Northeast Historical Archaeology

Volume 32 *The Finger Lakes National Forest Archaeology Project: A Case Study in Archaeology and GIS* | Article 6

2003

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Recommended Citation

Wehner, Karen B. and Holmberg, Karen G. (2003) "Analyzing the Settlement Pattern of the Burnt Hill Study Area," *Northeast Historical Archaeology*: Vol. 32 32, Article 6.
https://doi.org/10.22191/neha/vol32/iss1/6 Available at: http://orb.binghamton.edu/neha/vol32/iss1/6

Analyzing the Settlement Pattern of the Burnt Hill Study Area

Karen B. Wehner and Karen G. Holmberg

In the preceding two articles, Heaton and Smith and Boyle discussed how archival and archaeological data were entered into the GIS database and then used to analyze the strategies adopted by individual farmers faced with economic decline. In this article we examine similar phenomena at the community level by analyzing historic map data to recreate and interpret settlement changes in Hector, the town in which the Burnt Hill Study Area is located. The time range covered in this article spans the 1850s through the 1940s, a period during which land use throughout the Finger Lakes National Forest evolved from private farmsteading to federal administration under the USDA Soil Conservation Service (FIG. 1). This transition, clearly visible in historic maps, was marked by dramatic population decline and settlement reorganization (Beach 1874; Beers 1857; USGS 1946, 1949, 1950a-c; USPO 1911).

Degradation of local soils and economic depression within the context of larger political economic forces, such as the expansion of the American western frontier, ensured Hector's population decline (FIG. 2a-d). At the outset of the Finger Lakes National Forest Archaeology Project it was unclear, however, why settlement persisted in the patterns that it did following the agricultural boom-bust-abandonment cycle Heaton describes in the preceding chapter. In this article we outline our methods of adapting historic map data for GIS use, and employ this data to document the regional settlement history of the Burnt Hill Study Area. In doing so, we use information taken from a series of historic maps: county atlases published in 1857 and 1874; a US Postal Service map from 1911; and USGS quads from 1942/44.[1]

[1]Some portions of Schuyler county were surveyed by the USGS in 1942, the remainder in 1944. While "1942/1944" will be used when referring to the maps themselves, for purposes of data analysis, "1944" will be used to denote the final phase of Hector settlement examined by the project.

Archaeological Settlement Studies and GIS

Landscapes and human deployment within them have been considered by scholars of history (Turner 1899; Cronon 1983), geography (Jackson 1984; Meinig 1979), material culture (Schlereth 1990; St. George 1988), and architectural history (Upton 1990; Vlach 1993) as key venues for understanding the ways in which groups of people relate to their social and natural environments. In his pioneering study of ancient settlement in Peru's Viru Valley, Gordon Willey defined archaeological settlement pattern analysis as the study of "dwellings,... their arrangement, and... the nature and disposition of other buildings pertaining to community life." Based on the Viru Valley case study, Willey proposed that observable patterns in human settlement derive from the combined influence of environmental pressures, technological capabilities, historical events, and "the various institutions of social interaction and control" maintained by a culture (Willey 1953: 1–2).

Despite the importance Willey placed on the historical and social contexts of human settlement, many archaeologists since (e.g., Adams 1965; Sanders et al. 1979; Binford 1984; Hunt 1992; Stafford & Hajic 1992) have focused on its ecological determinants. Economic optimization theory has been used in this context to model site location as a function of distance from natural resources. While optimization models have proved useful for theorizing as well as describing settlement phenomena, the cost-benefit framework on which they are predicated assumes universal rational decision-making in Western economic terms. Other archaeologists have recognized that human settlements are carved out of vastly different environmental settings and are organized within diverse social and ideological systems operating at unique historical moments in time. Those who have aimed to

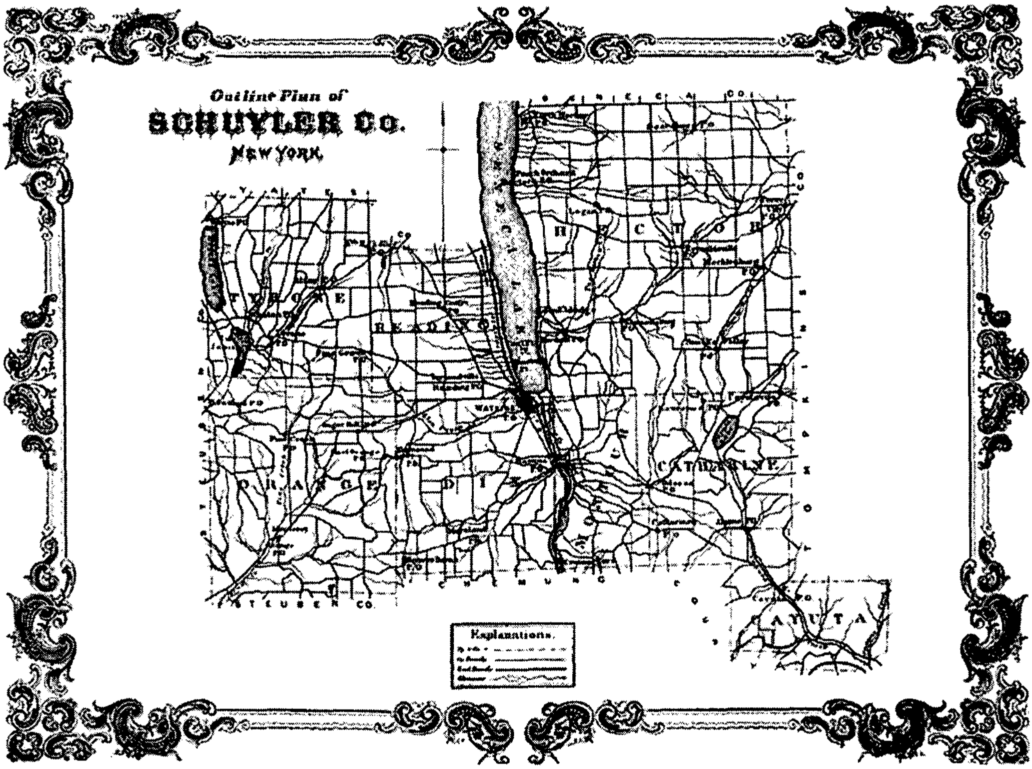


Figure 1. View of region surveyed under the New Military Tract grid system as it appeared in the 1870s, showing primary roads correlating with the gridlines, along with later secondary roads that evolved within the grid (Pierce & Hurd 1879: 29).

place settlement location and organization in its social and historical context have found productive explanatory models in phenomenology (Rubertone 1986; Rodman 1992; Tilley 1994) and ideology (Paynter 1982; Mrozowski 1991; Delle 1998). While such work has recontextualized settlement in its complex array of factors, by and large, it has ignored the potential of GIS technology to aid settlement pattern analysis.

With its ability to correlate the spatial and temporal dimensions of various data types, GIS is a powerful tool for examining archaeological phenomena from a combined historical, social, and environmental perspective (Kvamme 1999). By organizing data in thematic layers linked by geographical reference points, GIS technology makes it possible to spatialize and overlay change over time in a theoretically infinite number of variants. Furthermore, it integrates useful database operations such as data query and statistical analysis with the visual expression of such data in georeferenced plan maps. Recently, there has been much experimentation with GIS technology in archaeological settlement studies. Despite recognition of its analytical promise, however, GIS has been used in North American archaeology primarily as a device for generating predictive models calculating the probability that, given certain environmental traits, a geographic area will contain one or more archaeological sites (e.g., Carmichael 1990; Kvamme 1985; Warren 1990). Models constructed by Allen (1990) and Zubrow (1990) have attempted to incorporate social factors into this environmentally determinist context, but remain predictive rather than interpretive. The other dominant use of GIS in North American archaeology has been the construction of sophisticated digital filing systems documenting known sites and the spatial and temporal dimensions of regional settlement shifts for the benefit of ongoing cul-

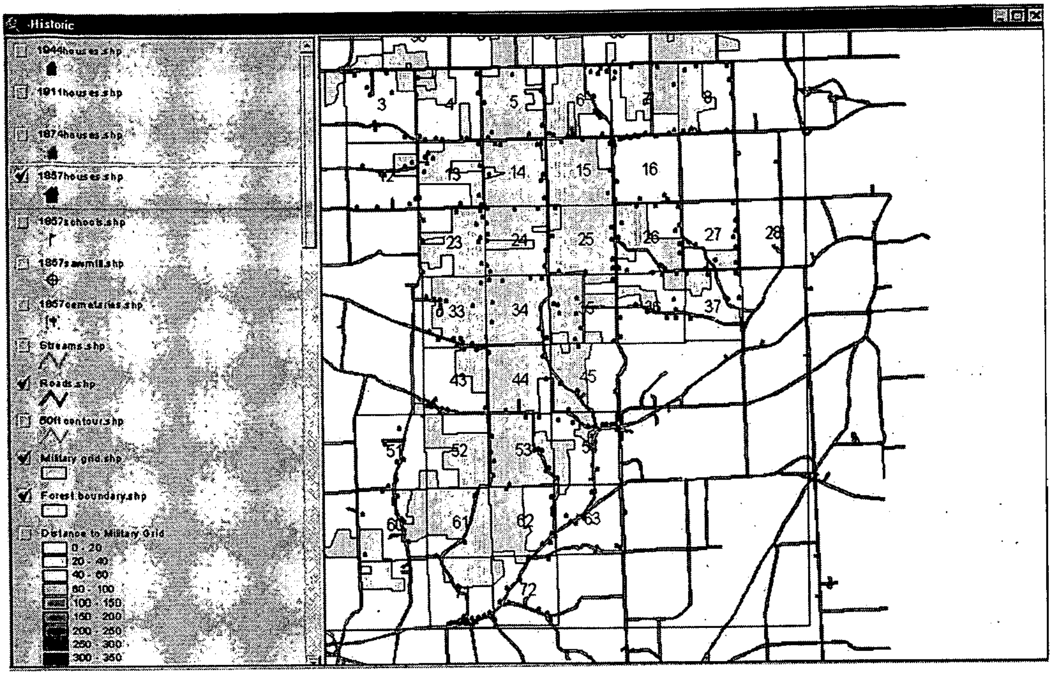


Figure 2a. ArcView point themes showing Hector settlement in 1857.

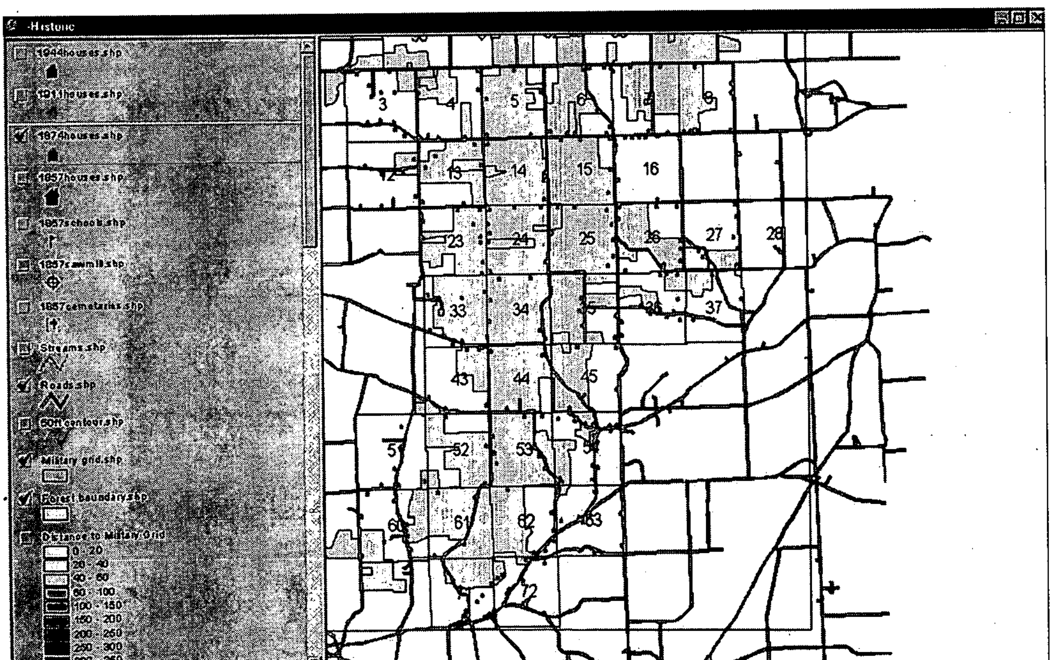


Figure 2b. ArcView point themes showing Hector settlement in 1874.

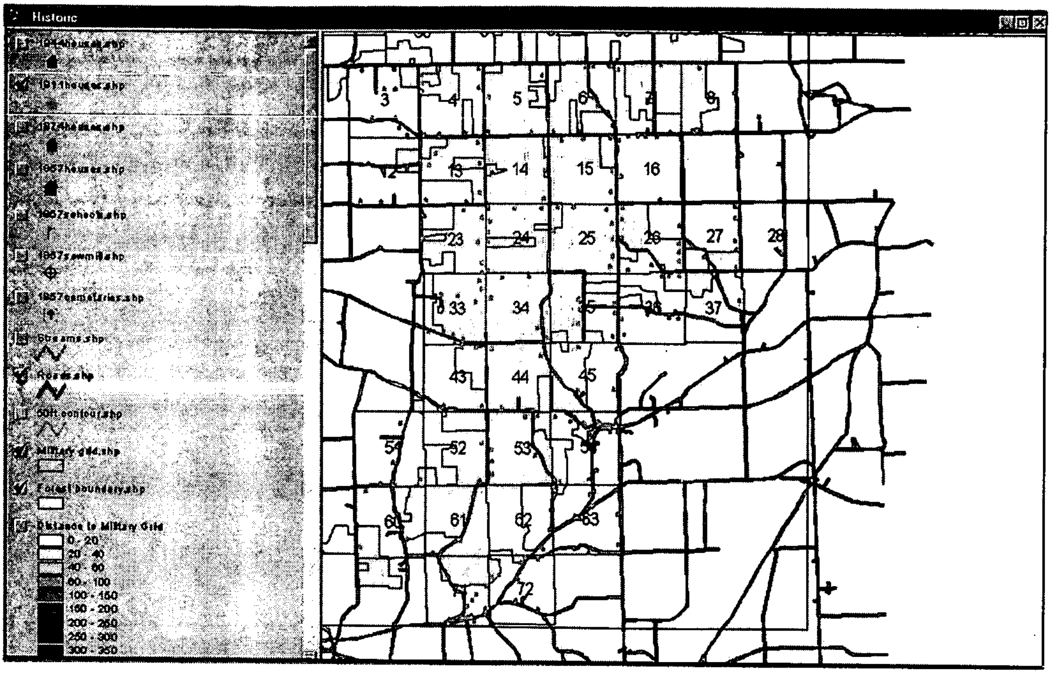


Figure 2c. ArcView point themes showing Hector settlement in 1911.

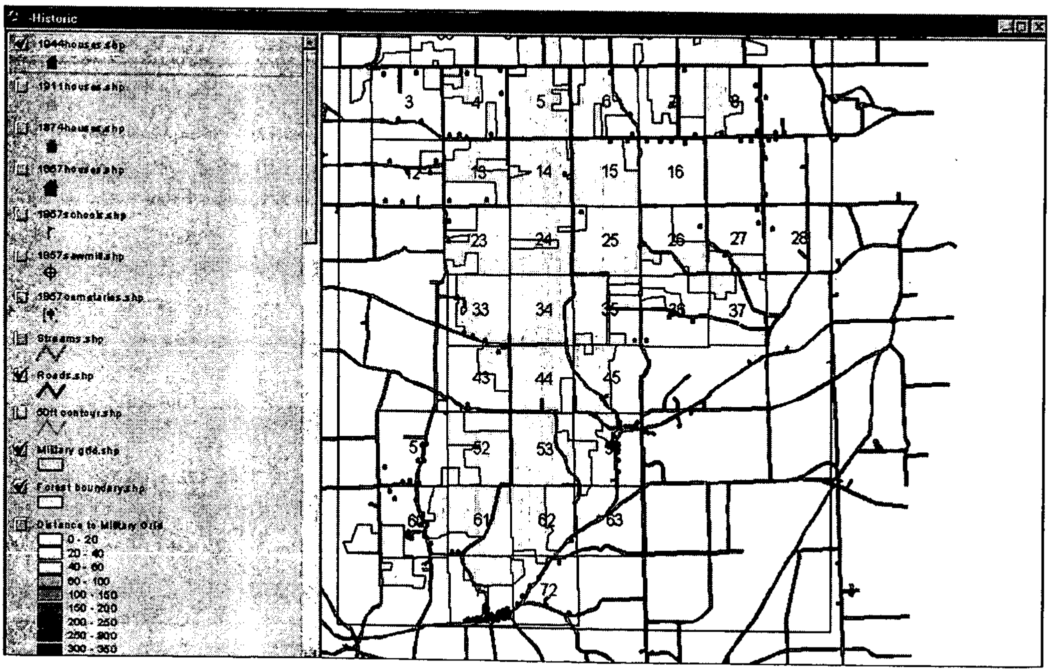


Figure 2d. ArcView point themes showing Hector settlement in 1944.

tural resource management (e.g., Jackson 1990; Kvamme 1989; Stine & Lanter 1990). For obvious reasons, GIS-based predictive modeling and digital filing systems have been particularly useful to archaeologists with CRM or other land-management oriented projects.

These predictive and organizational applications of GIS technology in archaeological settlement studies have demonstrated the utility of the technology as a site inventory or land management tool. Its analytical utility, however, remains under-explored (Kvamme 1999). The Finger Lakes National Forest Archaeological Project has attempted an interpretive application of GIS to settlement pattern analysis, following the example of Hasenstab's (1996) study of contact period Native American settlements in upstate New York. Hasenstab used GIS to interpret Late Woodland settlement shifts in terms of combined environmental and social transformations over time. The goal of the Finger Lakes Project, similarly, has been to use GIS as an explanatory tool to aid interpretation of Hector settlement patterns as a function of interwoven ecological, social, and historical factors.

Working with Historic Maps

While the Finger Lakes National Forest Archaeological Project originally aimed to recreate Hector settlement for each decade from the 1830s through the 1930s, maps depicting settlement features at the desired level of specificity were available only for 1857, 1874, 1911, and 1942/44. While this proved to be an acceptable range of dates for our purposes, the difficulty of locating usable map data does limit how historic maps can be used to reconstruct settlement patterns of the past.

Among others, Ravenhill and Gilg (1974) and Paynter (1982) have exhaustively covered the intentional and unintentional biases inherent in the production of historic maps. Following their lead, we would like to stress that historic maps, like all primary texts, must be read critically and with the context of their production in mind. Rather than representing objective reality, historic maps depict a subjective view of those settlement components deemed important to the goals of a given mapping project. Comprehensive land use maps documenting civic and commercial structures along with domestic dwellings and outbuildings afford a completely different image of a region's settlement history than does a U.S. Postal Service map depicting only the dwellings of residential mail customers. This exacerbates the problem of comparability between maps produced in different decades by different agents, using different surveying methods and varying representational scales. While these factors pose significant difficulties to the user of historic maps for settlement pattern study, historic maps are invaluable resources for the reconstruction and interpretation of past settlement patterning.

Collecting Data from Historic Maps

There are many sources for map collections depicting a variety of historic settlement data. The nature of settlement information desired will dictate which repositories and map types are most useful. In the case of the Finger Lakes National Forest Archaeological Project, 19th-century land use maps (Beers 1857; Beach 1874), an early-20th-century Rural Postal Delivery Route map (1911), and mid-20th-century USGS Topographic Quadrangle Series maps (1942, 1944) were obtained from the New York Public Library (1971) map archives.

Historic maps may contain data on topography, land survey, roadway, railway, waterway, and land use for residential, civic and commercial purposes. Topographic maps like USGS Quadrangles frequently incorporate other categories of cartographic data, such as land survey (state, county or township boundaries), and symbols denoting vegetation, roads, bridges, railroad tracks, rivers, lakes, canals, and other prominent features. The county atlases used for this study locate homes along with cemeteries, churches, schools, commercial and industrial sites. We found the U.S. Postal Service's Rural Postal Delivery Route series, published from 1908 to the present, useful for locating houses and some community institutions, like schools and churches (see USPO 1911).

Once located, historic map data must either be reproduced or transcribed if, as was the case with this project, entire settlement patterns are to be replicated within a GIS database. Historic maps typically are archived in microfilm or microfiche, flat xerox or photographic reproductions, or flat original documents. If the holding institution possesses reading machines equipped with coin-operated printers, producing copies from film or fiche is a simple matter.

Unfortunately, many institutions do not permit xeroxing of flat maps, particularly when a document is very old, unique, or in poor condition. To overcome this problem, we chose to manually transcribe settlement data directly from map documents into the GIS database, photocopying or digitally photographing maps whenever possible for later reference. This was accomplished easily by carrying a laptop computer into the map archives and inputting the locations of each settlement component directly onto a set of "point themes," in which each cartographic feature like houses or churches, was represented at a specific point by an icon. Depending on the scale of analysis to be undertaken, visually comparing distinctive roadway and waterway landmarks on historic maps with those contained on georeferenced themes depicting roadways and waterways within the GIS project file was sufficient for locating historic settlement components with acceptable accuracy. A major disadvantage of this approach to recording historic map data is that no digital version of the original map is retained for future reference. This becomes a problem if one wishes later to confirm the placement of settlement data in point themes, or to "attach" digital replicas of historic map images to one or more themes in the project file.

As the production of readily available digitized map archives was an important goal of the Finger Lakes National Forest Archaeological Project, we created static reference images of the study area as it appeared in historic maps from 1857, 1874, 1911, and 1942/44. Xerox copies of each map were scanned into a desktop publishing program, saved as jpeg graphic files and then "cut" into a series of individual files each matching a one-mile-square grid unit (compartment) of the New Military Tract. Where these Military Tract divisions were retained in the historic maps for 1857 and 1874, it was simple to identify the boundaries of each Military Tract, to copy and to paste these historic map pieces into new files saved under a map year Military Tract code (so that compartment 3 as depicted in the 1857 map was named "1857-3"). As historic maps for 1911 and 1942/44 did not retain these Military Tract lines, grid boundaries were located on the digitized maps by matching distinctive features from the earlier maps, such as irregularly-shaped road intersections.

Each historic map piece representing a single unit of the Military Tract was then "hotlinked" to the project's military grid theme. This provided ready access to a cartographic snapshot of each grid unit as it appeared in successive map years. Map images then could be viewed by activating the Military Tract theme, placing the cursor within the desired grid square, and selecting "hotlink" on the ArcView toolbar (FIGS. 3 and 4).

Hot-linking map images to the Military Tract theme was a simple way of permanently archiving the original cartographic images from which historic settlement data for Finger Lakes National Forest Archaeological Project were obtained. However, these snapshots of each grid square in successive map years were static image files. The settlement data depicted in them could not be queried or manipulated in any way, nor could the information from different squares be compared statistically across time or space. Furthermore, the settlement patterns they represented could not be related to the other data sets in the project file. Further manipulation of historic map data was required to convert settlement information into a format permitting statistical and spatial analysis relative to other project data sets, such as topography, roadways, waterways, and the Military Tract grid which organized 19th-century colonization in the region.

Entering Historic Settlement Data into ArcView Point Themes

To permit analysis of the spatial and temporal dimensions of settlement shifts depicted in the hot-linked map images, the location of each settlement component represented in each map year had to be entered manually into the project file in a format that would allow statistical and spatial queries based on

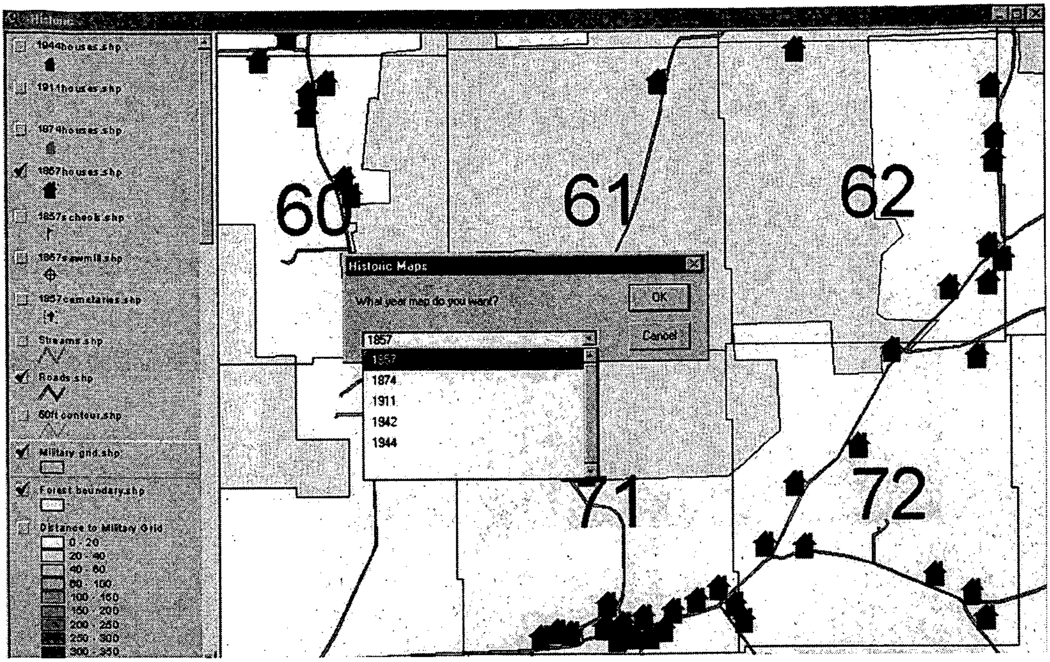
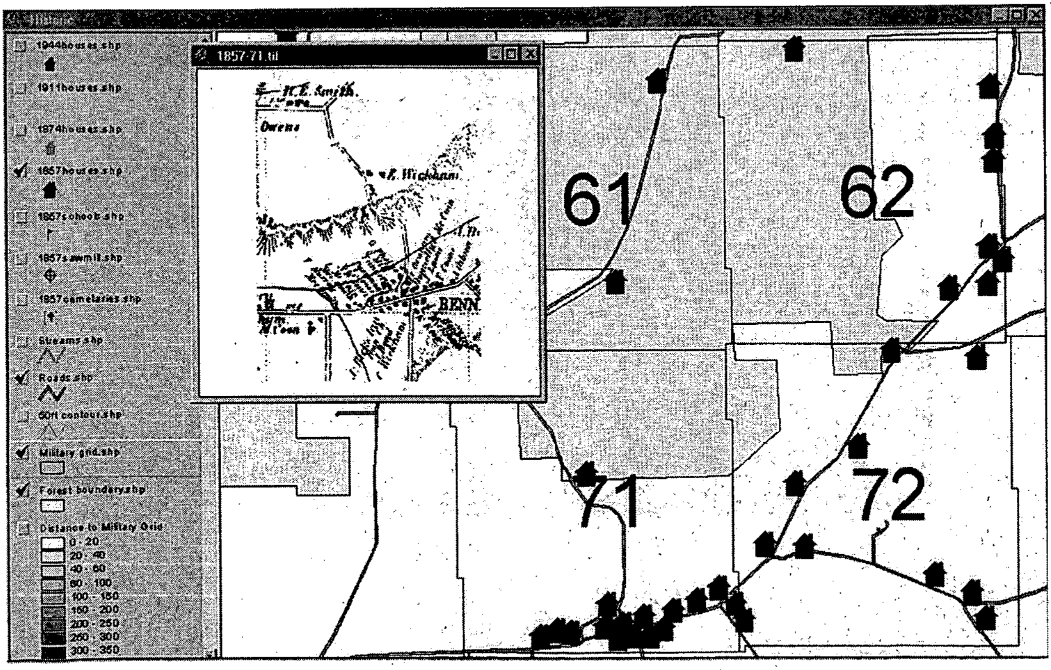


Figure 3. ArcView screen capture showing menu for hot-linked historic map images for 1857, 1874, 1911, 1942/44.



Firgure 4. ArcView screen capture, showing hot-linked image file for grid square 71 as it appeared in the 1857 map (1857-71).

the georeferenced locations of various settlement features within the study area landscape.

Georeferencing settlement data in a GIS program may be accomplished in several ways. In the case of maps denoting Universal Transverse Mercator (UTM) grid lines, the position of settlement features may be extrapolated in relation to the grid lines and then placed into a theme by reference to their designated UTM coordinates. All USGS 1:24,000 and 1:250,000 topographic maps carry a full UTM grid (Terry 1996). Unfortunately, for archaeological purposes, such recent maps frequently postdate the period of interest.

When dealing with maps lacking UTM data, things get considerably more complicated. Settlement features may be digitized directly into a GIS project theme from a historic map whose scale has been calibrated to match the GIS project base map. While this approach carries the advantage of reproducing exactly the arrangement of settlement data depicted on historic maps, it also reproduces the inevitable errors created by imprecise surveying and recording methods used to produce such documents. Rather than precisely fixing points based on astronomical observation of latitude and longitude, authors of 19th-century land use maps were likely to rely on rough direction and distance measurements using compass bearings and an odometer. By comparison to modern maps, watercourses and nonlinear roads are significantly distorted (Davidson 1986: 30). Geo-correction serves to ameliorate these problems via laborious processes ranging from simple measurement of linear distance or angles between map points to intricate computer-based regression models designed to assess agreement between historic map features and their enduring counterparts on modern maps (Stone and Gemmell 1977: 7-8). Given this inherent imprecision in historic map data, the effort required to geo-correct and to coordinate the scale of a historic map with that of a GIS project base map is not always worth the headaches it entails.

To examine how settlement densities changed over time, historic settlement data can be manually entered into a GIS project by placing settlement features as they appear on historic maps in their relevant locations on GIS point themes. To be effective, this process must be guided by distinctive, enduring landscape features such as roadways or waterways. Once all points correlating to settlement features have been entered into ArcView in this manner, each point may be georeferenced to its corresponding UTM coordinate on the project base map.

Given our project's analytical goals and the early dates and differing scales of the maps used, this manual point theme entry method was deemed best for the Finger Lakes National Forest Archaeological Project. To maximize visual clarity and analytical flexibility, a separate point theme (i.e. a theme in which features are represented by a single point) was created to represent all examples of each settlement component for each map year (1857, 1874, 1911, 1942/44). Thus, an individual point theme was created to represent the locations of all dwellings in 1857, one for churches in 1857, one for schools in 1857, and so on. All point themes were color-coded by year to permit instant recognition of the year to which settlement data belonged if more than a single year's worth of themes were activated at one time. Different categories of settlement data were matched across years by the use of distinctive point symbols, such as flags for schools and crosses for churches. As point themes for a given year may be activated or deactivated at will, the settlement themes function much like a digital version of transparencies which may be viewed singly or stacked together, revealing at a glance a qualitative sense of the relationship between different settlement types for a single year, or change over time between years (FIG. 5).

Once UTM coordinates corresponding to the locations of historic settlement data were linked to settlement point themes, it became possible to ascertain spatial and temporal relationships between various settlement features more rigorously. The following section presents the quantitative analyses applied to the settlement data we recorded.

Hector Settlement Pattern Analysis

Most GIS software packages enable users to calculate and represent relationships among theme data as they vary over space and time. In ArcView, a program extension known as Spatial Analyst calculates density, surface, and

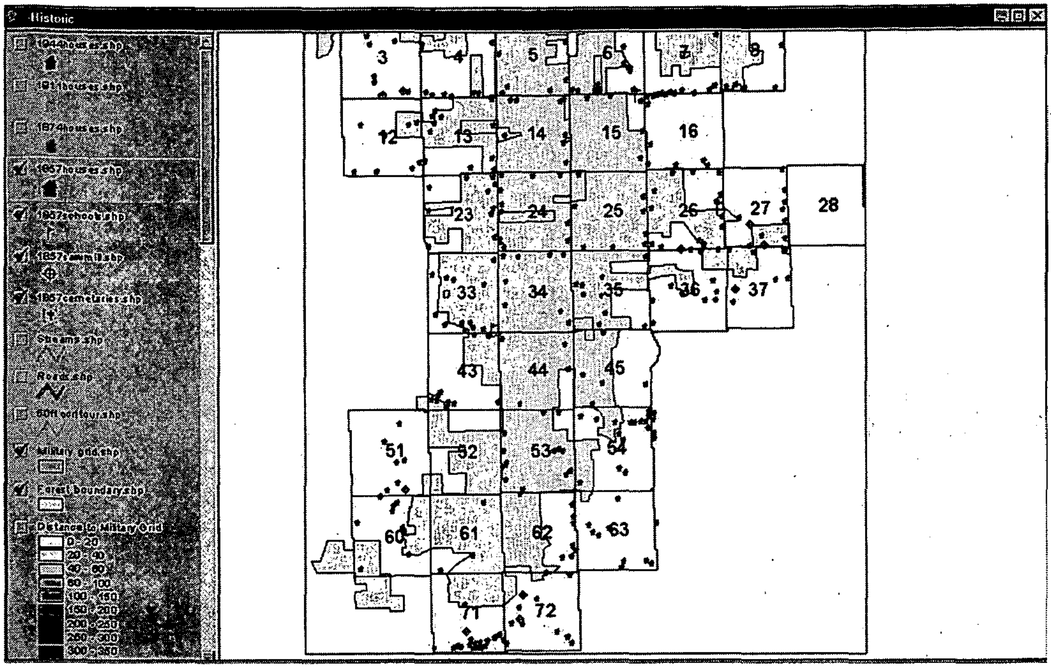


Figure 5. ArcView screen capture, showing all Hector settlement themes for 1857 activated.

distance characteristics of one or more data types, and generates histograms or continuous surface maps to represent the results graphically. Specific functions that are particularly relevant to archaeology include calculation of slope, catchment areas, nearest-neighbor densities, and viewshed. Most of these techniques are executed using simple menu-driven commands.

As noted previously, a major concern of the Finger Lakes National Forest Archaeological Project was to gain some understanding of why occupation in Hector persisted in the areas and patterns in which it did. Those who stayed in the region did so despite escalating economic and—once the federal government started buying out "problem area" landholders—political pressures to relocate. Our GIS database provided the analytical tools for expressing more precisely those settlement shifts that could be approximated by manipulating the point themes representing settlement locations and their shifts in each map year (FIG. 2a–2d).

In considering the analytical functions that would be most instructive given our project goals, it became clear that most categories of settlement data unfortunately were not comparable across map years. For example, schools were indicated on the 1857, 1911, and 1942/44 maps, but not on the 1874 map. Sawmills and other commercial concerns such as stores and hotels were absent from the 1911 and 1942/44 maps. Churches appeared only on the 1857 map. And while private farmsteads were the only category to appear consistently in all of the maps, even the denotation of this category varied by year. Barns and other outbuildings were indicated as distinct structures alongside dwellings in the 1857 map, while all structures associated with a domestic compound were consolidated into a single dot in subsequent map years. Thus, while residential site massing and relative proximity to commercial and civic concerns are important factors in regional settlement patterns (Roberts 1996: 76–79, 54–57), limitations in data comparability precluded us from considering them. The shifting relative locations of dwellings, however, provided a focus for statistical and spatial analysis with 315 dwellings depicted on the 1857 map, 253 dwellings in 1874, 215 dwellings in 1911, and 139 dwellings remaining by 1944 (FIG. 6).

While demography and economy are critical factors driving regional settlement

(Roberts 1996: 29), the scope of settlement analysis in the Finger Lakes National Forest Archaeological Project was limited to those factors assessable by reference to historic maps and to maps depicting current environmental conditions (e.g., topography and waterways) whose characteristics are presumed to have remained reasonably stable since the mid-19th century, and not on diachronic archaeological evidence. Interpretation of the results of spatial analysis of settlement data, however, drew heavily on Heaton's analysis of the rural settlement history presented in this volume.

Results of the Settlement Data Analysis

The settlement data analysis focused on tracking overall dwelling density and location as it shifted in relation to environmental and cultural features visible in the historic map landscape. For these purposes, nearest-neighbor cluster analysis, percentage slope of dwelling sites, and dwelling distance from waterways, roads, and the New Military Tract grid were calculated for all map years. With the exception of the nearest-neighbor R-values, temporal trends in these spatial relationships were depicted graphically using Spatial Analyst's histogram graphing function. The findings of each spatial technique are next presented and discussed briefly, followed by an integrative summary that characterizes settlement patterns each map year, and interprets how they evolved over time in the study area.

Nearest-Neighbor Analysis

Archaeologists routinely have borrowed models from ecology and locational geography to aid their descriptions of site distributional patterns. The nearest-neighbor statistic, a form of cluster analysis first outlined by Clark and Evans (1954), is a particularly useful tool for discerning non-random settlement patterns. With "random" distribution defined as that in which all sites are equally likely to occupy a given point, the nearest-neighbor statistic expresses deviation from randomness as "the ratio (R) of the mean distance expected for a randomly distributed population of a given density" (Earle 1976: 197). Deviation from random is defined as more clustered or more regularly spaced than would be expected to result from random distribution within a bounded region. An R-value of 1 indicates random distribution, an R-value of zero indi-

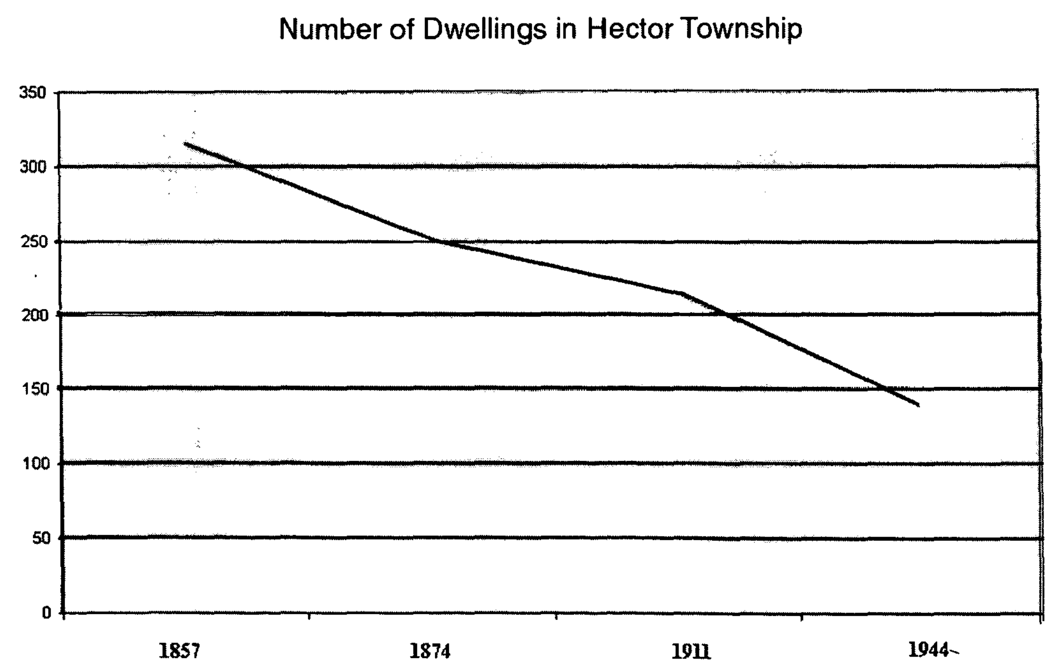


Figure 6. Number of dwellings in Hector township, 1857-1944.

cates intense clustering, and an R-value of 2 or higher indicates an evenly-spaced dispersion. Thus nearest-neighbor analysis gauges the accessibility of one dwelling to another, detecting the degree of regional settlement aggregation into hamlets or towns, or its relative diffusion in the form of isolated farmsteads.

Figure 7 graphs the R-values derived for Hector in 1857, 1874, 1911, and 1944. As the chart makes clear, nearest-neighbor analysis in the Finger Lakes National Forest revealed an overall trend of settlement nucleation from 1857 to 1944, albeit punctuated by a spike in regularly-spaced dispersion of settlement in 1911 (FIG. 6). This overall pattern is not surprising, given the demographic and economic history of the region recounted in Heaton's article on rural settlement history. Following agricultural boom and settlement growth in the 1830s, Hector suffered soil depletion, farmstead abandonment, and population decline by the 1870s. The overall pattern revealed by nearest-neighbor analysis suggests that, in contrast to the independent farmsteads established in the early-19th-century township, those remaining in Hector after its agricultural collapse tended increasingly to cluster in hamlets or small towns.

The seeming anomaly of 1911 data within this overall trend warrants special attention, particularly since it appears to disrupt a seemingly logical trajectory. While we will return to the question of this seeming anomaly, for the moment it begs a question that hounds the nearest-neighbor statistic: Does it say anything meaningful? While it is beyond the scope of this paper to address the critiques in detail, doubts have been voiced regarding the accuracy of archaeological patterns generated by the nearest-neighbor statistic (Shennan 1988: 253–254). Particularly damning is the observation that the technique may conceal internal variations within a seemingly uniform pattern (Roberts 1996: 56–57). Furthermore, the distribution of sites in a region may not be truly random, but may correlate with differential distribution of arable soils or land with appropriate slope for drainage. As useful as it may be in quantifying long-term settlement trajectories that may be discerned only roughly through visual assessment, the nearest-neighbor statistic merely defines patterns which must be related to other, contextually-specific factors if they are to be meaningful (Earle 1976: 198). Thus, additional spatial analyses of settlement shifts in Hector were undertaken to account for the unique environmental and social factors at work during the period of interest.

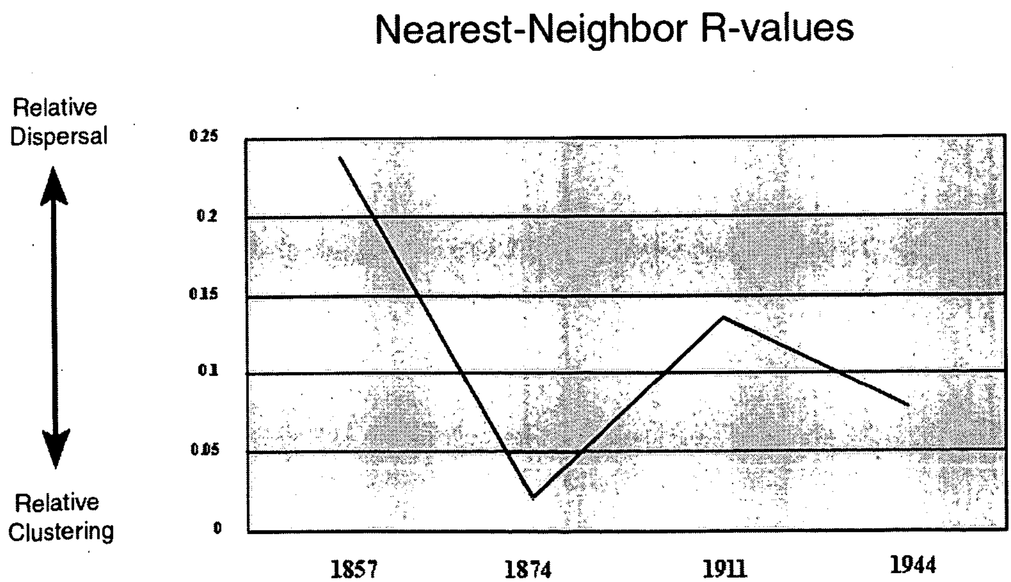


Figure 7. Nearest-neighbor R-values for Hector township, 1857-1944.

Slope of Dwelling Sites

Topography affects rural settlement profoundly by influencing drainage, soil cover, and the ability to raise crops and livestock effectively. A gentle slope of 1–2% provides adequate water drainage while maximizing the ease of erecting a dwelling and working the land. While a 5% grade might pose challenges to non-terraced agriculture, it is still a viable category for independent, non-mechanized farming (Roberts 1996).

Not surprisingly, histograms depicting the slope of dwelling sites in Hector for 1857, 1874, 1911, and 1944 show that 83% of all dwellings in all years were located on land sloping less than 5%, with well more than half (60%) located on land sloping 3% or less (FIG. 8). This calculation is based on the slope of land at the point occupied by the dwelling only, and thus does not reflect the slope of the property overall. Therefore, it is conceivable that a dwelling might have been located on the flattest part of a farmstead, leaving less optimally sloped land for agricultural purposes. Likewise, a dwelling might occupy the least agriculturally suited part of a farmstead, leaving more viable land for cultivation than might be suggested by the histogram.

Regardless of the quality of land devoted to housing versus agriculture, as revealed by findings for all map years, land slope evidently was an important factor in siting dwellings on the Hector Backbone. Furthermore, as comparison of histograms for successive map years reveals negligible change over time in the proportion of dwellings sited on land sloping 5% or less, slope apparently was a variable whose influence remained constant in the region despite dramatic changes in overall settlement patterns between 1857 and 1944.

Dwelling Distance from Waterways

Providing fresh water along with potential transportation routes, waterways are a critical

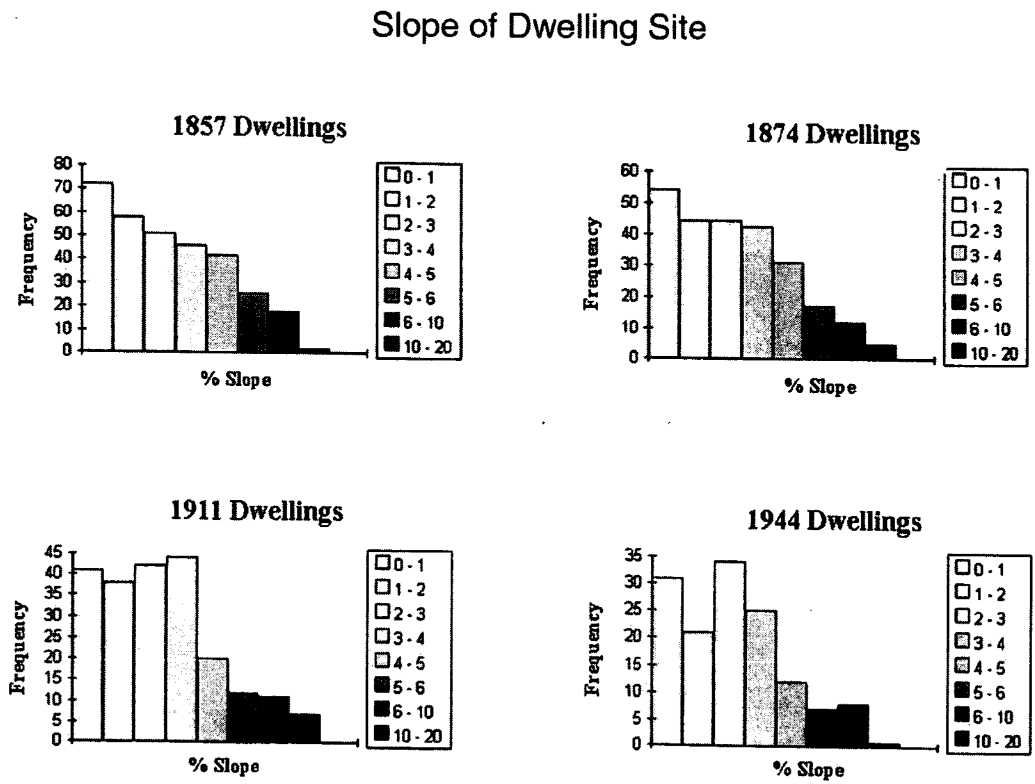


Figure 8. Histogram showing slope of dwelling sites in Hector township, 1857-1944.

factor in human settlement. Particularly in those regions where waterways are the primary circulatory and communications system, rivers and their tributaries constitute a "natural framework for the growth of trade and towns" (Linebaugh 1994: 165).

Due to its lack of navigable waterways, this was not the case in Hector (Crane and Perry 1977: 5). Clearly, access to water for everyday needs would have been a priority for the farmers who formed the majority of permanent settlers in the region. Aside from those who logged, however, and thus floated felled timber to sawmills for processing, local waterways along the Backbone would not have served as transportation routes (Gordon 1836: 736; French 1860: 611).

Aside from a slight drop in the number of dwellings located at the farthest distances (>500 m) from streams in 1944, no clear trend is visible in histograms measuring the distance of dwellings from Hector's network of streams in each map year (FIG. 9). While ready access to fresh water is a basic necessity, archaeological evidence uncovered in the Project survey proves that many farmers depended on wells to meet daily water needs. This no doubt is reflected in the significant number of dwellings located a great distance from streams in all map years. Apparently, direct distance from streams was not a significant variable shaping Hector's settlement patterns between 1857 and 1944.

A final observation will be made about Hector's waterways, to be revisited in the summary discussion. As shown in Figure 10, Hector's streams tend to snake along the Backbone's furrows, mirroring its peaks rather than crosscutting them. This contrasts markedly with the course of most of the region's roadways, whose linear pattern was determined largely by the New Military Tract grid.

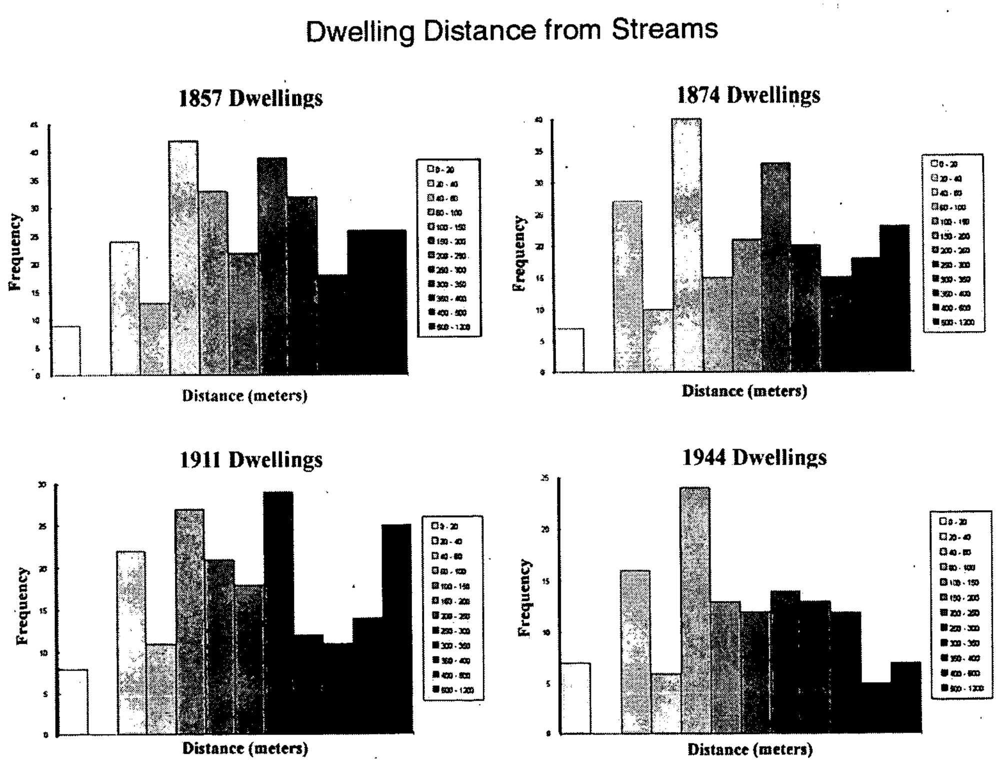


Figure 9. Histogram showing dwelling distance from streams in Hector township, 1857-1944.

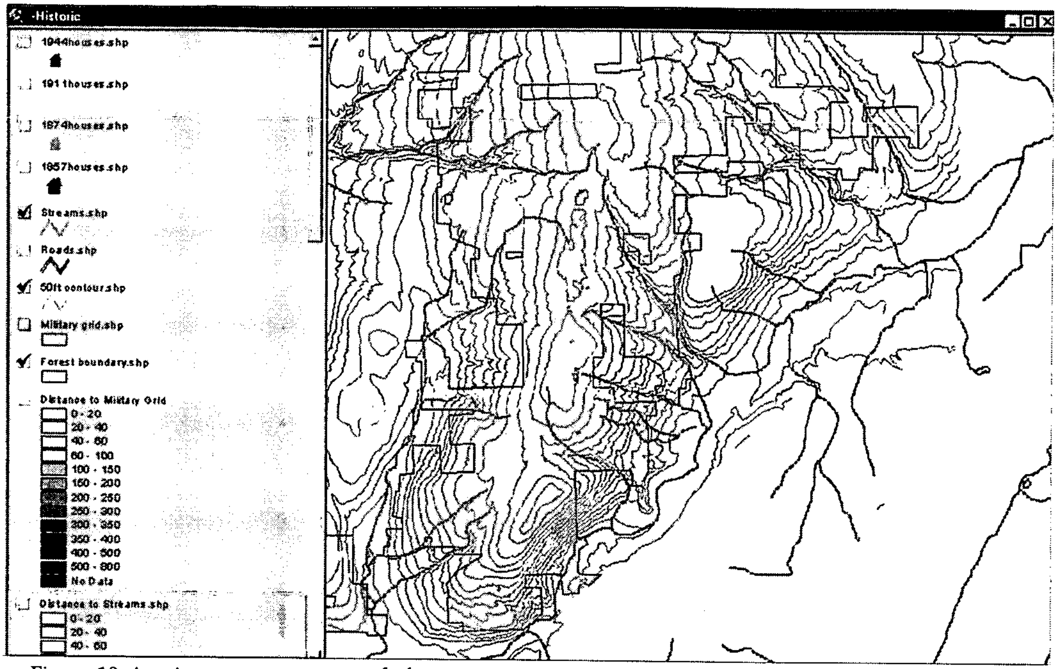


Figure 10. Arcview screen capture with themes activated to compare Hector streams and 50 m. contour lines.

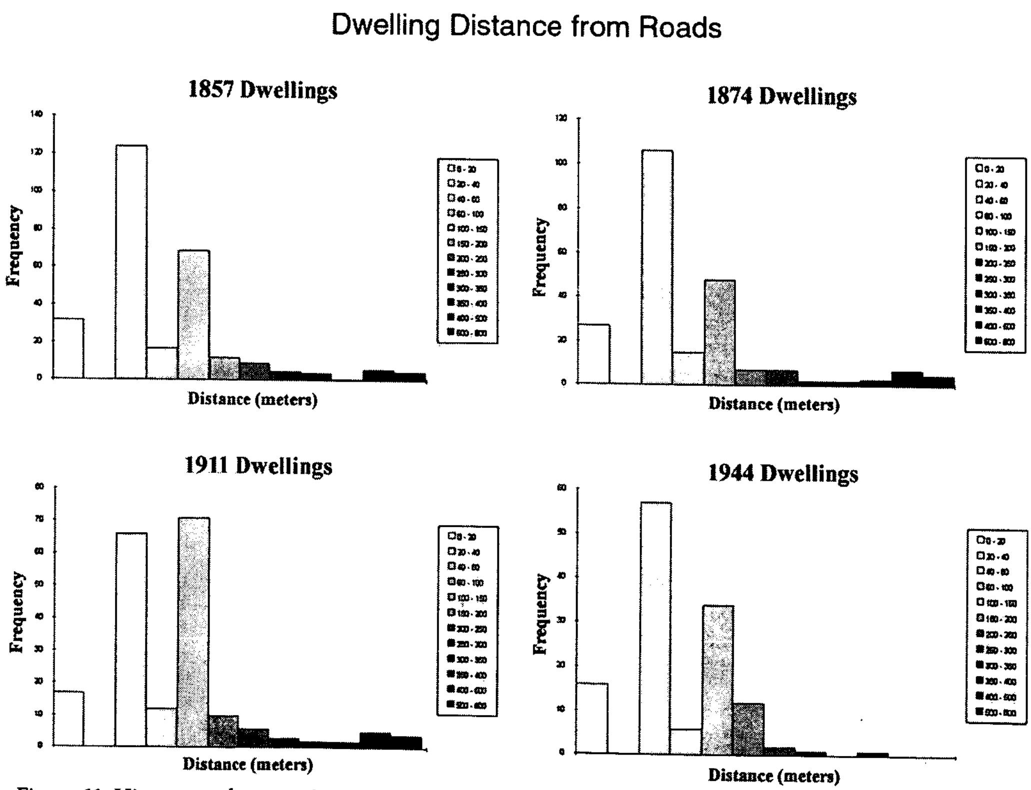


Figure 11. Histogram showing dwelling distance from roads in Hector township, 1857-1944.

Dwelling Distance from Roads

Roads rather than waterways were the primary mode of transportation in the Finger Lakes National Forest region from its American colonization through the 1940s (Parkerson 1995: 25–30). Laid out in linear fashion along the New Military Tract gridlines established in the late-18th century, Hector's original road system—like the Military Tract itself—defied the rolling topography of the Backbone. As new roads evolved along with 19th- and 20th-century settlement, however, they appear to have correlated more closely with the natural contours of the land. Illustrating this point, Figure 10 overlays themes depicting a portion of Hector's topography as revealed by 50-foot (15m) contour lines, its modern waterways, and its modern road system.

Histograms depicting dwelling distance from primary and secondary roads (i.e., not farm access roads) reflect a clear and enduring pattern in 19th- and 20th-century settlement in Hector vis-a-vis roadways. Figure 11 shows that across all map years, 50% of all dwellings in Hector were located within 60 meters of roads, with a total of 78% located within 150 meters. A subtle trend that will be discussed further in the summary is a slight but material decrease over time in the number of dwellings located more than 350 meters from roads. Down from a uniform average of 5-6% of all dwellings in 1857, 1874, and 1911, by 1944, less than 1% of all dwellings were located more than 350 meters from roads.

In regions where roads are the primary transportation network, it is perhaps self-evident that road accessibility (with some measure of privacy) will be a motivating factor in settlement location. Along with this basic logistical need, proximity to neighbors, to community institutions such as schools and churches, and to work opportunities outside the home tend to be important social factors shaping settlement patterns in specific contexts (Roberts 1996: 65). Road systems may either pre-exist—and thus encourage—settlement in a given area; likewise, roads may develop as needed to service settlers already in residence (Robinson 1994: 107). While we lacked the historic map data needed to assess whether the former or the latter best describes the trajectory of settlement in Hector, based on what is known of Hector's demographic and economic history, it is likely that settlement and road expansion evolved together to meet the changing needs of those occupying formerly self-sufficient farmsteads in an increasingly marginal agricultural region.

Dwelling Distance from the New Military Tract Grid

As discussed in previous articles in this volume, the New Military Tract, surveyed in 1789 and 1790, carved twenty-eight rectilinear townships onto the landscape of central New York. In Hector, the New Military Tract consisted of regular one-mile square (2.59 km^2) surveyors' units imposed on a highly irregular landscape. Overlaying the geometric grid and Hector's 50 foot (15m) contour lines, Figure 12 demonstrates that the New Military Tract, with its roadways, simply cross-cut the Backbone's topography as needed to maintain its regular pattern.

Interestingly, it is only in the histograms depicting dwelling distance from the New Military Tract grid that clear change over time is visible in Hector's settlement patterns. In contrast to the lack of change over time revealed by histograms graphing the slope of dwelling sites and dwelling distance from streams and roads in each of the map years, there is a marked shift of settlement away from New Military Tract gridlines between 1857 and 1944 (FIG. 13). Whereas 23% of all dwellings in 1857 were located within 60 meters of the New Military Tract grid, in 1874 that percentage dropped to 17%. By 1911 it had fallen to 12%. By 1944, only 3% of Hector's dwellings were located within 60 meters of the grid. Likewise, the ratio of dwellings located farthest away from the New Military Tract rose in a reverse trend, with the proportion of dwellings situated more than 350 meters from the grid rising from 11% in 1857 to 21% by 1944.

Discussion of Hector Settlement Patterns, 1857–1944

In sum, our spatial analyses suggest that dwelling patterns in Hector resulted from a complex interaction of environmental, cultural, and historical factors. While nearest-neighbor analysis indicated a general trend of increasing settlement density, other calculations indicated that one environmental factor—land slope—exerted a constant influence on dwelling site location, while distance from streams apparently was unimportant. We discerned only a minor rise in dwelling proximity to roads, while distance trends relating dwelling location to another cultural factor—the New Military Tract grid—showed significant change over time. While these exercises revealed otherwise hidden patterns in Hector settlement, to interpret their meaning it is necessary to consider more carefully the specific nature and context of New York's expansion and ongoing settlement in the Finger Lakes National Forest region.

With thin soils overlying rocky, steep terrain, the Hector Backbone was ill suited for sustained timbering and agricultural activity. Nineteenth-century colonization in the region, however, was predicated on the swift establishment of permanent farmsteads on the steepest uplands as well as the more arable lowlands (Crane and Perry 1977: 14). This quality-blind approach to land settlement reflected the New Military Tract surveying process, which produced a uniform set of land parcels despite the highly irregular terrain from which the Town of Hector was carved. Hector's sloping soils were depleted within decades of their settlement by early American farmers, whose rapid clear-cutting and intensive farming enhanced the region's innate vulnerability to erosion. These shortsighted agricultural practices hastened local economic depressive forces, prompting large-scale land abandonment by the 1870s. Land abandonment culminated in the early-20th-century federal buyout of farmers remaining in an officially "sub-marginal" agricultural zone created by decades of excessive exploitation of the Backbone's resources.

This "boom, bust, abandonment" trajectory is clearly visible in the point themes depicting dwelling locations in Hector for each map year (FIG. 2a–d). As nearest-neighbor R-values (FIG. 6) reflect, in 1857, farmsteads were regularly dispersed throughout a primarily rural landscape dotted with small towns. At this point farmers were as likely to occupy the steepest center of the Backbone as the flat lowlands to either side. The early influence of the arbitrary divisions established by the New Military Tract grid is apparent, as most dwellings located close to roads correlate with the grid rather than with roads that evolved secondarily in its interior. By 1874, settlement had aggregated somewhat, as the growth of towns counterbalanced ongoing farmstead abandonment. The more dispersed pattern of settlement in 1911 seems to reflect the acceleration of land abandonment from the 1880s through the 1910s. While many already had left the region for opportunities elsewhere, 215 dwellings—many still attached to self-sufficient farmsteads—remained in Hector by 1911. Given a 47% decline since 1857 of farmsteads operating in a region dogged by deteriorating soils, the pattern of dispersed farmsteads is not surprising. As has been discussed in previous articles, Hector's residual farmers compensated for decreasing crop yields from exhausted soils by purchasing neighbors' property, consolidating regional landholdings among fewer, more widely-dispersed residents.

By 1944, when the region's soils were no longer agriculturally viable, clustered village or town settlement evidently was the most viable option for Hector residents, perhaps owing to non-agricultural employment opportunities. As shown in the 1944 point theme (FIG. 2d), the federal government by this time had purchased most of the idled lands along the Backbone, earmarking them for reforestation and other productive non-agricultural use. Dwellings remaining in Hector were located primarily along the fringes of this newly-created public domain that was to become the Finger Lakes National Forest. Settlement had moved noticeably away from the lines dictated by the New Military Tract grid which had encouraged early settlement along its primary road system. Instead, residents tended to cluster primarily on interior roads which correlated more closely with waterways and the Backbone's natural topography.

For further insight into why settlement shifted as it did in Hector from 1857 to 1944, it is instructive to consider native Iroquois settlement patterns in the present-day Finger Lakes region. This is because Iroquois land use pat-

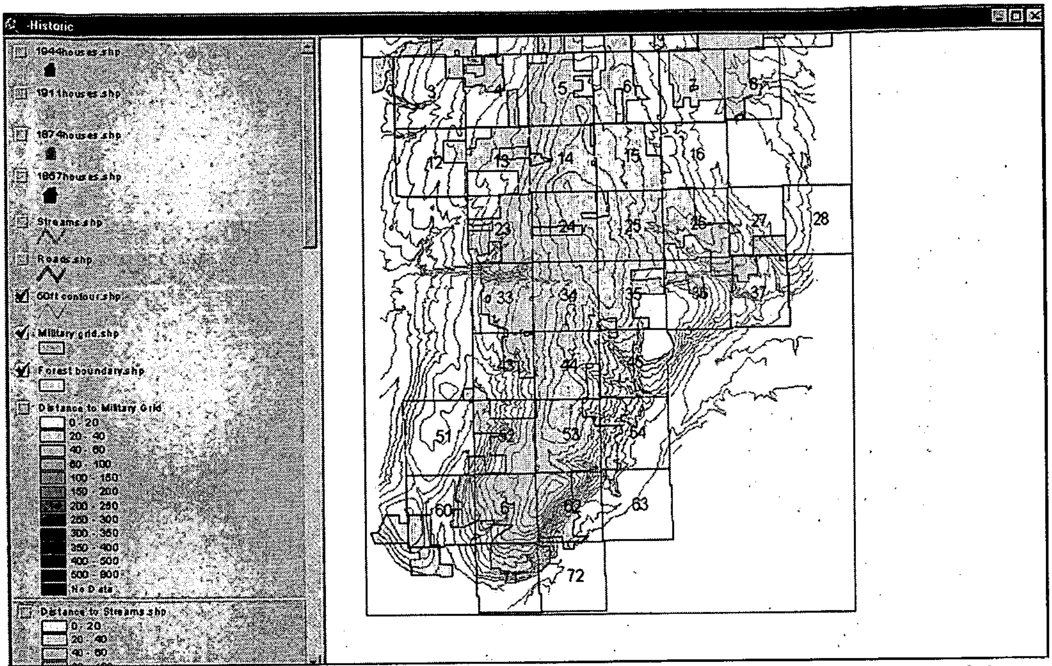


Figure 12. Arcview screen capture with themes activated to compare New Military Tract and 50 ft contour lines.

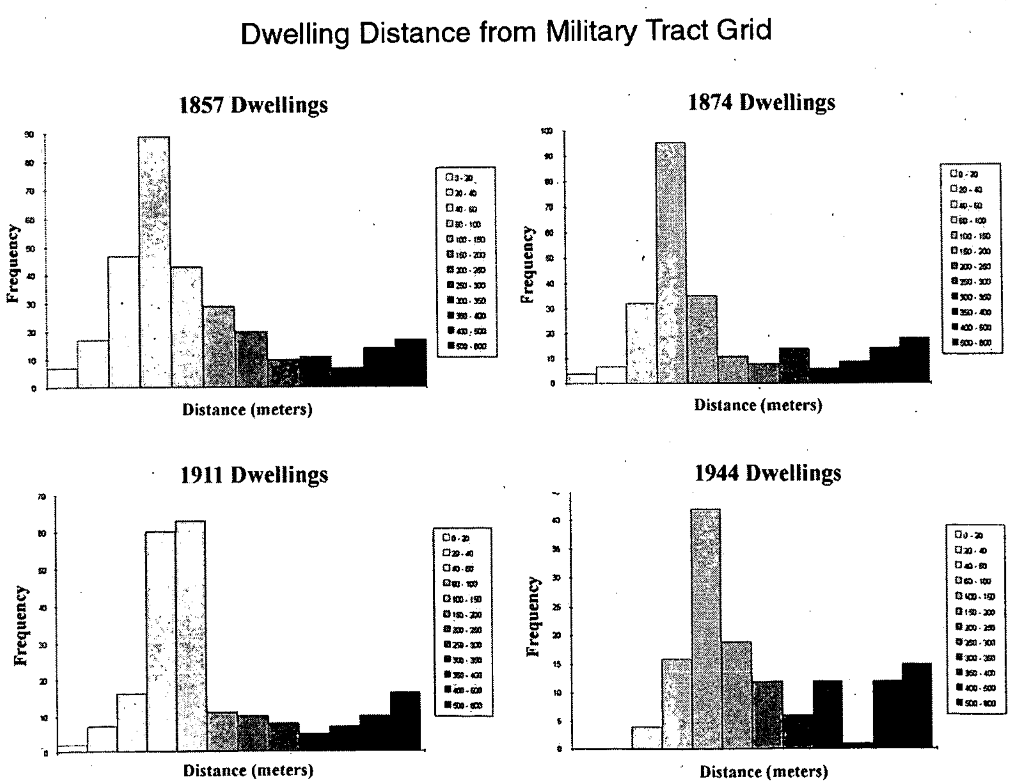


Figure 13. Histogram showing dwelling distance from the New Military Tract grid in Hector township, 1857–1944.

terns differed so greatly from the strategy pursued by Hector's 18th- and 19th-century Yankee farmers. Unlike farmers who settled permanently in independent homesteads linked by a geometric network of roads, New York's native inhabitants congregated in fluid clusters alongside meandering lakes or navigable rivers, which served for transportation. These settlements were transient, inhabited for no more than the ten to twelve years for which local soils remained fertile under continuous cultivation. Iroquois subsistence did not depend solely on agriculture in any case, as fishing and hunting supplemented the cultivation of corn, beans, squash, and pumpkin. Crops were distributed among semi-permanent dwellings of bark sheets lashed to poles, and field locations were shifted yearly to compensate for fluctuating soil quality. The entire Iroquois population in what is now New York state has been estimated at about 15,000 prior to their devastation by American military forces beginning in 1779 (Wheeler 1935: 14; Wallace 1970: 141). Of this total population, approximately 2,000 members of the Seneca nation occupied about a dozen impermanent villages along the east coast of Seneca Lake, within the boundaries of the present-day Town of Hector (O'Callaghan 1849: 27). Since it lacked navigable rivers, Hector's fragile interior appears to have been more sparsely inhabited by the late-18th-century Seneca.

Selective, migratory, and mixed-subsistence Iroquois settlement on this minor scale clearly would have had less impact on Hector's resources than did its indiscriminate, sedentary, and intensive agricultural usage by over 300 Yankee farmsteads. This was especially true given that commercial farms were as likely to occupy the steepest parts of the Backbone as to exploit the more stable flatlands. Iroquois settlement patterns are not presented merely to condemn the settlers' blindness to the limitations of their natural environment, however. Rather, the counter-example is offered for insight into trends we identified in the shifting of dwelling locations throughout the study area, and particularly in relation to waterways, roads, and the New Military Tract grid.

By 1944, decades of voluntary land abandonment and federal buyout efforts had shifted settlement almost entirely off the Backbone. While many of the displaced were relocated outside of Hector altogether, some probably joined those already living in towns or relatively clustered village configurations along Hector's secondary roads (FIG. 2d). As noted already, these secondary roads were more likely than primary roads to be aligned with the natural topography followed by Hector's streams, none of which were navigable over any significant distance. In their relative proximity to each other and to such waterways, 1944 dwelling patterns resembled Native American settlement trends more closely than those of their Yankee forebears. While we do not suggest that Hector's 20th-century residents mimicked Native Iroquois practices, similarities between Iroquois and mid-20th-century settlement in Hector are thought-provoking, as they point to a shared awareness of Hector's environmental conditions that was lacking throughout most of the region's Anglo-American settlement history.

The coincidence of 1944 and Iroquois settlement patterns suggests that the limitations posed by Hector's terrain finally were acknowledged by mid-20th-century American settlers, whether by choice or out of necessity. By 1911, settlement along Hector's secondary roads had started to rise. Unlike the New Military Tract and its primary road system, secondary roads and the streams they mirror tended to work with Hector's irregular topography rather than against it. In contrast to Native Americans, 20th-century Hector residents did not depend on water for transportation. Nonetheless, roads circumventing Hector's ridges and gullies would have reduced erosional damage, and would have been easier to navigate than steep hilly roads. As with the Iroquois, 1944 settlement was characterized by avoidance of the Backbone. While the Iroquois presumably chose this arrangement at least partly due to the lack of navigable streams in Hector's interior, for later settlers the decision had been made by predecessors who exhausted the region's limited agricultural potential. Whether by choice or not, this settlement shift had positive environmental implications for the region, as clearing the land of farmers struggling to compensate for declining crop returns favored renewal of the Backbone's depleted resources. Whether for good or for ill, by 1944, "unsettling" the Backbone virtually had become an environmental and economic necessity.

In addition to indirect similarities with 18th-century Iroquois trends, Hector's 1944 dwelling pattern equally reflects the enormous changes that marked its transition from a 19th-century boom region to federally-managed problem area. Settlement had aggregated substantially by 1944, reflecting the decline of independent farmsteads that had formed the basis of Hector's boom economy. Given environmental and economic pressures to abandon settlement patterns better suited to an agriculturally viable region, it is no surprise that dwellings were located increasingly closer together and closer to roads by the time Hector's proportion of village and town settlement had reached an all-time high.

As Figure 2d shows, however, a number of residents chose to remain isolated from their neighbors in 1944. Furthermore, some even chose to retain ownership of "sub-marginal" plots landlocked within the thousands of acres henceforth subject to federal administration, though it is unclear at this point how many of those that remained continued to farm. Thus, despite the explanatory power of environmental, economic, and political factors as causative elements in Hector's settlement trajectory, such exceptions prove that ecological and social determinants may shape human settlement, but never may be assumed to dictate it entirely.

Conclusion

The goal of the Finger Lakes National Forest Archaeology Project was to create a GIS database that would function as both a data repository and analytical tool for use by the USDA Forest Service. This article has reported our methods for collecting, processing, and integrating historic map data into a GIS project file. Beyond obtaining maps of the appropriate scale and specificity, the Finger Lakes National Forest Archaeology Project goals required that historic map data be processed to allow for settlement analysis as well as digital storage. These goals were accomplished by digitizing historic settlement data in both static and dynamic ways so as to maximize the contribution of historic maps to the GIS database.

Additionally, we have presented our analysis of Hector dwelling patterns using simple correlations generated by GIS. Our findings suggest that environmental determinants, social factors, and historical contingencies were thoroughly entwined in creating the specific trajectory of Hector settlement between 1857 and 1944. One could argue that social forces dominated the shift of dwellings away from Military Tract roadways, which were entirely social features. In fact, the grid, while a social artifact, affected Hector's long-term settlement patterns in profoundly environmental terms. Primary roads associated with the grid cut straight through some of the steepest and least agriculturally viable terrain on the Backbone. With initial settlement gravitating toward these grid-based primary roads, the region's most fragile lands were subject to proportionately more damage than more stable lands in the flatter lowlands. Exacerbated by a westward-moving center of gravity in overall American settlement and trade patterns, mismanagement of Hector's limited resources plunged the formerly prosperous Finger Lakes National Forest area into serious depression by the turn of the 20th century. The study area was targeted for government reclamation as a delayed but direct result of the combined implications of this westward expansion and local environmental degradation. The government intervention spawned by these economic and environmental disasters may have curtailed the settlement options of Hector's residents by 1944, but as the distribution of 1944 dwellings shows, some measure of personal choice—impossible to measure archaeologically—remained. Thus, while restricted in scope, the Hector case study contributes valuable insight into the complexities of settlement pattern analysis, and particularly its interpretive challenges.

Clearly, the manner in which historic map data is collected, integrated into a GIS file, and interpreted will vary from project to project, shaped by individual research objectives and the constraints posed by available technologies and funding. It is the authors' hope, however, that the Finger Lakes National Forest

Archaeology Project will serve as a useful example for others facing the difficulties and opportunities posed by historic map data in interpretive applications of GIS.

References

Adams, Richard McC.
1965 *Land Behind Baghdad: A History of Settlement on the Diyala Plains.* University of Chicago Press, Chicago.

Allen, Kathleen M.S.
1990 Modeling Early Historic Trade in the Eastern Great Lakes using Geographic Information. In *Interpreting Space: GIS and Archaeology,* ed. by Kathleen M.S. Allen, Stanton Green, and Ezra B.W. Zubrow, pp. 319–329. Taylor and Francis, London.

Beach, Nicholas
1874 *Atlas of Schuyler Co., New York.* Pomeroy, Whitman & Co, Philadelphia.

Beers, S.N.
1857 *Map of Schuyler Co., New York, with Plans of the Villages.* J.H. French, Syracuse.

Binford, Lewis R.
1984 Hunters in a Landscape. In *In Pursuit of the Past: Decoding the Archaeological Record.* Thames and Hudson, New York.

Carmichael, David L.
1990 GIS Predictive Modeling of Prehistoric Site Distributions in Central Montana. In *Interpreting Space: GIS and Archaeology,* ed. by Kathleen M.S. Allen, Stanton Green, and Ezra B.W. Zubrow, pp. 216–225. Taylor and Francis, London.

Clark, Philip J., and Francis C. Evans
1954 Distance To Nearest Neighbor As A Measure Of Spatial Relationships In Populations. *Ecology* 35(4): 445–453.

Crane, Steven and Richard Perry
1977 Report: Archaeological-Historical Survey, 1976-1977, Hector Land Use Area in Town of Hector, Schuyler County, Towns of Lodi and Covert, Seneca County, New York. Manuscript on File, Hector Ranger Station, Hector, NY.

Cronon, William
1983 *Changes in the Land.* Hill and Wang, New York.

Davidson, Thomas E.
1986 Computer-Correcting Historical Maps for Archaeological Use. *Historical Archaeology* 20: 27–37.

Delle, James A.
1998 *An Archaeology of Social Space: Analyzing Coffee Plantations in Jamaica's Blue Mountains.* Plenum Press, New York.

Earle, Timothy K.
1976 A Nearest-Neighbor Analysis of Two Formative Settlement Systems. In *The Early Mesoamerican Village,* ed. by Kent V. Flannery, pp. 196–223. Academic Press, New York.

French, John H.
1860 *Gazetteer of the State of New York.* 5th ed. R. Pearsall Smith, Syracuse.

Gordon, Thomas F.
1836 *Gazetteer of the State of New York.* T.K. and P.G. Collins, Philadelphia.

Hasenstab, Robert J.
1996 Aboriginal Settlement Patterns in Late Woodland Upper New York State. *Journal of Middle Atlantic Archaeology* 12: 17–26.

Hunt, Eleazer D.
1992 Upgrading Site-Catchment Analyses with the Use of GIS: Investigating the Settlement Patterns of Horticulturalists. *World Archaeology* 24: 283–308.

Jackson, Jack M.
1990 Building an Historic Settlement Database in GIS. In *Interpreting Space: GIS and Archaeology,* ed. by Kathleen M. S. Allen, Stanton W. Green, and Ezra B. W. Zubrow, pp. 274–283. Taylor and Francis, London.

Jackson, John B.
1984 *Discovering the Vernacular Landscape.* Yale University Press, New York.

Kvamme, Kenneth L.
1985 Determining Empirical Relationships Between the Natural Environment and Prehistoric Site Locations: A Hunter-Gatherer Example. In *For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique and Theory,* ed. by Christopher Carr, pp. 208–238. Westport Publishers, Kansas City.
1989 Geographic Information Systems in Regional Archaeological Research and Data Management. In *Archaeological Method and Theory, Vol. 1.,* ed. by Michael

B. Schiffer, pp. 139–203. The University of Arizona Press, Tucson.
1999 Recent Directions and Developments in Geographical Information Systems. *Journal of Archaeological Research* 7(2): 153–201.

Linebaugh, Dennis L.
1994 Settlement Patterning in the Grand River Valley, Ottawa County, Michigan: An Ecological Approach. In *Spatial Patterning in Historical Archaeology: Selected Studies of Settlement*, ed. by Dennis L. Linebaugh and Gary Robinson, pp. 139-175. William and Mary Center for Archaeological Research, Occasional Papers in Archaeology, 2, The College of William and Mary, Williamsburg.

Meinig, Donald W.
1979 *The Interpretation of Ordinary Landscapes: Geographical Essays*. Oxford University Press, New York.

Mrozowski, Stephen A.
1991 Landscapes of Inequality. In *The Archaeology of Inequality*, ed. by Randall H. McGuire and Robert Paynter, pp. 79–101. Basil Blackwell, Oxford.

Nelson, Lee H.
1971 *Dictionary Catalog of the Map Division*. 10 Vols. G.K. Hall and Co., Boston.

O'Callaghan, Edmund B.
1849 *The Documentary History of the State of New York, Vol. I*. Weed, Parsons and Co., Albany.

Parkerson, Donald H.
1995 *The Agricultural Transition in New York State: Markets and Migration in Mid-Nineteenth Century America*. The Henry A. Wallace Series on Agricultural History and Rural Life. Iowa State University Press, Ames.

Paynter, Robert
1982 *Models of Spatial Inequality: Settlement Patterns in Historical Archaeology*. Academic Press, New York.

Ravenhill, William, and Andrew Gilg
1974 The Accuracy of Early Maps? Towards a Computer Aided Method. *Cartographic Journal* 11: 48–52.

Roberts, Brian K.
1996 *Landscapes of Settlement: Prehistory to the Present*. Routledge, London and New York.

Robinson, Gary G.
1994 Material Culture and Settlement Pattern among the Germans in the New World: The View from Frankenmuth, Michigan. In *Spatial Patterning in Historical Archaeology: Selected Studies of Settlement*, ed. by Donald W. Linebaugh and Gary G. Robinson, pp. 91–116. William and Mary Center for Archaeological Research, Occasional Papers in Archaeology, 2. The College of William and Mary, Williamsburg.

Rodman, Margaret
1992 Empowering Place: Multilocality and Multivocality. *American Anthropologist* 94(3): 640–656.

Rubertone, Patricia E.
1986 Historical Landscapes: Archaeology of Place and Space. *Man in the Northeast* 31: 123–138.

Sanders, William T., Jeffrey R. Parsons, and Robert S. Santley
1979 *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization*. Academic Press, New York.

Schlereth, Thomas J.
1990 *Cultural History and Material Culture: Everyday Life, Landscapes, Museums*. UMI Research Press, Ann Arbor.

Shennan, Stephen
1988 *Quantifying Archaeology*. 2nd ed. University of Iowa Press, Iowa City.

St. George, Robert B. (ed.)
1988 *Material Life in America: 1600–1860*. Northeastern University Press, Boston.

Stafford, C. Russel. and Edwin R. Hajic
1992 Landscape Scale: Geoenvironmental Approaches to Prehistoric Settlement Strategies. In *Space, Time, and Archaeological Landscapes*, ed. by Jacqueline Rossignol and LuAnn Wandsnider, pp. 137–161. Plenum Press, New York and London.

Stine, Roy S. and David P. Lanter
1990 Considerations for Archaeology Database Design. In *Interpreting Space: GIS and Archaeology*, ed. by Kathleen M.S. Allen, Stanton Green, and Ezra B.W. Zubrow, pp. 80–89. Taylor and Francis, London.

Stone, J.C. and A.M.D. Gemmell
1977 An Experiment in the Comparative Analysis of Distortion on Historical Maps. *Cartographic Journal* 14: 7–11.

Terry, N.G.
1996 How to Read the Universal Transverse Mercator (UTM) Grid. *GPS World* 4/96: 32.

Thomas, David Hurst
1990 *Columbian Consequences, Vol. 3.* Smithsonian Institution Press, Washington, DC.

Tilley, Christopher
1994 *A Phenomenology of Landscape: Places, Paths, Monuments*. Berg, Providence.

Turner, Frederick J.
1899 *The Significance of the Frontier in American History*. University of Chicago Press, Chicago.

United States Geological Survey (USGS) National Mapping Program
1946 Topographic Quadrangles, 7.5 Minute Series, New York State, Trumansburg (1942).
1949 Topographic Quadrangles, 7.5 Minute Series, New York State, Lodi (1942).
1950a Topographic Quadrangles, 7.5 Minute Series, New York State, Bennettsburg (1944).
1950b Topographic Quadrangles, 7.5 Minute Series, New York State, Burdett (1944).
1950c Topographic Quadrangles, 7.5 Minute Series, New York State, Mecklenburg (1944).
1991 New York Index to Topographic and other Map Coverage. U.S. Department of the Interior, Washington, D.C.

United States Post Office (USPO) Department
1911 Map of Schuyler County, New York, Showing Rural Postal Delivery Service Routes. U.S. Post Office Department, Washington, D.C.

Upton, Dell
1990 Imagining the Early Virginia Landscape. In *Earth Patterns: Essays in Landscape Archaeology*, ed. by William Kelso and Rachel Most, pp. 71–86. University of Virginia Press, Charlottesville.

Vlach, John. M.
1993 *Back of the Big House: The Architecture of Plantation Slavery*. University of North Carolina Press, Chapel Hill.

Wallace, Anthony F.C.
1970 *The Death and Rebirth of the Seneca*. A.A. Knopf, New York.

Warren, Robert E.
1990 Predictive Modeling of Archaeological Site Location: A Case Study in the Midwest. In *Interpreting Space: GIS and Archaeology*, ed. by Kathleen M.S. Allen, Stanton Green, and Ezra B.W. Zubrow, pp. 201–215. Taylor and Francis, London.

Wheeler, Mary A.
1935 *New York State Yesterday and Today*. Charles Scribner's Sons, New York.

Willey, Gordon R.
1953 *Prehistoric Settlement Patterns in the Viru Valley, Peru*. U.S. Government Printing Office, Washington, D.C.

Zubrow, Ezra B. W.
1990 Modeling and Prediction with Geographic Information Systems: A Demographic Example From Prehistoric and Historic New York. In *Interpreting Space: GIS and Archaeology*, ed. by Kathleen M.S. Allen, Stanton Green, and Ezra B.W. Zubrow, pp. 307–329. Taylor and Francis, London.

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