwick Site primarily from the two main artifact-bearing strata: the plowzone and upper subsoil, designated Stratum II and Stratum III-1 respectively. Samples were collected from thirty-three 1-x-1 meter (3.3-x-3.3 ft) test units, and also from 15 soil

cores placed on a 10 meter (32.8 ft) interval across the site area. Chemical analysis was carried out in order to assess the potential spatial variation in anthropogenic soil alterations on site. Such signatures can potentially elucidate the location of activities and site structures, which can be problematic to identify through field observations alone on small, low-density sites. All samples were submitted for analysis to the University of Delaware's Soil Testing Program where a 'Routine Soil Test" was run including a Mehlich 3 extraction (Mehlich 1984) and inductively coupled plasma optical emission spectrometry (ICP-OES) for eleven elements: phosphorus (P), calcium (Ca), potassium (K), magnesium (Mg), manganese (Mn), copper (Cu), zinc (Zn), iron (Fe), boron (B), aluminum (Al), and sulfur (S). The Routine Test package also includes tests for pH, organic matter content, phosphorus saturation ratio (PSR), cation-exchange capacity (CEC), and base saturation.

While numerous elements can be useful for archaeological soil chemistry; phosphorus, potassium, calcium, and magnesium are the most widely useful for spatial interpretations of past human activities on archaeological sites. They are commonly deposited, relatively stable in most soils, and most scholars agree with their associations with both general and specific anthropogenic inputs. Phosphorus (P) is most often associated with general organic refuse including human and animal waste and linked to kitchen and residential middens as well as gardens and animal pens. Calcium (Ca) is associated with wood ash, animal bone, shell, and architectural products made with lime such as plaster. Potassium (K) is prevalent within plant tissue and has been linked to hearth areas and the presence of ash. Magnesium (Mg) has been associated with areas of intense burning, but scholars disagree on the validity of that assertion and it is recommended that any interpretations made from Mg levels should be understood as tentative (Ascher and Fairbanks 1971; Keeler 1973; Pogue 1988; Woods 1988; Neiman et al 2000; Fischer 2001; Wilkins 2009; Fesler 2010).

Microsoft Excel was used to generate descriptive statistics, charts, and relative values such as Z scores, useful for comparing the relative level of enhancement of multiple elements that may differ greatly in terms of their actual concentration within the soil. A Z score of 1 corresponds to that sample's concentration of a given element equaling one standard deviation greater than the mean concentration of the entire assemblage, while a Z score of -1 corresponds to a sample whose value is one standard deviation below the mean for that element. Z scores for both Stratum II (Ap) and Stratum III-1 (B1) were mapped and the distributions analyzed using ArcGIS software, version 9.3.

A statistical test for spatial autocorrelation was also applied to the soil chemistry distributions in order to evaluate the degree of dispersion, clustering, or randomness of the distributions (Hodder and Orten 1976:174). The test, known as Moran's I, produces an index value (I) characterizing the nature of the spatial patterning as dispersed, clustered or random. The Z scores characterized the extent of patterning, and p values evaluated statistical significance of the Z scores. A clustered pattern can be interpreted as the propensity of a given data point to have similar values to the surrounding points. In a dispersed pattern, the values of a given point differ significantly from values of surrounding points. A random pattern indicates that value of a given point cannot reliably

be used as predictor of the values of surrounding points. Clustering of soil chemical values can indicate that the concentrations of the element may relate to human activity.

In general, the variation in mean soil chemical values by strata is consistent with field observations and artifact counts that show the majority of anthropogenic activity at Warwick is captured in the plowzone (Stratum II) and upper subsoil (Stratum III). Figure 52 (p. 86) shows that these two strata contain the highest average chemical values for P, K, Ca; though Mg appears to have the greatest concentration in Stratum IV (B2), which may be due more to geological variation than anthropogenic deposition of Mg-bearing material.

Comparing the two main cultural strata of the site, the plowzone (Ap) and upper subsoil (Level 1 in B1), significant differences between the distributions of three of the four elements in consideration are apparent both spatially and statistically: potassium, calcium, and magnesium. Only phosphorus exhibits a significant correlation (Pearson's = 0.385, p = .03) between the two principal strata of interest (Table 17, p. 87). This is likely due to the limited mobility of phosphorus within soils due its strong propensities to form leaching and digestion-resistant compounds with elements abundant in soils such as iron and aluminum (Smeck 1985; Stevenson and Cole 1999). Therefore, the lack of congruity between the plowzone and subsoil distributions of potassium, calcium, and magnesium is likely due to a combination of post-depositional processes at the site and the ability of those elements to cycle through biological and geological pathways after anthropogenic deposition. Interestingly, Fischer's (2001:95) study of a plowed historic nineteenth-century site in piedmont Virginia has shown the opposite result: potassium, calcium, and magnesium exhibited similar distributions in both the plowzone and subsoil, and phosphorus did not. However, multiple factors such as duration of occupation, time since deposition, and soil composition could explain differences in how various elements are retained in soils.

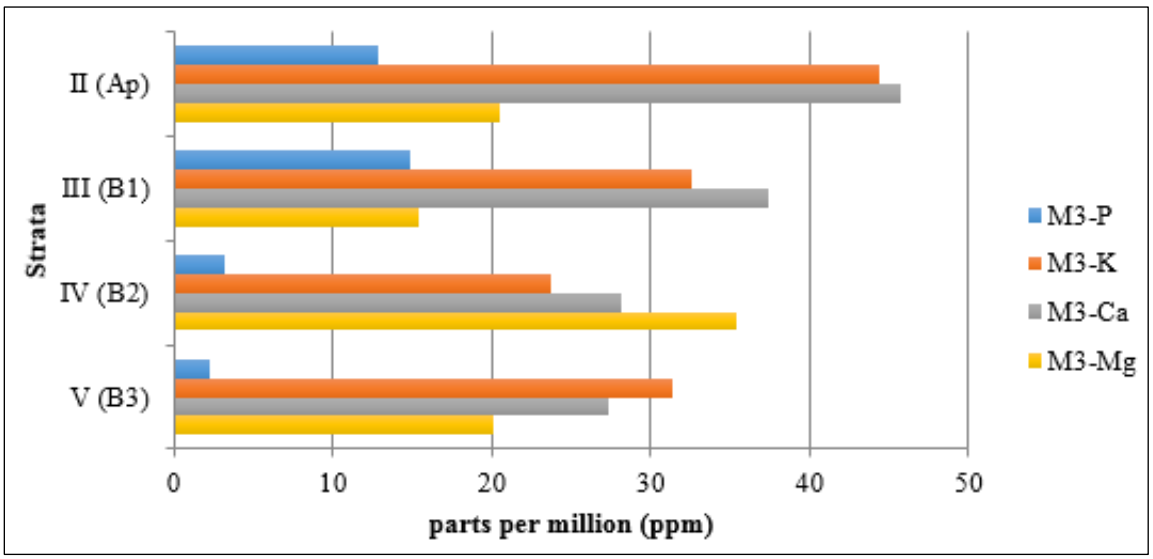

Figure 52: Bar Chart Showing the Mean Value of Phosphorus, Potassium, Calcium, and Magnesium by Stratigraphic Context.

Table 17: Correlations Between Plowzone (Ap) and Suboil (B1-1) for Selected Elements at 18CE371.

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	Ap_P & B_P	32	.385	.030
Pair 2	Ap_K & B_K	32	.145	.429
Pair 3	Ap_Ca & B_Ca	32	-.017	.927
Pair 4	Ap_Mg & B_Mg	32	.094	.610

Visual inspection of the distribution maps of the four elements in both Strata II (Ap) and III-1 (B1) reveal some interpretable similarities to artifact distributions. Phosphorus, in both the plowzone and subsoil, is concentrated to the eastern half of the site, along the E2002 and E2003 transects, and between the N1995 and N2000 transects. This concentration is roughly similar to the distribution of total artifacts and most similar to the distribution of debitage, but not microdebitage, suggesting this area could be the location of secondary refuse deposition that included organic materials such as plant and animal matter or waste (Figure 53 and Figure 54, pp. 88−89). While the autocorrelation statistics (Table 18, p. 90) for the plowzone phosphorus indicate a somewhat dispersed patterning, the subsoil pattern is significantly clustered, suggesting that distribution is a genuine locus of anthropogenic deposition.

The distribution of potassium in the plowzone occurs along a southwest-to-northeast axis, beginning with two primary areas of intense concentration around N1994/E1996 and N2003/E2003 (Figure 55, p. 91). The northeast potassium concentration does align with a concentration of fire-cracked rock. Potassium is associated with the deposition of both ash and more generally plant matter, suggesting that this area was the location of a hearth or at least an area for disposing of hearth-related refuse. The subsoil pattern of potassium enrichment (Figure 56, p. 92) resembles the plowzone visually, with high values extending further north and west in the subsoil, though statistically the potassium values of the two strata are not correlated. Both patterns do exhibit a moderate clustering according to autocorrelation statistics.

Calcium is concentrated in the plowzone in the eastern portion of the site, somewhat similar to the phosphorus distribution, though elevated calcium levels extend further north (Figure 57, p. 93). This patterning does not align well with any artifact distribution, existing somewhat further east than the various lithic categories. Calcium concentrations are associated with deposition of shell and bone, and this pattern may suggest that food preparation activities at the Warwick site were spatially segregated from tool maintenance areas. The subsoil distribution of calcium is markedly different (Figure 58, p. 94), as three isolated concentrations exist further west just around the E2000 transect between N1994 and N2002. This pattern is rather similar to the distribution of total artifacts, which would suggest the opposite conclusion from the plowzone calcium distribution. Moreover, addition of shell, lime, or other products to enhance soil productivity potential altered the calcium content of the sediments. It is unclear at this point whether either the calcium distribution is a result of anthropogenic activity, whether

prehistoric, historic, or modern. The autocorrelation results for calcium in both strata indicate spatial randomness, casting further doubt on the interpretability of the distributions (see Table 18, p. 90).

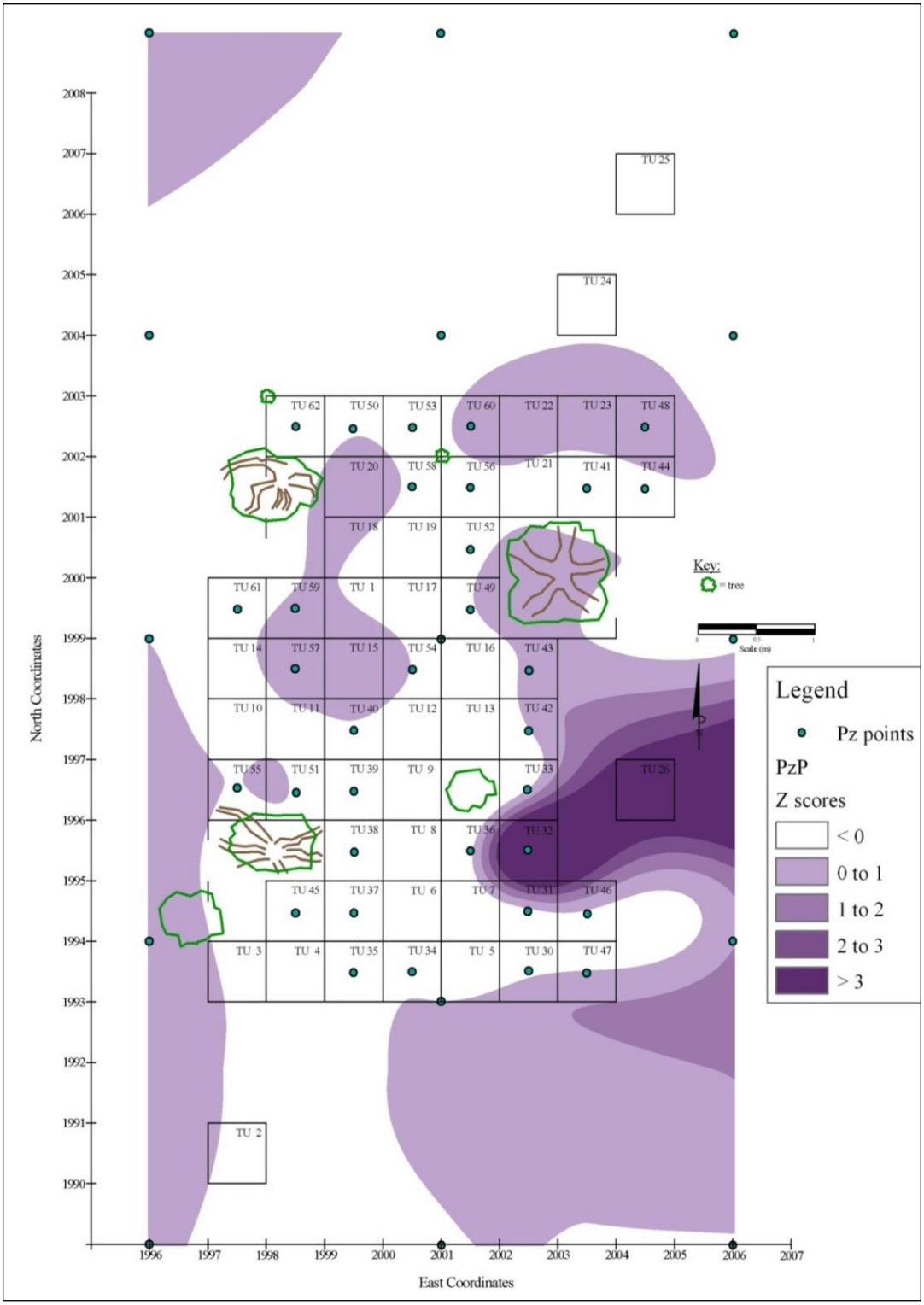

Figure 53: Distribution of Phosphorus in the Plowzone.

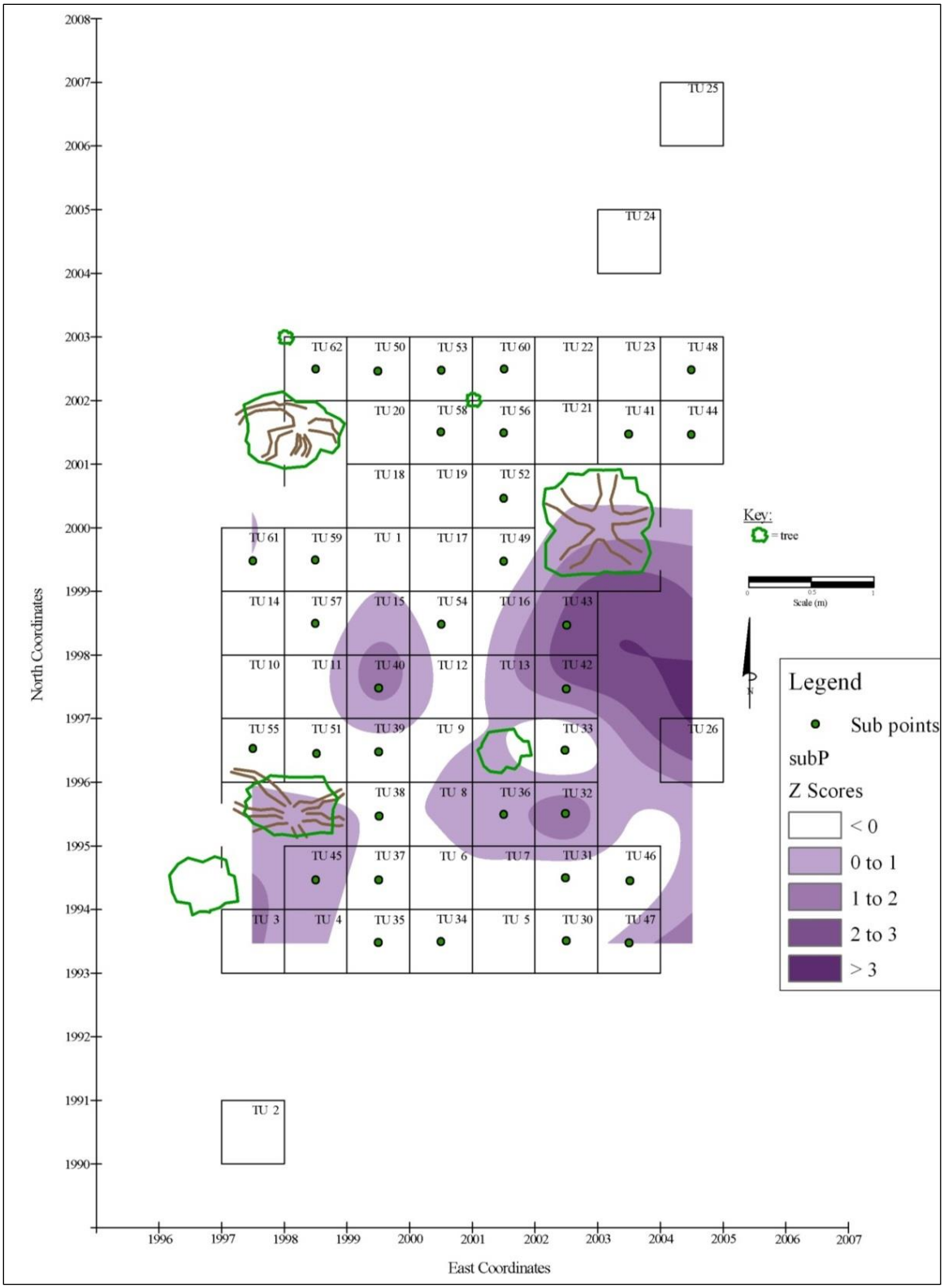

Figure 54: Distribution of Phosphorus in the Subsoil.

Table 18: Spatial Autocorrelation (Moran's I) Values for Selected Elements.

Stratum	Element	Index	Z Score	P Value	Result
B1	Mg	0.29951	2.09715	0.03598	Clustered
B1	Ca	-0.111985	-0.794737	0.426767	Random
B1	K	0.146047	1.192052	0.233241	Somewhat clustered
B1	P	0.328776	2.310926	0.020837	Clustered
Ap	Mg	0.039635	1.627573	0.103616	Somewhat clustered
Ap	Ca	0.008786	0.721827	0.470401	Random
Ap	K	0.045048	1.583147	0.113388	Somewhat clustered
Ap	P	-0.048919	-1.000981	0.316836	Somewhat dispersed

The distributions of magnesium in the plowzone exhibit little concentration in the site core, and the highest values at the northern extremity of the area sampled with soil cores (Figure 59, p. 95). Despite being somewhat clustered (see Table 18, p. 90), the magnesium content of plowzone soils does not appear to relate to the prehistoric occupation of the Warwick site. The subsoil distribution of magnesium (Figure 60, p. 96) is very distinct from the plowzone, exhibiting a significantly clustered concentration in the northwest quadrant of the site core centered around N2000/E1999, in the same vicinity as the highest concentration of total artifacts and debitage distributions. A somewhat less intense concentration also extends north and east into the area associated with fire-cracked rock and potassium concentrations. Magnesium has been tentatively linked to both to ash deposition and heat-affected soils, suggesting that the pattern of magnesium of Warwick may be indicative of a hearth or hearth-related refuse.

Overall, the soil chemical distributions of phosphorus, potassium, and magnesium added to and reinforced the artifact distributions previously discussed. Subsoil chemical distributions seemed to associate more precisely with artifact patterns than did the plowzone, while calcium did not appear to be informative in either strata. The spatial autocorrelation statistics (see Table 18, p. 90) support this conclusion, as well as support the larger interpretation of the Warwick site as a small, relatively short-term occupation with a small number of activities and associated activity areas. Longer term or more continuous occupations would likely generate a higher degree of spatial clustering, even on a plowed site. At Warwick only magnesium and phosphorus, both the B1 stratum, were clustered with high significance ($p < 0.1$), and even they had relatively low Z scores indicating that the clustering is not extreme. These results are consistent with a relatively brief, short-term occupation.

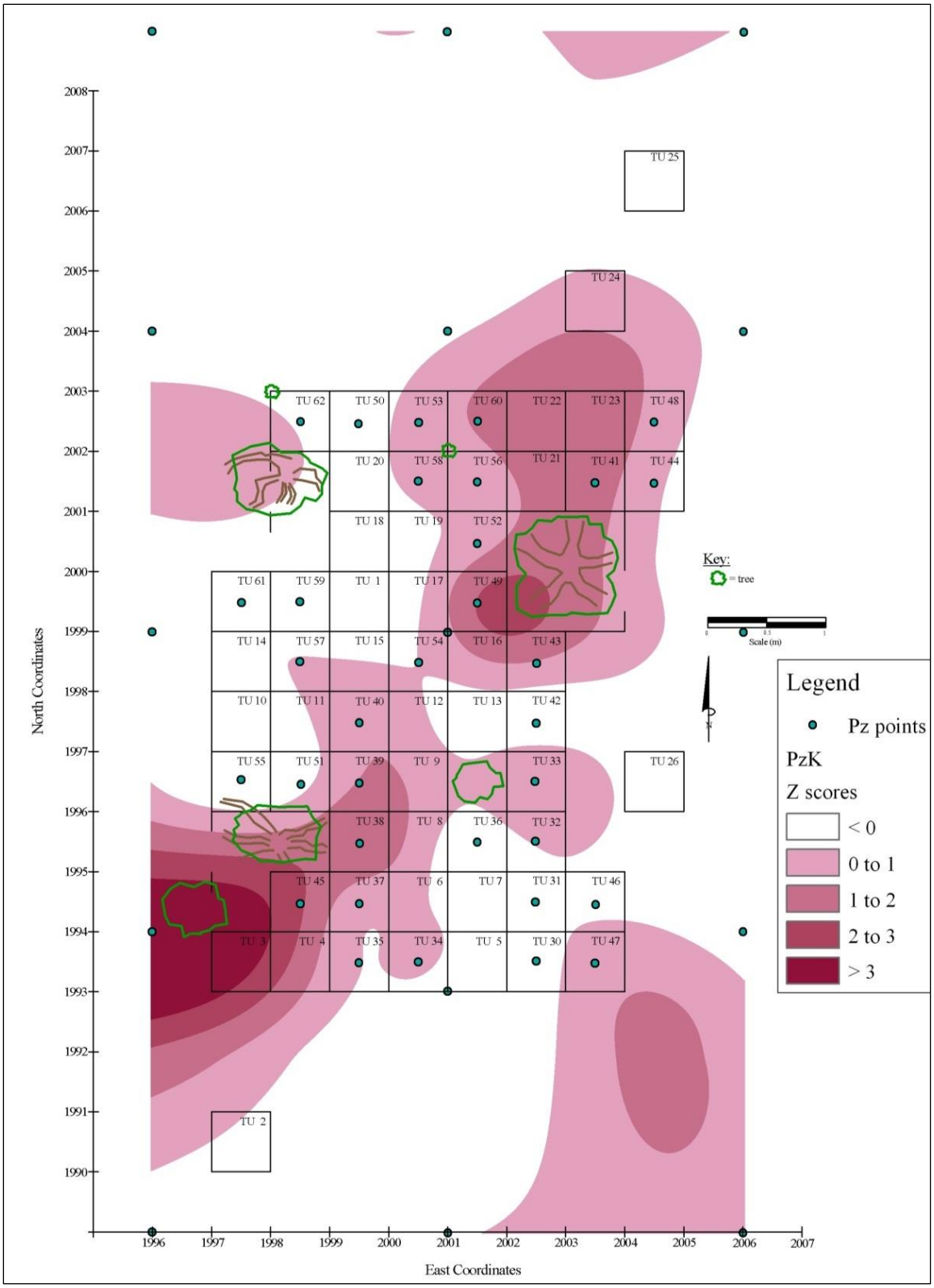

Figure 55: Distribution of Potassium in the Plowzone.

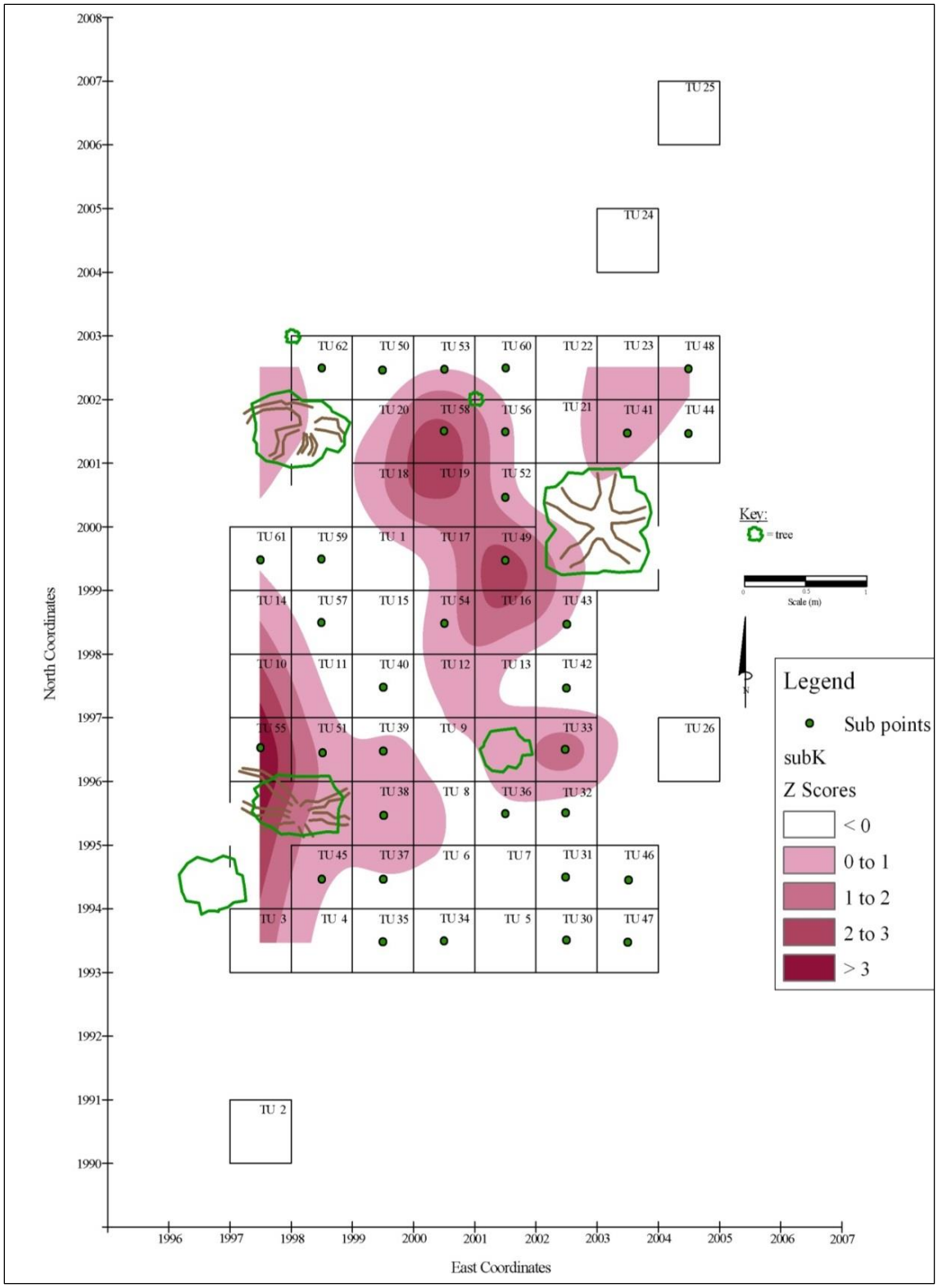

Figure 56: Distribution of Potassium in the Subsoil.

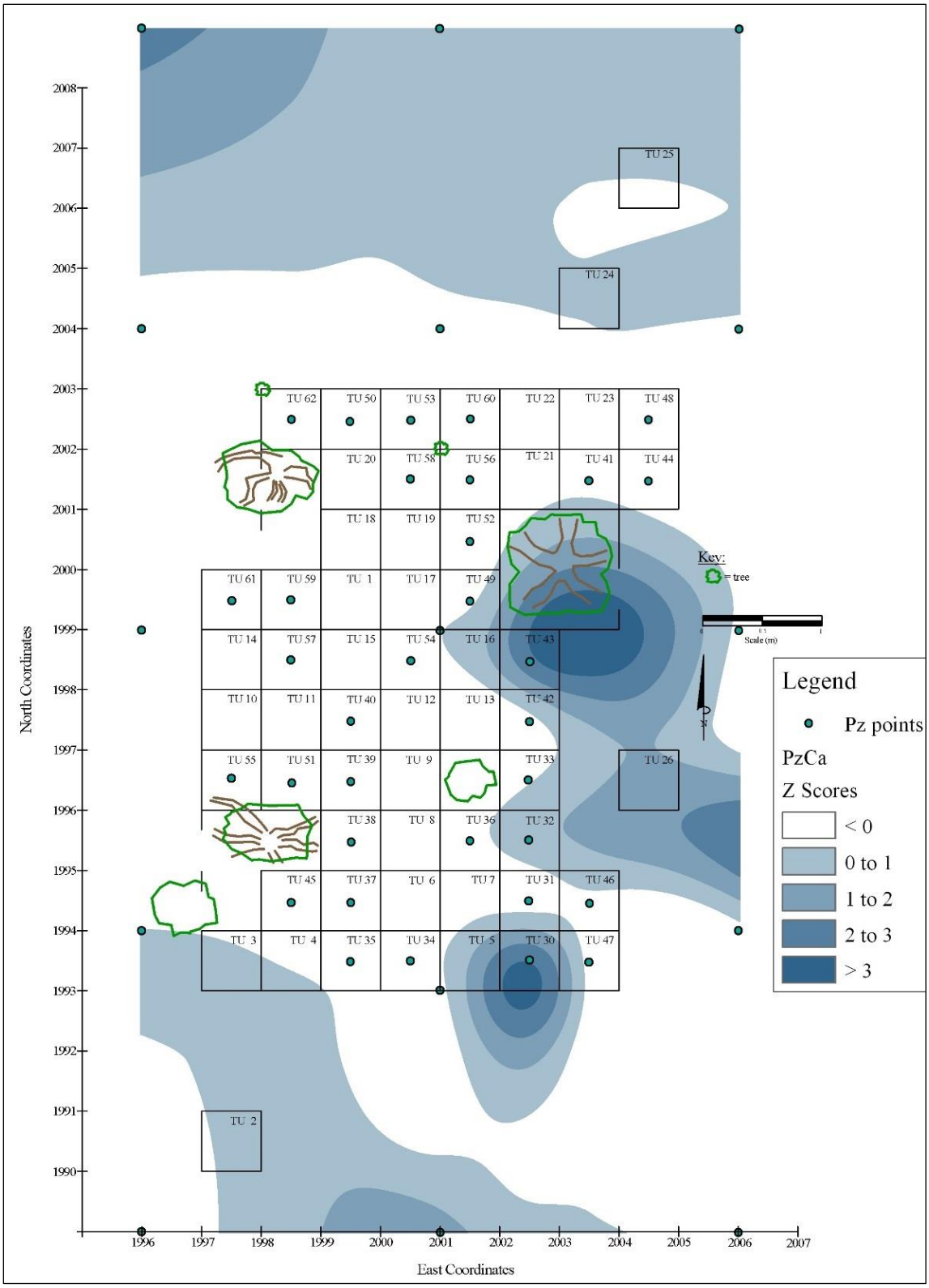

Figure 57: Distribution of Calcium in the Plowzone.

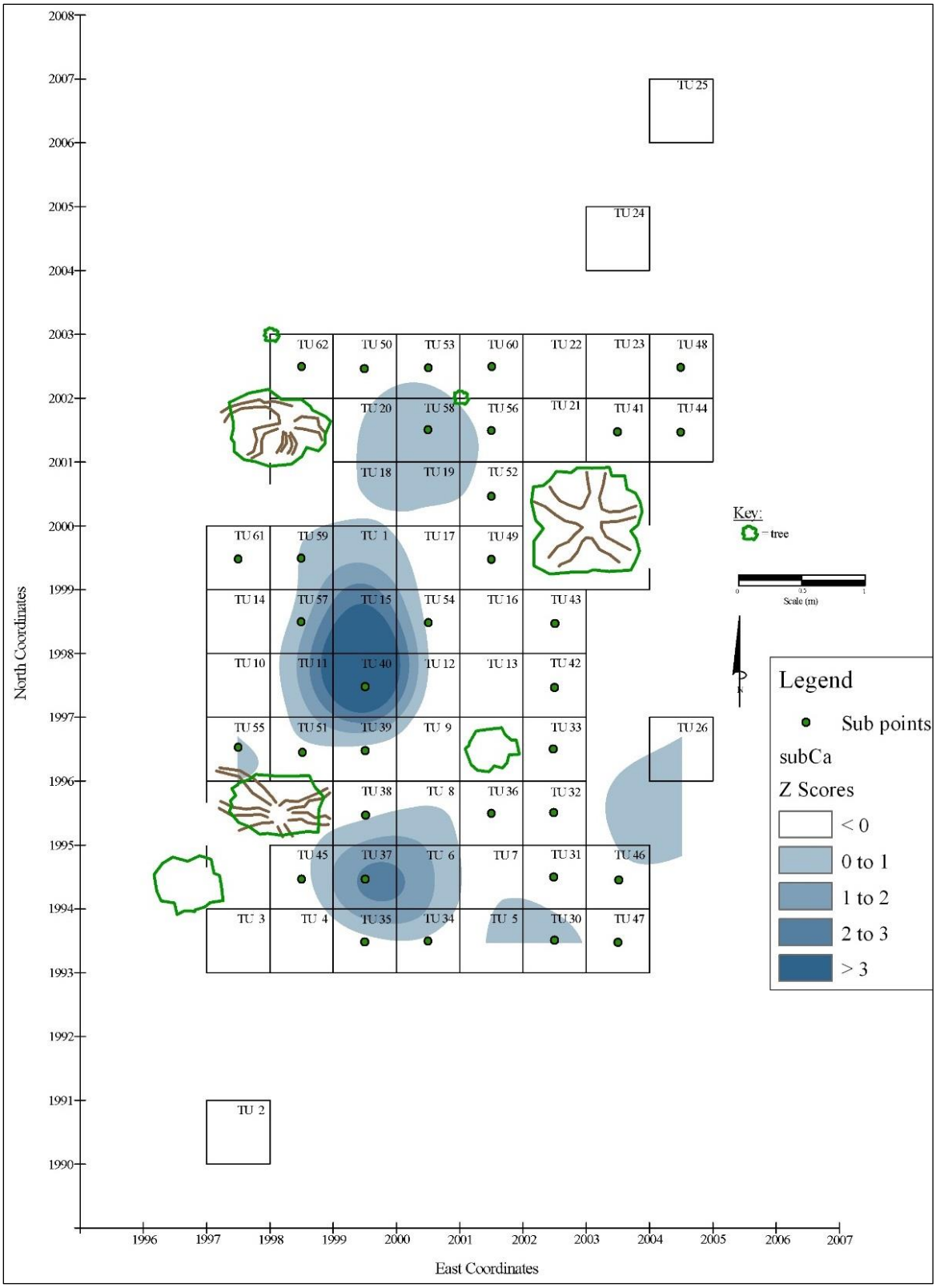

Figure 58: Distribution of Calcium in the Subsoil.

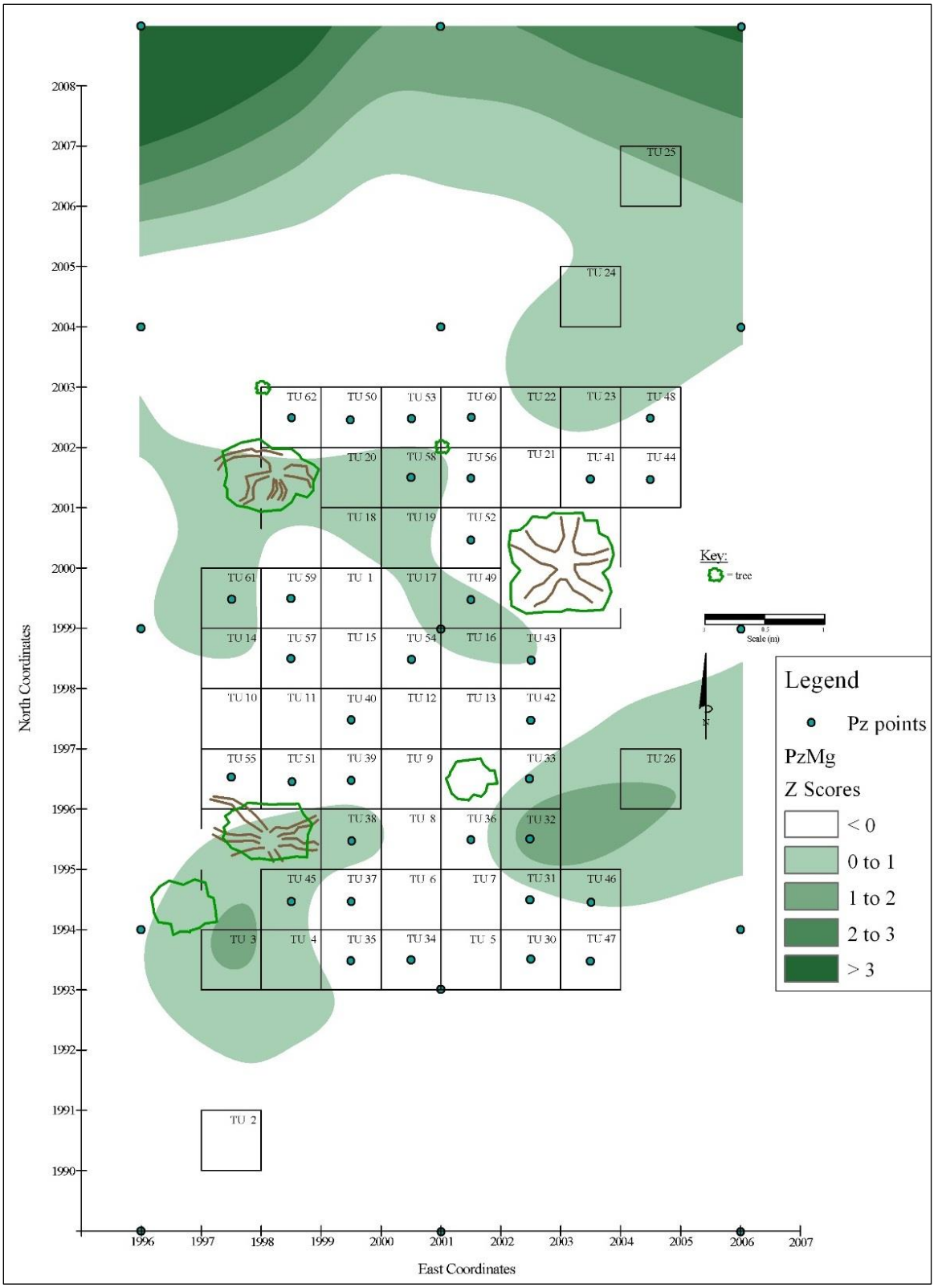

Figure 59: Distribution of Magnesium in the Plowzone.

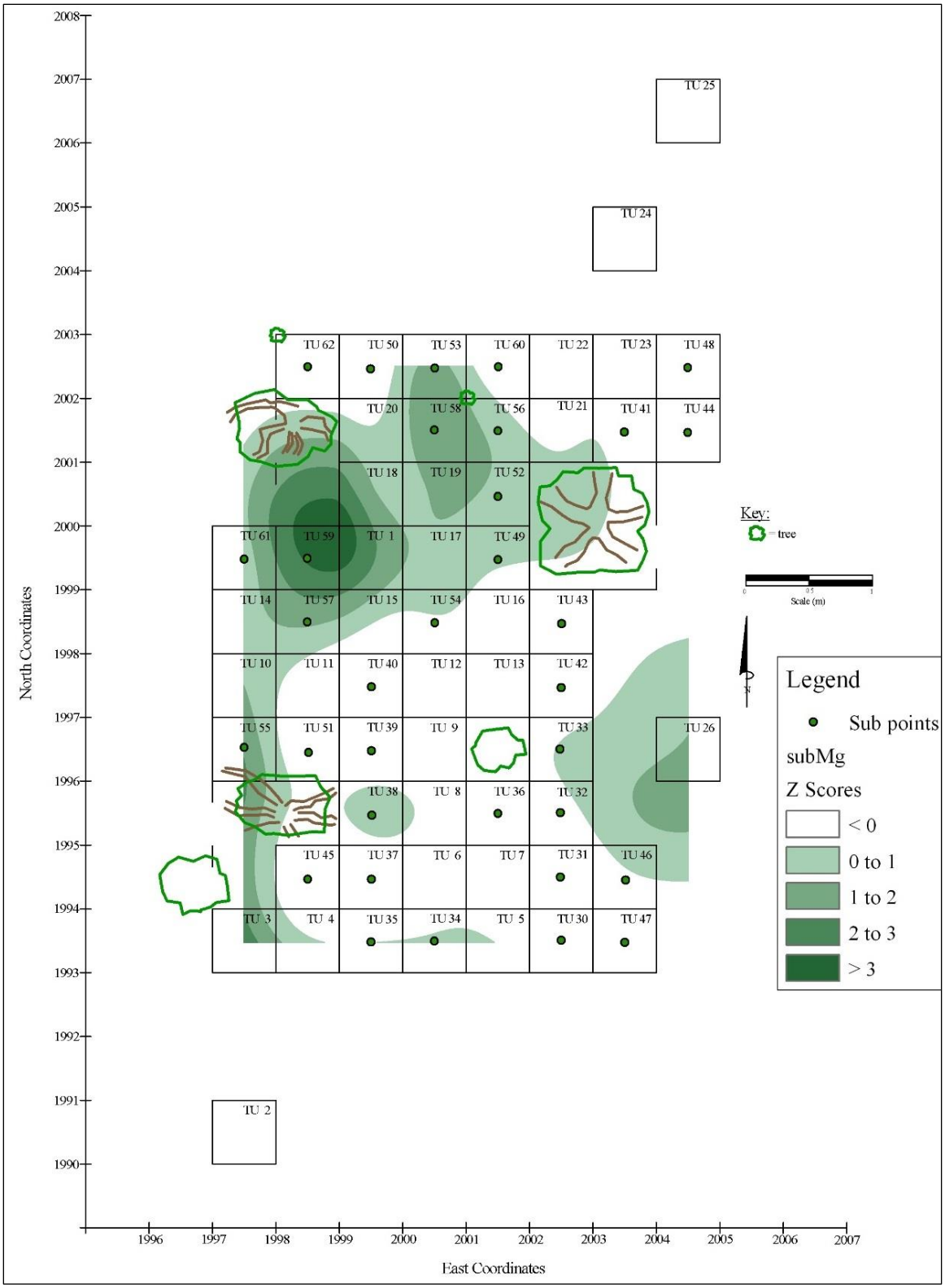

Figure 60: Distribution of Magnesium in the Subsoil.

The Site in the Region

Lee (1979) identifies the dynamic of movement of both individuals and groups across a broad region as central to hunter-gatherer life. The Warwick Site occupies a low terrace near the headwaters of a low-order tributary of the Sassafras River, at the eastern edge of the drainage divide separating streams flowing into Delaware Bay from those emptying into the Chesapeake Bay. Eighteenth-century maps illustrate an early post road following the drainage divide from the falls of the Delaware River to the head of the Chester River, roughly the alignment of present-day U.S. 301 (Figure 61). The post road continued south to join an eastern route that followed the spine of the Delmarva Peninsula south to the mouth of the Bay and the James River. Early roads tended to follow paths previously trod by Native Americans. A pre-contact trail, therefore, likely passed through the environs surrounding the Warwick Site. GIS was used to examine the viewshed from the Warwick Site and to model the likely location of least-cost paths to the Warwick Site.

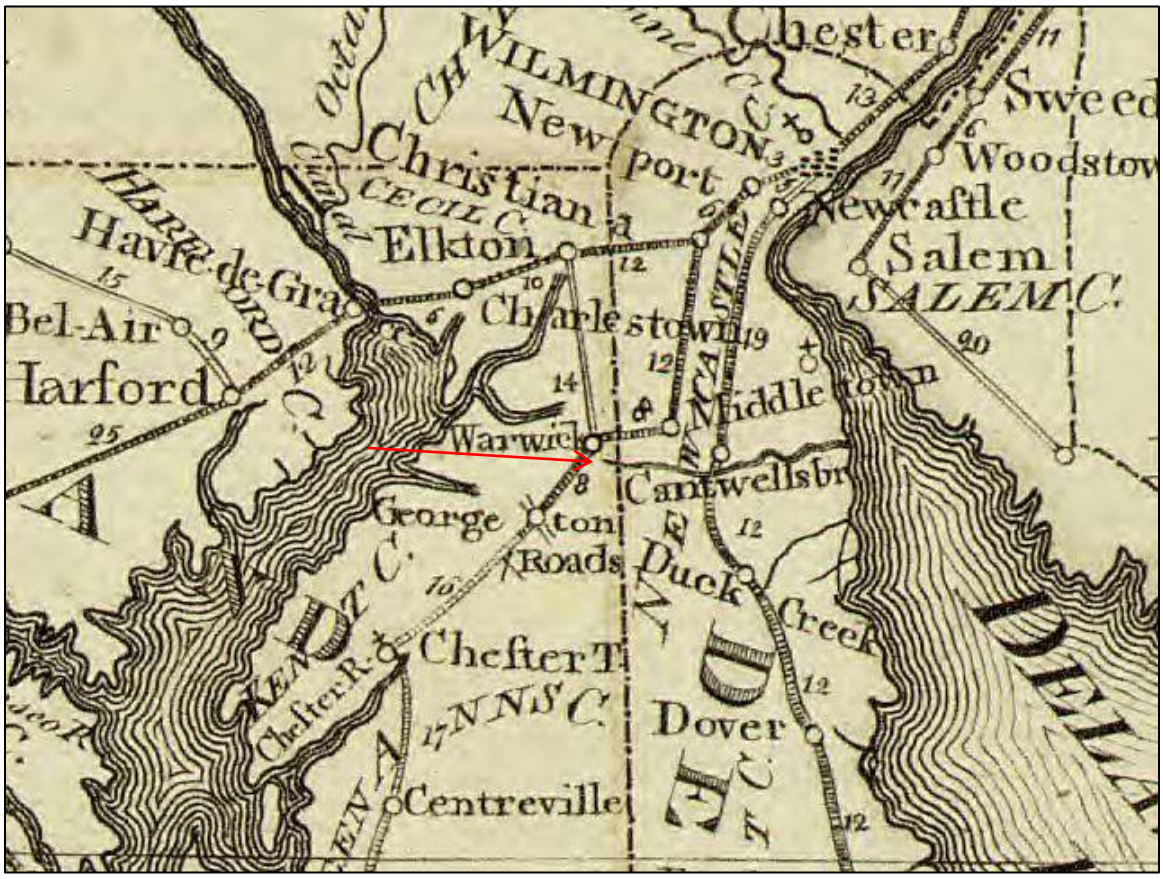

Figure 61: Detail from a *Map of the United States exhibiting the post roads & distances* (Bradley 1796) Showing the Project Vicinity.

The Local Landscape: Analysis of Viewsheds and Least-Cost Paths

To situate the Warwick Site in relation to the movement of both humans and game through the surrounding landscape, viewshed and least-cost analyses were undertaken

using Geographic Information Systems. Geographic Information Systems, or GIS, allow rapid calculation of visible terrain from specified locations (Wheatley 1996). Digital Elevation Models (DEMs) consist of a matrix of cells, where each cell contains a value approximating the terrain's elevation above sea level. The data from the cells form the basis for the calculations. When obstructed by cells with higher elevations, the target cell is not visible in the viewshed map. The resulting viewshed maps allow the analyst to explore views of the landscape from different landforms.

Analysis of viewsheds and least-cost paths was undertaken using ESRI's ArcView GIS using a 30-meter (98.4-ft) resolution digital elevation model (DEM) from the U. S. Geological Survey. Observation points were created within and adjacent to the Warwick Site. Using GIS software, center points were created to generate a comparative viewshed from the site and nearby high ground. For this analysis, we assumed that only elevation obscured the view, meaning maximum viewshed is depicted. The probable presence of forests surrounding the site and the absence of information about the exact timing of the occupation or occupations introduces uncertainty about the precise range and direction of visibility. Nevertheless, viewshed analysis provides a valuable starting point for establishing the relationship between the site and the surrounding environs (Figure 62).

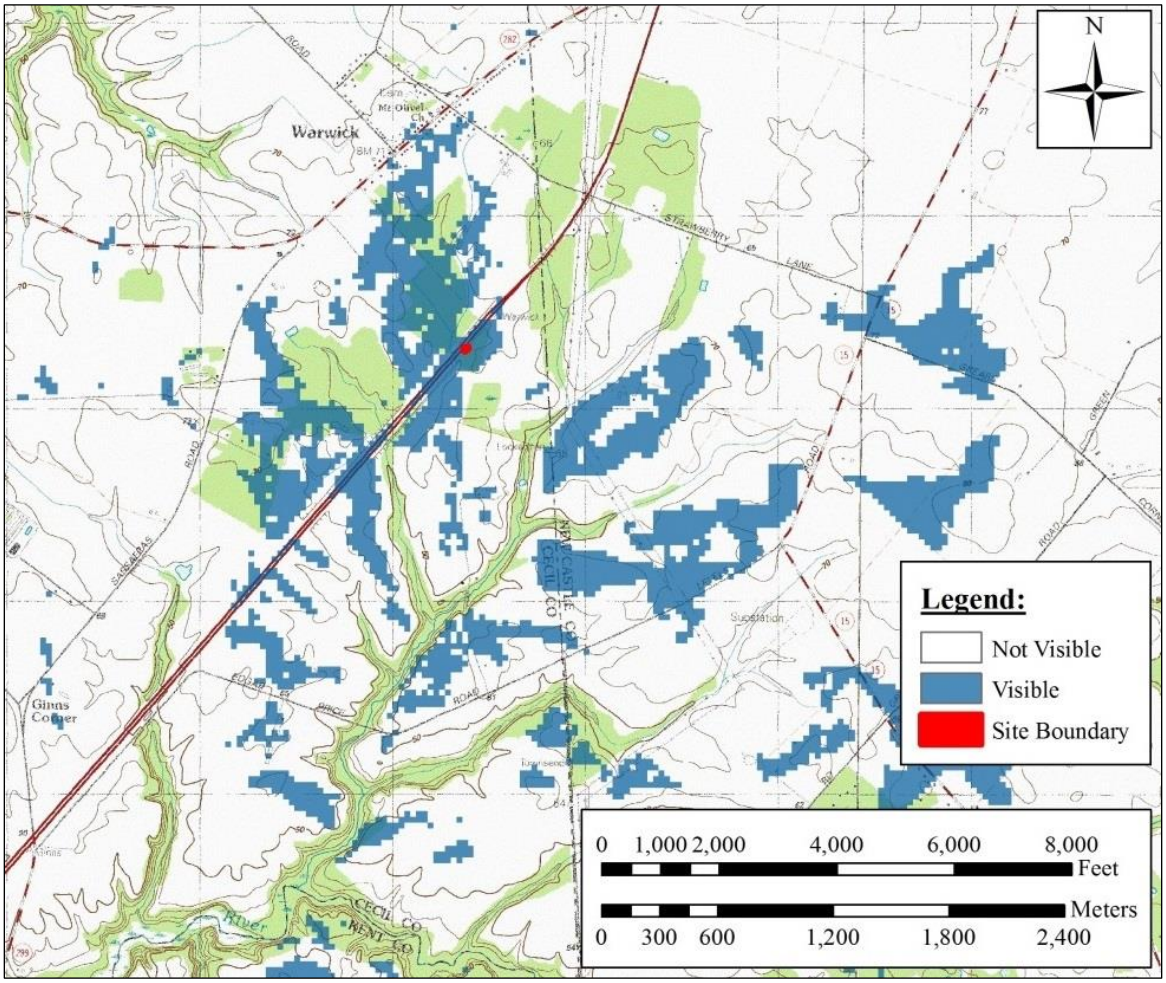

Figure 62: Viewshed from the Warwick Site.

Views from the Warwick Site extend north and west for a considerable distance downstream, useful if game regularly watered along the streams or if travelers passed through along a path. Higher elevations to the east obscure views along the terrace, though portions of the terrace south of the site would have been visible during at least the late fall and winter. The site does not, however, provide a commanding view of the surrounding landscape, suggesting that monitoring regional movement of people and game was not the sole reason the site setting. If monitoring was a goal of the people who occupied the Warwick Site, views downstream and toward streams were most important. Alternatively, the Warwick Site may have been one of a number of locations involved in monitoring the movement of game and humans during a single expedition. If so, the "notion site" perhaps impedes understanding of the relationship between the accumulation of artifacts designated the Warwick Site and the circa 5000–3000 B.P. cultural landscape (Dunnell 1992:38). Binford (1983b:117–138), for example, discusses interrelated locations that result from an integrated suite of activities used during caribou hunts. Centering the viewshed approximately 250 meters (820 ft) east atop a slightly higher terrace opens views to the northeast and east (Figure 63); multiple viewing stations on higher elevations within 1.6 kilometers (1 mi) of the Warwick Site would access much of the surrounding landscape.

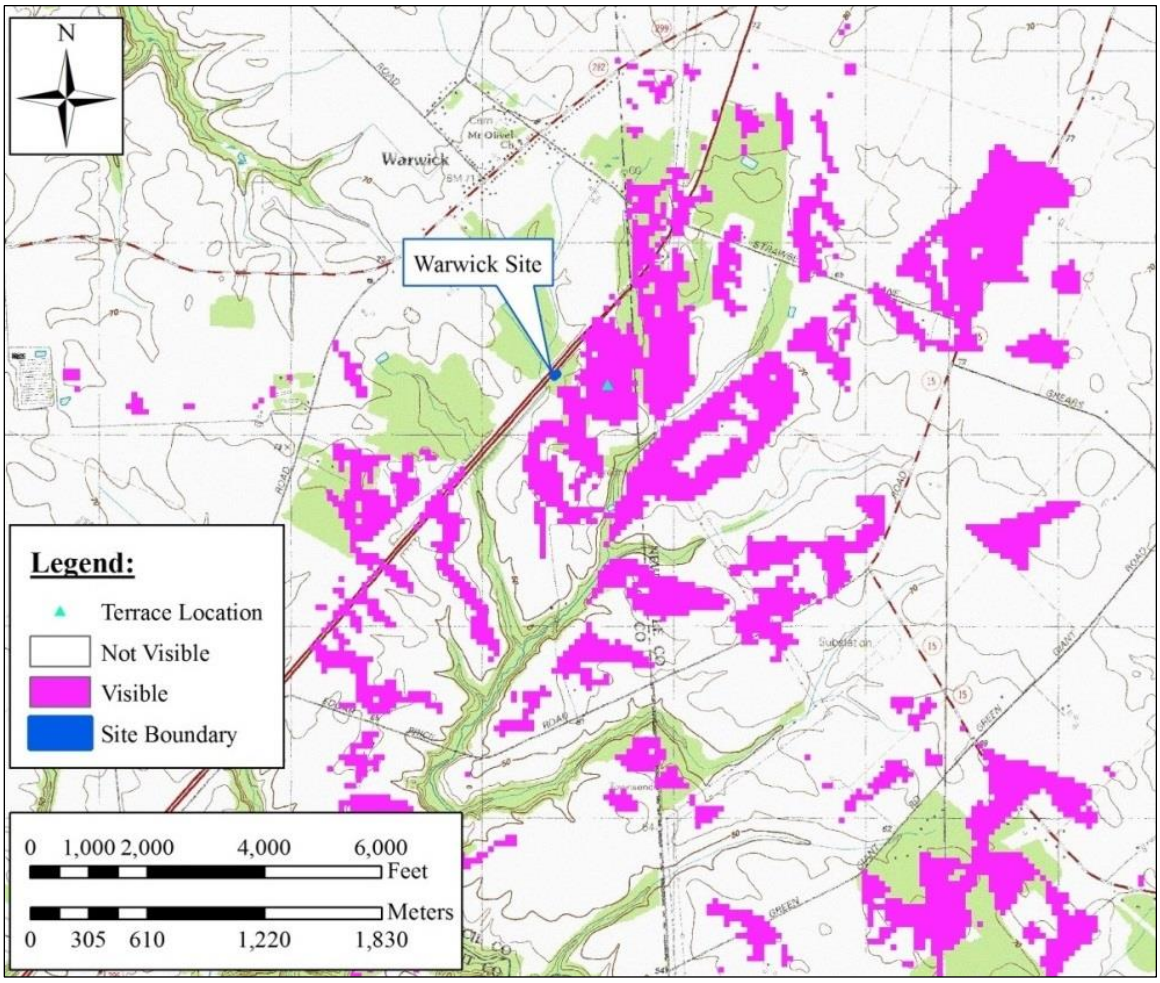

Figure 63: Viewshed from the Upland Terrace East of the Warwick Site.

Least-cost analysis of travel routes rely on digital elevation models to evaluatie the most efficient route between two points. In this case, points were selected at the approximate head of navigation for small boats on nearby streams to approximate the nearest probable location of the larger camps typically found in productive fluvial settings. Selected tributaries of the Chesapeake Bay include Little Bohemia Creek, Great Bohemia Creek, and the Sassafras River. Silver Lake and Noxtown Lake, both at the head of branches of the Appoquinimink River, and Blackbird Creek empty into Delaware Bay (Figure 64). The Warwick Site lies within 10 kilometers (6.2 mi) of all but Blackbird Creek, demonstrating easy access from the probable location of larger settlements throughout much of the region.

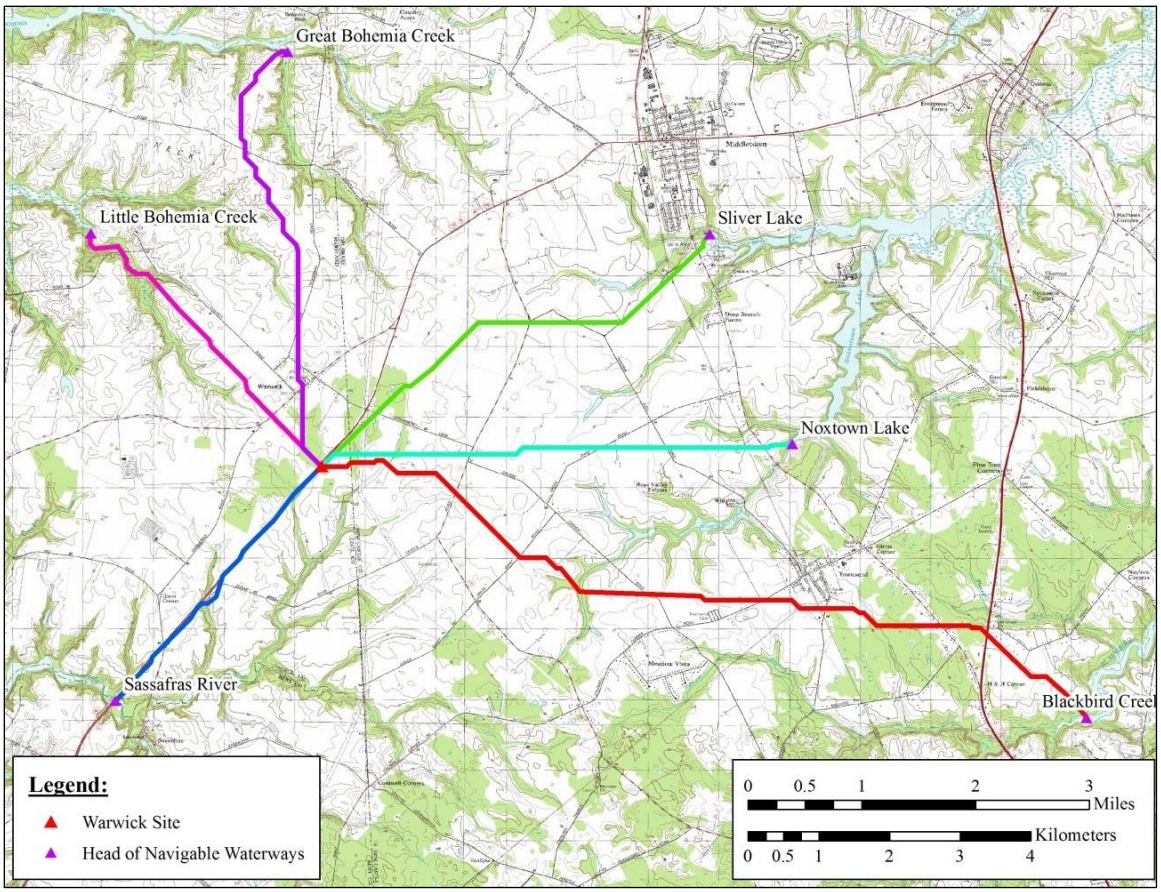

Figure 64: Least-Cost Paths from the Warwick Site to the Sassafras River (4.3 km; 2.7 mi), Little Bohemia Creek (4.8 km; 3.0 mi), Great Bohemia Creek (6.4 km; 4.0 mi), Silver Lake (6.7 km; 4.2 mi), Noxtown Lake (6.7 km; 4.2 mi), and Blackbird Creek (12.4 km; 7.7 mi).

Least-cost analysis of travel routes from the same points to the Sassafras River, the southernmost of the drainages, generally confirms the impression drawn from Bradley's (1796) map of post roads. Least-cost routes from Great Bohemia Creek and Silver Lake, the northernmost points selected, to the Sassfras River pass through or in the general vicinity of the Warwick Site (Figure 65, p. 101). The southern segment of the Silver Lake to Sassafras River approximates the location of U.S. 301, while the northern section

veers to the northeast. In sum, the likely travel routes for game and humans occurred in the immediate vicinity of the site, and potential locations of base camps exist with one days travel from the site.

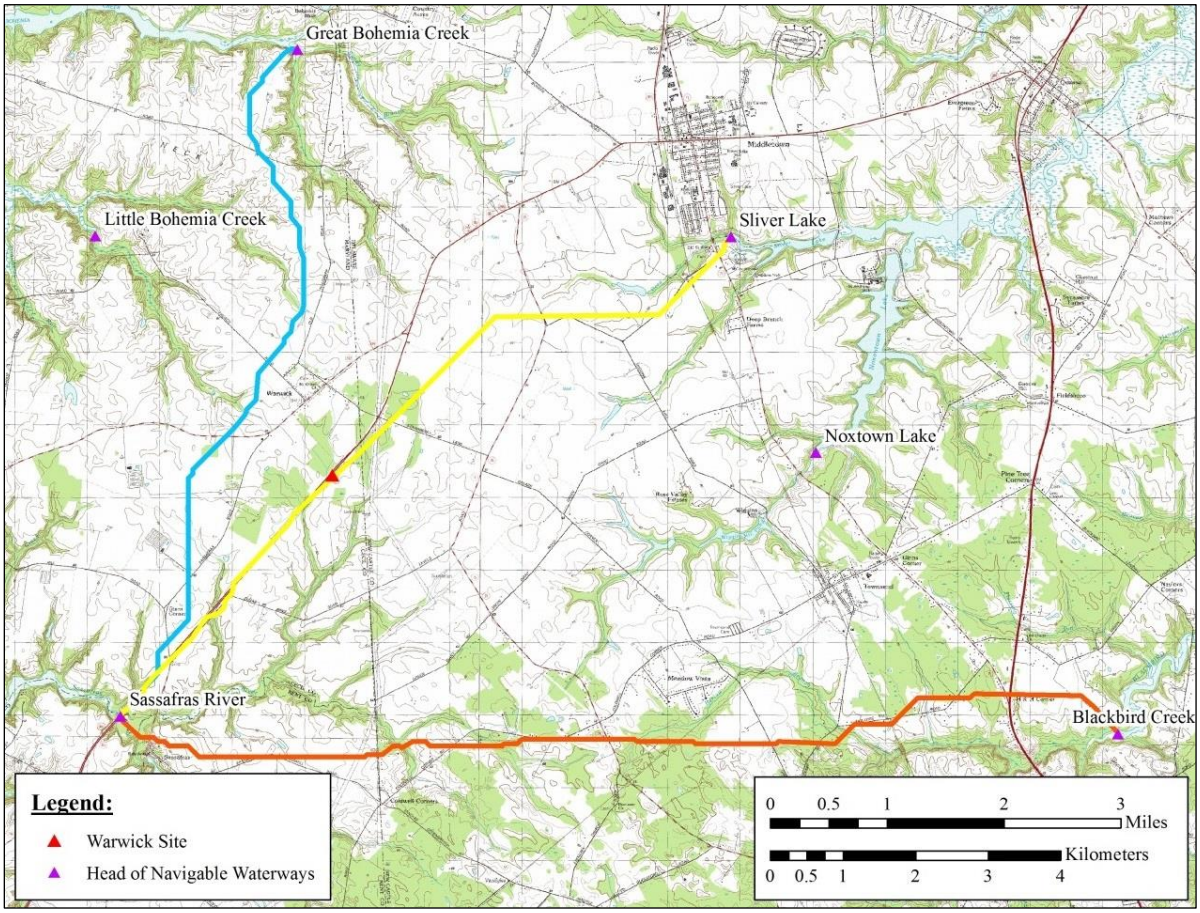

Figure 65: Least-Cost Travel Routes from Great Bohemia Creek, Silver Lake, and Blackbird Creek to the Sassafras River.

Regional Comparison

In 1989, 441 of the 788 (56 percent) sites with diagnostic artifacts recorded in the Delmarva Archaeological Data System included narrow-bladed stemmed points (Custer 1989:147). More recently collected data confirms the predominance of Late Archaic to Early Woodland sites in the northern Delmarva Peninsula. Kellogg (1992) reviewed known sites in the U.S. 301 corridor prior to the expansion of the road. The absence of temporally diagnostic artifacts prevented assignment of 82 of the 178 prehistoric sites in the corridor to a more specific time period. The remaining 96 prehistoric sites were assigned temporal periods using Custer's (1984, 1989) paradigm, which classifies Early and Middle Archaic sites as Archaic, and Late Archaic through Middle Woodland sites as Woodland I; Woodland II refers to the traditional Late Woodland period. Of the 96 sites with temporally diagnostic artifacts, seven percent dated to the Paleoindian era, 20 percent to the Archaic period, 50 percent to the Woodland I period, and 23 percent to the

Woodland II epoch. Late Archaic and Early Woodland sites are prominent in other northern Delmarva data bases and surveys as well.

A search of the Maryland Historical Trust site files revealed 317 sites with Late Archaic components and 198 sites with Early Woodland components. Late Archaic components appear very common in the Northern Delmarva Peninsula counties of Cecil (N=39), Kent (N=70), and Queen Annes (N=175). Early Woodland diagnostics have been identified on 51 sites in the three northern Delmarva counties, constituting roughly 25 percent of all sites in the state-wide sample. The site files, unfortunately, represent an unsystematic accumulation of data collected by a wide range of individuals with varying knowledge of the archaeological record and diagnostic artifact types. Moreover, the search may not have recovered sites with, for example, Middle Archaic through Middle Woodland diagnostics if the search term does not appear in the file for a particular site. Consequently, the precision of the data appears questionable. Yet systematic surveys of large areas in Cecil, Kent, and Queen Anne Counties, most examining areas near the shoreline of the Chesapeake Bay and its tributaries, also suggest that Late Archaic and Early Woodland materials commonly occur throughout the region (Gibb 2003; Hoffman and Baumgardt 1992; Payne 1980; Pickett et al. 2002; Stevens et al. 1989; Wilke and Thompson 1977; cf. also Hoffman 1993; Thomas and Payne 1981; Ward 1986).

Regional models of settlement patterns, including models of Late Archaic and Early Woodland settlement, emphasize the importance of highly productive, diverse riverine environments as settings for large-scale base camps, aggregation sites, and, during the Late Woodland, semi-sedentary villages (e.g., Custer 1989:186; Dent 1995:185–186, 200–214; Klein 2010; LeeDecker et al. 2005:267–268). Systematic survey and excavation in northern Cecil County, along the Elk River and near the mouth of the Susquehanna River, demonstrates the importance of riverine settings for peoples like those who occupied the Warwick Site, as does McNamara's (1985) work at the Conowingo Site (18CE14) on the floodplain of the lower Susquehanna River and numerous excavations in Delaware (e.g., Custer 1989:186; LeeDecker et al. 2005:267–268; Custer et al. 1996;132–135).

Stevens et al.'s (1989) survey of the Veterans Administration Medical Center grounds at the mouth of the Susquehanna River identified seven prehistoric sites, two of which lacked points, pottery, and other temporally diagnostic material. Temporally diagnostic artifacts unearthed at five of the sites documented Late Archaic, Early Woodland, or both occupation periods. Three sites comprised components dating to the Middle Woodland, Late Woodland, or both the Middle and Late Woodland periods.

Survey along the Elk River implies that Late Archaic sites rank among the most common time periods represented in surveys near the region's major rivers and riverine settings represent persistent places, returned to again and again over millennia for various purposes (Hoffman and Baumgardt 1992; Payne 1980; Pickett et al. 2002; cf. also Hoffman 1993; Thomas and Payne 1981; Ward 1984, 1986). The combined Elk River surveys identified four prehistoric sites, all multicomponent sites that included significant Late Archaic-to-Early Woodland occupations. While important for situating the Warwick Site in the regional landscape, the number of people present, the duration of the

occupations, the activities represented, and the microenvironments exploited in riverine settings likely differed from the opportunities provided by the Warwick Site's environs.

Fortunately, the sample of sites from Kent and Queen Annes Counties includes surface survey of plowed fields and river banks in the interior by archaeologists familiar with the region (Kavanaugh 1979; Lowrey 1994). Kavanaugh (1979:8) examined all accessible areas within 62 meters (200 ft) of the headwaters of the Chester River and, in some areas, fields with good surface exposure within 154 meters (500 ft) of the headwaters. As often occurs, sites lacking diagnostic artifacts represent the most common type of prehistoric site identified during the fieldwork (N=37). Early Archaic diagnostics occurred on one site, Late Archaic diagnostics on nine sites, Early Woodland diagnostics on three sites, Middle Woodland diagnostics on two sites, and Late Woodland diagnostics on four sites (Kavanaugh 1979:19−24). Examination of the much larger sample of sites reported by Lowrey (1994) produces a similar pattern.

Lowrey (1994:Appendix) identified six sites with Paleoindian components, 37 with Early Archaic components, 43 with Middle Archaic components, 62 with Late Archaic components, 29 with Early Woodland components (including 12 with Adena materials), 18 with Middle Woodland components, and 22 with Late Woodland components in Queen Annes County. Thus, Late Archaic diagnostics occurred on 28 percent of the sites examined by Lowrey (1994), Early Woodland diagnostics on 13 percent of the sites. Sites were classified by broad environmental zones: Zone 1 referred to low-lying lands near the broad estuarine bay at and upstream from the mouth of the Chester River; Zone 2 consisted of the higher, upstream terraces along the Chester River; Zone 3 comprised the mid- and upper sections of tributary creeks flowing into the Chester River; and Zone 4 designates a poorly drained band of soils that extends from the headwaters of the Chester River tributaries to upper stretches of the low-order streams that eventually empty into the Choptank River. Eighty-one percent (N=57) of the sites occurred in Zones 3 and 4, and 46 of the 57 interior sites (81 percent) were located in Zone 4, the areas that most closely resemble the landscape surrounding the Warwick Site. Interior sites tended to be small in size and exhibit relatively low artifact densities, sites Lowrey (1994:13–18) characterizes as short-term, transient camps. Cobble resources, probably eroded from the banks of incised drainages, were important resources, though seasonally available nuts, deer, squirrel, beaver, and fish, he suggests, were likely harvested, hunted, or captured.

Academic and CRM archaeologists have undertaken numerous large-scale excavations of Late Archaic-Early Woodland/Woodland I sites in Delaware (e.g., Bowen et al. 2003; Custer and Bachman 1984; Petraglia et al. 1998; Petraglia et al. 2002; Thomas 1981; Vestar 2011a, 2011b, 2011c). Spatially discrete Late Archaic to Early Woodland components were identified at a number of sites in Delaware. For comparative purposes, the Late Archaic component from the White Oak Point (44WM119) shell midden, an unrepresented site type, has been included in the sample of sites used to evaluate the duration and intensity of the occupations at the Warwick Site (Waselkov 1982).

"Conventional models of settlement organization in Delmarva," Versar (2012:198) observes, "have been criticized as rigid and dogmatic." Ethnographic and ethnoarchaeological studies imply a more fluid, less hierarchical relationship between the

uses of different environmental settings than implied by the base camp-procurement camp dichotomy. Statistical analysis of the density and diversity of material recovered from a sample of Late Archaic and Early Woodland sites provides less compartmentalized view of landscape use than does site typology.

In general, the amount of debris that accumulates at different locations and during different occupations correlates with the number of people who resided or visited a given site, though complications exist. In addition, as the duration of occupation increases, the number of tasks carried out on site rises, resulting in the accumulation of an increasingly diverse array of artifacts (cf. Gallivan 2002; Lightfoot 1984). Based on these two principles, analysis of the size and diversity of the assemblage recovered from particular locations provides information concerning the relative number of residents and the length of occupations represented by the features and assemblage recovered from a particular archaeological site. Regional data provide a basis for interpreting the Warwick Site, as well as establishing a regional context for Late Archaic and Early Woodland land use. Spatially discrete deposits dating to the Late Archaic and Early Woodland Periods were examined. Sites and portions of sites that contain distinct Late Archaic-Early Woodland components include:

Lums Pond (7NC-F-18), Area 1

Area 1 of the Lums Pond Site, like the Warwick Site, consists of the block excavation of a plowzone in an upland setting. Area 1, which occupies a high terrace overlooking a tributary of St. Georges Creek, dates to the Woodland I, or Late Archaic-Early Woodland, Period(s). Thirty-three one-square meter (10.8 ft^2) test units formed the excavation block. Spatial and attribute analysis of the assemblage identified a lithic-reduction site within Area 1 (Petraglia et al. 1998).

In Area 3, located on a low-lying terrace adjacent to the tributary stream, excavation revealed a buried plowzone that contained Late Woodland/Woodland II artifacts separated from an underlying surface that produced Late Archaic-Early Woodland/Woodland I artifacts by approximately 50 centimeters (1.57 in) of alluvium. No features were identified during the excavation of Area 3, though radiocarbon assays from Stratum D clustered around 3300 B.P. Possible latent features, similar to those encountered at the Warwick Site, included a cluster of fire-cracked rock and two concentrations of debitage. Like Area 1, Petraglia et al. (1998) interpret Strata D/E as a lithic-reduction site. In Custer's (1989) terms, both Area 1 and Stratum D/E in Area 3 would be termed micro-band camps.

Puncheon Run (7K-C-51), Metate Block

Situated on a peninsula between the St. John's River and Puncheon Run, site 7K-C-51 extended over approximately 8 hectares (20 ac). This analysis focuses on an area identified as the Metate Block by the excavators, a reference to a large metate recovered near the center of the area. LeeDecker et al. (2005) interpret the area as the remains of a fishing camp repeatedly occupied by small groups between 4000 and 3000 B.P. Artifacts, hearths, and the metate were identified within a 76-square-meter (818.1-ft^2)

excavation block. The large metate represents site furniture (Binford 1983a:295), presumably an indication of intent to return to the location to harvest and process local resources.

Black Diamond Site (7NC-J-225)

Located on an upland terrace overlooking a Bay/Basin depression, the Black Diamond site contained short-stemmed points with broad blades and long-stemmed points with narrow blades that suggested a Terminal Archaic occupation. Artifacts occurred primarily in the first 10 centimeters (4.0 in) below the plowzone, suggesting a single surface disturbed by plowing and bioturbation. Excavation revealed clusters of artifacts, large and small basins, and post-like soil anomalies; soil chemistry suggested that at least some features may have been produced naturally. Quartzite reduction represents the most prominent activity carried out on site. Analysis, however, identified a functionally diverse assemblage and features. Based on the assemblage, features, and well-maintained site area, Versar (2011c) describes the site as an extended occupation.

Blackbird Creek (7NC-J-195D)

The Blackbird Creek Site, in the Coastal Plain Uplands overlooking Blackbird Creek, was occupied during the early centuries of the Early Woodland period (Vestar 2012). Archaeological deposits occurred in the plowzone and underlying cultural features. Features consisted primarily of deep, refuse-filled pits. While a mixed assemblage of Late Archaic through Late Woodland artifacts were recovered from the overburden, radiocarbon dates from the pits clustered around 3000 B.P. For this reason, only artifacts recovered from features were included in the analysis presented below. A seasonal occupation for processing oil rendered from fish was inferred from the assemblage and features.

White Oak Point (44WM119)

Data from the White Oak Point Site was included to document short-term occupations at a shell midden from the relevant time periods. White Oak Point, in the lower Potomac River Valley, comprised spatially discrete components ranging in age from the Late Archaic through the early historic era. The site was occupied "during the spring by small groups of Indians, who established temporary camps for the primary purpose of gathering and subsequently roasting oysters" (Waselkov 1982:206). During the Late Archaic, deer hunting also occurred in the vicinity of the site, implying a group composed of men, women, and, most likely, children.

Discussion

The estimated density derived from the entire assemblage of prehistoric material recovered from 18CE371 equals 50.1 artifacts per cubic meter (35.3 m^3). The only excavation in the sample that produced fewer artifacts per cubic meter than the Warwick Site was the Blackbird Creek Site (7NC-J-195D) feature assemblage. The Blackbird Creek Site was interpreted as a seasonal occupation where fish were caught and fish oil was processed. Sole reliance on artifacts recovered from pit features, necessitated by the

temporally mixed deposits in the plowzone, likely reduced the density and diversity of the portion of the assemblage included in the analysis. Feature assemblages generally accumulated over a shorter time span than plowzone contexts. Artifact density, therefore, implies that the assemblage recovered during the fieldwork at the Warwick Site results from the activities of one or more small groups.

Calculating assemblage diversity, a measure of the variety and abundance of artifact categories present for a given sample size, has become complex (Baxter 2001; Bobrowsky and Ball 1989). To avoid numerous zero values, calculation of diversity relied on the frequency of: debitage; cores, points and other bifaces; ground, pecked, and battered stone; fire-cracked rock; miscellaneous other lithic artifacts; and the number of container fragments, whether stone or ceramic. The analysis attempted to calculate a measure of the range of activities regularly carried out at different sites based on variation in amount of different types of artifacts recovered. Simpson's Dominance index, essentially an evenness measure, ranges from zero when a single species constitutes the entire assemblage, to one when an equal number of artifacts occur in each artifact class.

The analysis supports the proposed interpretations of the sites, characterizing the assemblages from all but the Black Diamond Site as low density and low-to-moderately diverse. The dense, diverse assemblage from the Black Diamond Site appears consistent with the interpretation of the site as an extended occupation by a moderate-sized group. As noted earlier, reliance on only refuse unearthed from pits at the Blackbird Creek Site perhaps limited the depositional context, suggesting the context reduced the evenness value of the assemblage depicted in Figure 66 (p. 107). Regardless, the data appear consistent with the interpretation of the Warwick Site as one or more short-term occupations where few activities were carried out by a small group or groups. The small size of the Warwick Site, even relative to other short-term occupations, confirms the impression gleaned from the density and evenness data. The difference between the distribution of debitage and phosphorus implies the distribution of debitage accumulated through a combination of primary and limited secondary refuse disposal. The clustered distribution implies a combination of a core activity area identified by microdebitage and abandonment-phase primary refuse surrounded by a toss zone of organic refuse and debitage associated with the peak in phosphorus values. The concentration of FCR and potassium north of the debitage may identify a second, hearth-centered activity area. Of course, the specific activities that relied on organic artifacts, like cooking particular foods, processing specific animals, harvesting nearby plants, or performing small-scale rituals, remain unknowable through the material culture and soil chemistry data preserved at the Warwick Site.

Ebright (1989) conducted Phase II testing at the Denbigh Farm Site (18QU218), which resembled the Warwick Site in the low artifact density and diversity, the absence of cultural features, and the upland setting. The site, bisected by a tributary of Mill Creek, occupies an upland setting in the interior of Queen Anne County. Mill Creek empties into the Corsica River, itself a tributary of the Chester River. Fieldwork included surface survey, shovel testing, and the excavation of four test units within concentrations of artifacts. The 30 prehistoric artifacts recovered from Phase II testing provide a density estimate of 20 artifacts per cubic meter (35.3 ft^3); evenness, calculated from the entire

assemblage, equaled 0.30. Unlike Warwick, the Denbigh Site was dispersed across a broad area and bipolar debitage dominated the assemblage. Moreover, recovery of a bifurcate-based point during the survey implies that, like sites throughout the region, the Denbigh Site was reoccupied over millennia. The Warwick Site differs in the presence of a small concentration of material deposited over, at an archaeological time scale, a short period of time. In this respect, and a few others, the analysis of the Warwick Site raises larger questions about the potential range of archaeological research and explanation in the northern Delmarva Peninsula.

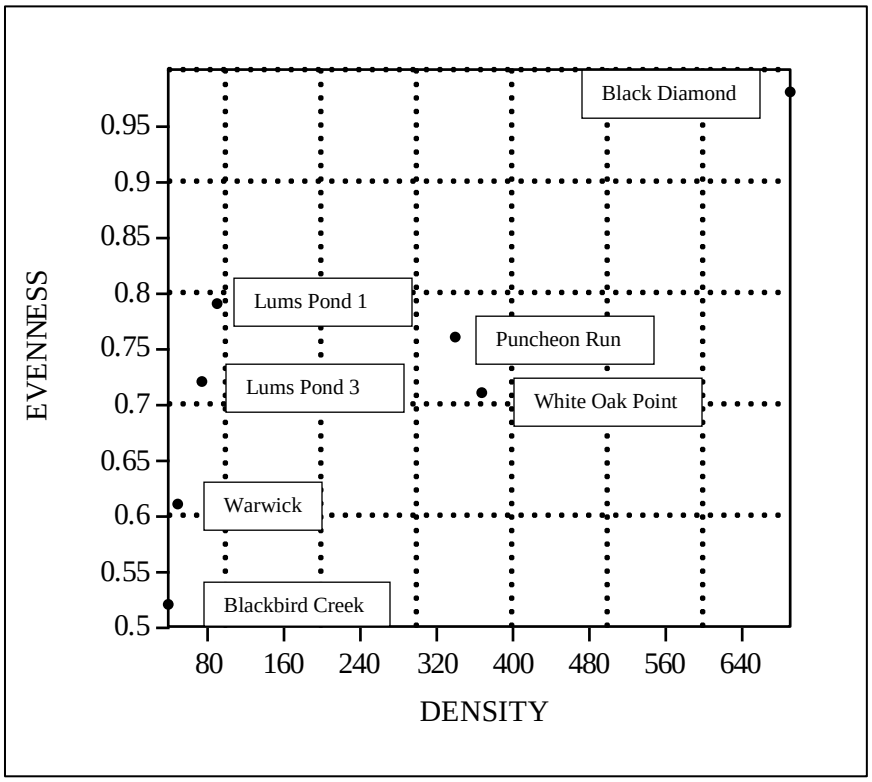

Figure 66: Graph of Assemblage Evenness by Assemblage Density Per Cubic Meter Excavated.

Environmental Change, Long-Term Social Evolution, and the Warwick Site

Prior to Willey's (1953) study of the interrelationships among archaeological sites in the Viru Valley of Peru, archaeologists tended to focus intently on the description and analysis of single sites (cf. also MacNeish 1964). The work of Gardner (1979, 1987), in particular, popularized studies of regional settlement systems in the Middle Atlantic. Settlement pattern studies in the Chesapeake Bay Region typically classify archaeological sites into typological categories based on the size of groups and the range of tasks evinced by the assemblages from individual sites. Custer (1988a:43–47), for example, identified macro-band base camps, micro-band base camps, procurement sites, and staging sites, along with patterns of movement between different types of sites. Macro-band base camps occur "in highly productive environmental settings with predictable sources of fresh water" near rivers and estuaries (Custer 1988a:43). The inter-riverine

interior, in contrast, witnessed short-term occupations focused on one or a few tasks. The analysis of a sample of assemblages presented earlier demonstrates the range of variation within sites not considered macro-band base camps, as well as pointing to the critical importance of regional studies for any understanding of northern Delmarva archaeology. Sites classified as macro-band base camps likely vary considerably as well, comprising regional aggregations by large of groups that typically live apart for much of the year, as well as longer-term occupations by smaller groups that reside together for longer periods of time. In addition, persistent places, "places that were repeatedly used during long-term occupations of regions" due to "unique qualities that make it particularly suited for certain activities, practices, or behaviors," seldom appear in discussions of regional settlement, though the general concept insinuates itself into discussions of particular sites (Schlanger 1992:97). Typological classifications clearly retain a heuristic value, but, as Phillips et al. (2003:61–62) pointed out and most archaeologists implicitly acknowledge, established types of any kind often present an unintended impression of concrete existence, potentially hindering the recognition of significant variation (cf. also Dunnell 1992).

The assemblage from the Warwick Site, unlike base camps, appears consistent with the conduct of a relatively restricted range of activities, primarily tool maintenance and, perhaps, tasks necessarily carried out using fired rocks, during, in an archaeological sense, a limited period of time. Of course, organic materials may have been used for a wide range of activities at the site. Regardless, the assemblage, the size and structure of the site, and the landform imply short-term occupation by groups based elsewhere in the region. Ethnographic studies indicate that the relationship between residential camps and outlying satellite locations varied in accordance with the duration of the occupation of the residential camp. As Binford (1983a:371) explains:

> We can imagine a group of hunter-gatherers moving about the landscape. A particular place may be used as a hunting camp at one time, a transient camp at another, and a short-term observation stand at still another, depending on the relative placement of the residential camps. As the system changes and a more permanent residential settlement is established such situational variations would be reduced. The relative "economic potential" of different places becomes increasingly stabilized as a function of increasing permanence of the residential camp. Correspondingly, the use made of ancillary places becomes increasingly repetitive.

It follows that the occupation and abandonment of the Warwick Site perhaps reflects broader changes in settlement systems that altered the location and duration of occupation at sites elsewhere in the region, as well as the Warwick Site. Many sites in the interior, unlike the Warwick Site, evince repeated short-term occupations for varied purposes over millennia. Nevertheless, long-term transformation of the regional and local environment and regional settlement systems perhaps explain the absence of clear evidence for activity predating 5000 B.P. and postdating 3000 B.P. at the Warwick Site.

Environmental Change and the Occupation and Abandonment of the Warwick Site

Environmental explanations for temporal shifts in regional settlement abound, though advocates of cultural ecology clearly recognize the entwined impact of both the natural and social environments on biosocial evolution (e.g., Custer 1989:24–25, 1996:1). The slowing and near-cessation of sea-level rise over the course of the Archaic dramatically reconfigured the Delmarva Peninsula. The response of river systems to solar activity and atmospheric events altered the formation processes that affected both Early Woodland settlement patterns and archaeological preservation. Geoarchaeologists have demonstrated an increase in the stability of floodplains during the Late Archaic (circa 5500–3000 B.P.; cf. Custer 1984; Schuldenrein 1994; Stevens 1991). In contrast, the data suggest cycles of aggredation and erosion characterized the 2850 to 2400 B.P. period, though regional variation in Early Woodland floodplain development exists. Geomorphological and radiocarbon data suggest that: 1) Early Woodland floodplain surfaces potentially supporting extended occupation occur less frequently and in fewer settings than do stable surfaces dating to the Late Archaic or Middle Woodland periods; 2) cycles of inundation, aggredation, and erosion characterized Coastal Plain and some Piedmont landforms, creating metastable surfaces; and 3) due to the distinctive environment of at least the southern Delmarva Peninsula, marsh formation and aeolian deposition possibly affected the Early Woodland archaeological record in the region at least as much as floodplain dynamics (cf. Klein 2003a).

Assuming that the predominance of Lamoka Points indexes a circa 5000 to 3000 B.P. occupation, active use of the Warwick Site closely approximates the period between the Late Archaic stabilization and Early Woodland destabilization of floodplains throughout the region. Floodplain instability likely affected the riverine settings that characterize many longer-term Late Archaic settlements as well as affecting the headwaters of the rivers that empty into the Chesapeake Bay. Invoking a generalized transformation of the headwaters of the Sassafras River, however, seems too tenuous and imprecise to explain the occupation and abandonment of the Warwick Site. Climatologists Kutzbach and Webb (1991) describe how global-scale climate change forces vegetation change at regional and local scales, but observe that local vegetation cannot be predicted from global models. Distinctive conditions of soil, species histories, edge effects, and so forth leave the specific response of local environments to climatic shifts unresolved by the relatively few variables in global models (Kowalewski 1995:154). The presence of sites otherwise similar to 18CE371 that contain earlier and later diagnostics emphasizes the fraught link between large-scale environmental processes and the use and abandonment of specific microenvironments. Moreover, attempts to correlate two or more broadly dated events introduces considerable wiggle room into the links between imprecisely dated, regional environmental events and imprecisely dated archaeological developments. Furthermore, the combination of a plateau in the radiocarbon curve and floodplain instability hinders attempts to distinguish diagnostics in use circa 2850 B.P. from those popular circa 2400 B.P. via either absolute or stratigraphic dating. Overlapping attributes of the various Late Archaic and Early Woodland diagnostic points compound these problems (Custer (1989:147–149).

Climate Change, Social Signalling, and the Evolution of Point Form

Fiedel (2005:O-9–O-10) recognized the potential problems involved in the correlation of climatic and archaeological data, including a review the difficulties presented by radiocarbon dates in an analysis of biosocial studies in the northern Delmarva Peninsula. Nevertheless, Fiedel (2005:O-8) observes, projectile point styles "seem to have a duration of about 1,500 years…about the same periodicity as seen in North Atlantic climate events." Moreover, "the moments of transition coincide so often as to raise the possibility of climatic causation" (Fiedel 2005:O-8). Observable changes in style, hafting technique, and material preferences may imply disturbance of cultural transmission of the knowledge and/or exchange systems underlying particular point forms. The fluted points of the Paleoindian Period, Fiedel (2005:O-7) suggests, represent costly signals. Costly signals appear in competitive situations, and only when the social distance between the communicator and the recipient precludes accurate assessment of the relevant qualities of the signaler by the audience. In addition, an effective signal: 1) more or less honestly advertises difficult-to-perceive qualities of the signaler; 2) exceeds the capabilities of competitors; 3) presents information that can be decoded by the preferred audience; and 4) reaches a large audience not directly familiar within the signaler. The receiver decodes the information in the signal and uses it to decide what type of benefits might be gained by interacting with the signaler. The long-term cost of the signal assures individuals that the signaler has "sufficient personal resources or belongs to a kin group of sufficient resource holdings or productivity to qualify as either an equal or social superior" (Bliege Bird and Smith 2005:223). The cost of the signal precludes faking over the long term, though, of course, in the short term individuals may find the signals of honest and dishonest signalers equally convincing. The argument that fluted points represent costly signals appears correct; Archaic and Woodland points, however, do not appear costly in this sense, though Waguespack et al. (2009:797) raise the possibility that all stone points represent costly signals.

Fiedel's (2005) discussion highlights the limited theoretical attention point form in the Middle Atlantic has received, though the issue appears directly relevant to variation in the form of stemmed points in the Warwick Site assemblage and concurrent point types generally. Stewart's (1982:77) complaint that "archaeologists still cannot agree on what it is that types represent and how they may be used in the study of the past" demonstrates the theoretical and practical limitations of typology in the Middle Atlantic region. Reliance on types "requires the assumption of strong covariation among all diagnostic attributes throughout the life of a type" (Plog and Hantman 1990: 441). The strength of co-variation among attributes results from the nature of the social relations in which style participates, and the functional requirements imposed by the use of the tool (Braun 1985). During periods of continuously changing demographic and social relations, manipulation of stylistic variation as an active symbol of social relations may occur. Likewise, shifting subsistence patterns may impose new functional, and hence technological, requirements on tool use. This predictable variation in point form theoretically limits the archaeologist's ability to identify well-defined types, for such types may be the exception. Despite theoretical and practical limitations, point typology remains the commonly accepted method of constructing chronologies and inferring regional patterns of interaction.

The debate between Sackett (1985, 1990) and Weissner (1983, 1985, 1990) encompasses the range of many non-Darwinian approaches to stylistic theory, and aspects of the discussion appear compatible with Darwinian approaches to style. Sackett's (1985) "isochestic style" results from learned ways-of-doing employed automatically and generally not reflected upon. Isochrestic style, therefore, may vary within communities or extend across social boundaries; isochrestic attributes may not change as social relations fluctuate. In contrast, style "that transmits information about personal and social identity" (Wiessner 1983:256), referred to as symbolic style by Plog (1990), results from the creation of personal and social identity through comparison with others. Iconic style, which appears closest to a costly signal, nevertheless may or may not be a costly. Icons typically exhibit redundant attributes and potentially encode a range of explicit and vague values, even, like a flag, contradictory ones. The visibility and the labor requirements of artifacts and attributes of artifacts appear most important for the identification of isochrestic, symbolic, iconic, and costly symbols or styles. Highly visible attributes potentially reflect a range of non-functional considerations and interaction (Carr 1995:247–248). Hidden or obscured attributes, in contrast, potentially encode only isochrestic style. Visibility possesses both perceptual and contextual aspects. Common household items project information to a limited audience, and therefore comprise a mix of isochrestic and symbolic style. Cordage twist patterns on pottery are examples of isochrestic style, while decorative motifs on Late Woodland vessels likely represent symbolic style (e.g., Klein 2003b). In contrast, Klein (1997, 2010) suggests that soapstone bowls represent costly signals, and most likely encode the mix of ideas and values typical of iconic style, based on the limited distrubtion of soapstone quarries, the labor requirements of the bowls, the distinctiveness and limited range of bowl forms, and the inferred visibility and common recovery of large bowl assemblages from sites that likely result from regional aggregations.

Stemmed points, in Fiedel's (1988:71) words, represent "a challenge to archaeological theory." Points, regardless of the range of actual uses, were manufactured primarily as projectile tips or knives. Perhaps as a consequence, "most of the variability through millennia in point form is seen in the shape of the base (e.g., flutes, side and corner notches, flared stems, contracting stems), and the changes are manifestations of shifting modes of point hafting" (Fiedel 2005:O-8). Hafting typically obscures much if not all of the hafting element, though the basic distinction between side- and corner-notched versus stemmed points may remain evident. Therefore, variation in the hafting element of various stemmed point forms, and perhaps variation in the shape of all stems, likely represents isochrestic style, and reflects learning networks rather than expressing personal or group affiliation or beliefs. On the other hand, blade form, visible from a moderate distance and, when lost, to travelers passing through the landscape, potentially encodes a greater range of styles. The distinctive serrated blades of the Palmer type, the large blades of broadspears, and the triangular shape of Late Woodland points represent the most alluring candidates for symbolic or iconic styles. Unfortunately, sharpening reconfigures the shape and dimensions of blades over time. Nevertheless, the presence of numerous stemmed points like those unearthed at the Warwick Site with differently shaped stems and bases within individual features at sites elsewhere in the region implies that: 1) any given community comprised numerous learning networks, whether inherently, through regular movement of individuals between groups, acquisition of materials via exchange, or due to some combination of these possibilities; or 2) learning networks shifted at an ethnographic time scale and therefore

remain invisible at an archaeological time scale. Either way, broad-bladed points and artifacts like soapstone bowls appear more likely to signal local and regional identities than hafting elements on points with narrow blades.

Agency and the Cultural Landscape

The near-surface archaeological record accumulated over a period of time that typically exceeds the human lifetime; yet, many archaeological explanations rely on an ethnographic time scale, which Fred Plog (1974) attributes to the "Tyranny of Familiar Things" (see also Wobst 1978). Still, as anthropologists studying human history, accounting for human intent seems unavoidable. Native Americans across the continent manipulated the environment through a host of techniques, including burning to remove undergrowth, improve visibility, enhance the growth of valued plants, and create environments that attracted game (Lightfoot et al. 2013; Smith 2011; Stevens 1991). The recovery of charred seeds and nuts commonly harvested by Late Archaic peoples, as well as numerous fragments of charred wood, from flotation samples across the site identifies large-scale burning by Native Americans as one potential cause. The plow-zone context of the flotation samples, unfortunately, leaves the context and timing of the firing unclear. Still, consideration of the possibility of burning as a tool of landscape management at the local scale at least introduces agency into the relationship between global and regional climatic trends and the cultural environment of a particular site. Fire provided an efficient and effective means of reshaping flora to increase the abundance and range of favored resources. As Smith (2011:836) points out:

> Humans have a long history of niche construction—of modifying their environments in a wide range of different ways, large and small, through behavior patterns that are both deliberate and inadvertent….Although the consequences of human niche construction are not always anticipated, one of the primary goals of environmental engineering by human societies has been to increase their share of the annual productivity of the ecosystems they occupy by increasing both the abundance and reliability of the plant and animal resources they rely on for food and raw materials. Using fire and simple technology in the modification of vegetation communities, our distant ancestors were shaping environments more to their liking in ways that we can see in the archaeological record back perhaps as far as 40,000 years ago.

Localized fires potentially created a mosaic of different plants at distinct stages of maturity, and, in particular, created incipient communities of plants that provide foods for humans and game at the expense of slow-growing climax communities. In the woodlands of eastern North America, the creation of edge environments attracted deer, a particularly important part of the diet of Native Americans (Smith 2011:838). Most domesticated plants originated as weedy invaders of disturbed ground, meaning niche creation played an important role in the domestication of native plants (Smith 2007:194–195). Unfortunately, anthropogenic fires, like other methods of niche construction, mimic natural events, complicating the use of archaeological data to document human modification of landscapes prior to circa 350 B.P. Evidence for large-scale burning

throughout temporally restricted strata or living surfaces at sites throughout the region potentially provides a more secure basis for the investigation of prehistoric landscape manipulation. Similarly, a correlation between particular site types and burned landscapes, while not conclusive, would suggest landscape management. Egghart (2005:87) has interpreted the D-shaped pits excavated on numerous sites in Delaware as "culturally induced tree falls." By building a fire in a shallow trench excavated beneath one side of a tree, he suggests, Late Archaic and Woodland peoples felled trees to "open forest areas to promote the growth of food producing plant species, and perhaps to enhance mast production by eliminating competing, non-economically valuable trees" (Egghart 2005:87). Elsewhere, Egghart (2010:135) suggests that landscape modification increased dramatically during the Late Archaic. In eastern North America in general, changes in the relative frequency of gray squirrels versus fox squirrels in Late Archaic assemblages have been cited as evidence that Native Americans encouraged the growth of nut- and mast-bearing trees; similarly, the increase in the range and frequency of undomesticated maygrass, knotweed, and little barley in archaeological assemblages circa 3000–2000 B.P. indicates encouragement, and perhaps incipient domestication, of these weedy invaders of disturbed ground (Smith 2007:192). McKnight and Gallivan (2007:183–184) infer increased rates of land clearing during and after the Middle Woodland from an increase in pine pollen in the archaeological record of the Chesapeake Bay region; the pattern appears to begin during the Early Woodland in the Coastal Plain, and the ratio of deciduous wood to comestibles plummets from Middle Archaic through Middle Woodland times throughout the region, though biases in the sample may be problematic.

In addition to the use of fire, hunter-gatherers created niches and encouraged the establishment of productive environments through: broadcast-sowing of valued annual plants; transplanting and encouraging perennial fruit-bearing species and root crops; encouragement of the *in situ* growth of a range of valued resources, particularly in the vicinity of regularly visited and occupied settings; and other methods of modifying portions of the ecosystem to enhance the environmental diversity and the abundance and accessibility of economically important species of plants and animals (Smith 2011). Investigation of these processes requires the creation of a regional data base, essentially an expansion of the database discussed by McKnight and Gallivan (2007) to include broader archaeobotanical, pollen, and phytolith data, evidence from Chesapeake Bay and river cores, like that reported by Brush (1986:151), and ethnohistoric information, as well as cooperation of ecologists and Native Americans interested in related issues. In this, and in many other respects, the analysis of a Warwick Site raised more questions than it answered. Still, the discussion demonstrates that the archaeological record offers the opportunity to contrast the implications of different theoretical constructs, to consider the implications of volitional action within particular social and historical contexts, and to incorporate models that expand upon the unforeseen, to the participant, relationships between agency, social structure, social trajectory, and longer-term selective and environmental pressures. In sum, theoretically informed regional studies are essential to the interpretation of even a single archaeological site; in complex systems, like human societies, cause and effect may be neither spatially nor temporally proximate.

Conclusion

The Warwick Site, a small, low-density accumulation of tools, debitage, and fired-rock, represents a ubiquitous class of archaeological site. Interpretations of similar sites seldom extend beyond establishing a date based on diagnostic artifacts and classifying the site as a transient camp, processing station, a way station, or, even more generally, a short-term camp or extractive locus. By analyzing attributes of the artifacts and site structure, and placing the site in a regional context, however, more detailed, interpretation became possible. The excavation, moreover, provided an opportunity to evaluate several issues relevant to Delmarva archaeology as a whole through comparison with a sample of broadly similar sites.