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Introduction to the Finger Lakes National Forest Archaeology Project

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This volume presents research conducted at the convergence of two projects: the first a survey, inventory, and assessment of historic sites located within the boundaries of the Finger Lakes National Forest, a small national forest located in central New York; the second a pedagogical experiment conducted in the spring of 1998, the goal of which was to assess how a rather typical CRM project could be used to train archaeology graduate students in manipulating Geographic Information Systems (GIS) technology to control and interpret archaeological data. This convergence resulted in the construction of a GIS-based data management system for historic-period cultural resources in the Finger Lakes National Forest. In this volume we demonstrate through our case study how we used ArcView, a desktop GIS system, to create an interactive data management system for historic sites located in the Finger Lakes National Forest. In doing so we simultaneously demonstrate how we used the data collected for the construction of our database to interpret settlement and landscape changes that resulted from social changes affecting the farming community of this small part of central New York during the late-19th and early-20th centuries.

In the late summer of 1997, Dave Lacy, Forest Service archaeologist responsible for site management in both the Finger Lakes (New York) and Green Mountains (Vermont) National Forests, contacted the lead author (Delle), an historical archaeologist who then resided in the Finger Lakes region, to discuss the feasibility of updating the inventory of historic sites located within the boundaries of the Finger Lakes National Forest. Although an inventory of sites had been compiled in the mid-1970s by two scholars then teaching in New York State, neither was a trained historical archaeologist; Steven Crane was a historian with an interest in historic preservation, Richard Perry was a trained cultural anthropologist with an interest in Native American culture history (Crane and Perry 1977). While Crane and Perry had conducted a thorough survey of the Finger Lakes National Forest and had submitted a report to the US Forest Service, their report did not meet current standards and was of little current use to the Forest Service. Lacy and Delle agreed that the Forest Service required more specific information about the location of historic sites so that the impact of day-to-day forest service activities on historic sites could be better mitigated. These activities include the construction and maintenance of hiking trails and bridle paths, logging, and cattle grazing. As a software package known as ArcView GIS had been used on previous projects in the Finger Lakes National Forest to digitally plot such ecological variables as drainages, land cover, and bird habitat within the forest (see Falconer 1998), it was decided that the best way to proceed with modernizing the archaeological database would be to create a series of GIS-based archaeological layers or themes in ArcView. This would create a GIS-based data management system for the cultural resources located within the forest compatible with environmental data already processed. So was born the Finger Lakes National Forest Archaeology Project.

This field project coincided with an experiment in graduate pedagogy. Beginning in January 1998, Delle organized a graduate seminar titled "Spatial Techniques in Archaeology" at New York University, where he was employed as a Visiting Assistant Professor during the 1996-97 and 1997-98 academic years. The seminar included graduate and undergraduate students from NYU, as well as several graduate students from Columbia University. The goal of the course was twofold: to introduce the students to archaeological applications of GIS, and to construct the GIS-based data management system for the Finger Lakes National Forest. The experiment was to discern how well the Finger Lakes CRM project could be used as a training exercise for the seminar participants. The students enrolled in that seminar were each assigned a specific class of information to enter into the database, including historic map data, the artifact catalogue of the surface collections, digital images (both photographs and drawings) of artifacts contained in the artifact catalogue, the CAD drawings of the farmsteads that were mapped during the inventory and assessment, and historic information drawn from title chain research conducted on the various properties that have been incorporated into the Finger Lakes National Forest. Each student was responsible for developing a design by which their data set could be integrated into the overarching GIS database structure designed by James Delle, Mark Smith, and Patrick Heaton. It should be noted that it was not the intent of the project to digitize every available data source, as such would be beyond the scope of a semester-long project. Rather, a GIS database architecture was constructed with the most readily available data, in the hope that future researchers could build upon the existing database by entering other as yet untapped sources of data resulting from excavations and more thorough documentary research. It should also be noted that time and resource constraints did not allow for a new systematic survey of the entire forest property. Rather, the team relocated the sites previously identified by Crane and Perry, georeferencing and mapping previously unrecognized sites as they were located during the course of mapping the previously known sites.

The final product of this project is an integrated GIS database which can now be used by the Forest Service to manage data concerning the historic sites so far identified in the Finger Lakes National Forest. This volume describes how this was accomplished and suggests how historical archaeologists can use GIS to control and interpret data on a regional scale.

What is GIS?

Computer software packages known as geographic information systems (hence the acronym "GIS") allow for the management, display, manipulation, and analysis of nearly any kind of spatially referenced data. GIS is analogous to an interactive map, displaying features as they are related in space. Unlike computer aided drafting (CAD) programs, which also create maps, GIS links database information to map features so that the visual "map" display becomes an analytical medium for the researcher to investigate relationships between and among data sets. GIS is therefore useful to archaeologists in numerous ways, including the recording and analysis of the spatial patterning of artifact distributions.

The underlying principle of GIS is that it can model spatial components of data without severing them from other database characteristics. While some data attributes can be displayed spatially on maps, they retain links to other database attributes allowing for detailed analyses. In other words, although GIS creates maps that can be printed, a GIS project differs from a simple map because the software knows that the miscellaneous components of the map are linked to database information, and the software has the ability to query that information and use it. The researcher cannot only examine the spatial layout of information but can query the map for characteristics and relationships of the data. Large collections of research data with multiple attributes can be easily organized and reorganized for scientific investigation, and analyses can be quickly performed and evaluated.

GIS is extremely versatile. GIS projects can model data in countless ways that exploit the computer's ability to recognize and layer spatial data. The actual tools of GIS analysis are equally diverse. The geographic (map) display of GIS shows variables in their spatial relationship. Statistical calculations can be run on variables to establish comparative arguments or to define sets of features for further analysis. Features with similar characteristics can be highlighted, the distances between them calculated and displayed, and distance frequencies graphed. High volumes of information with incongruent properties can be modeled and explored. Thematic layering of data lets

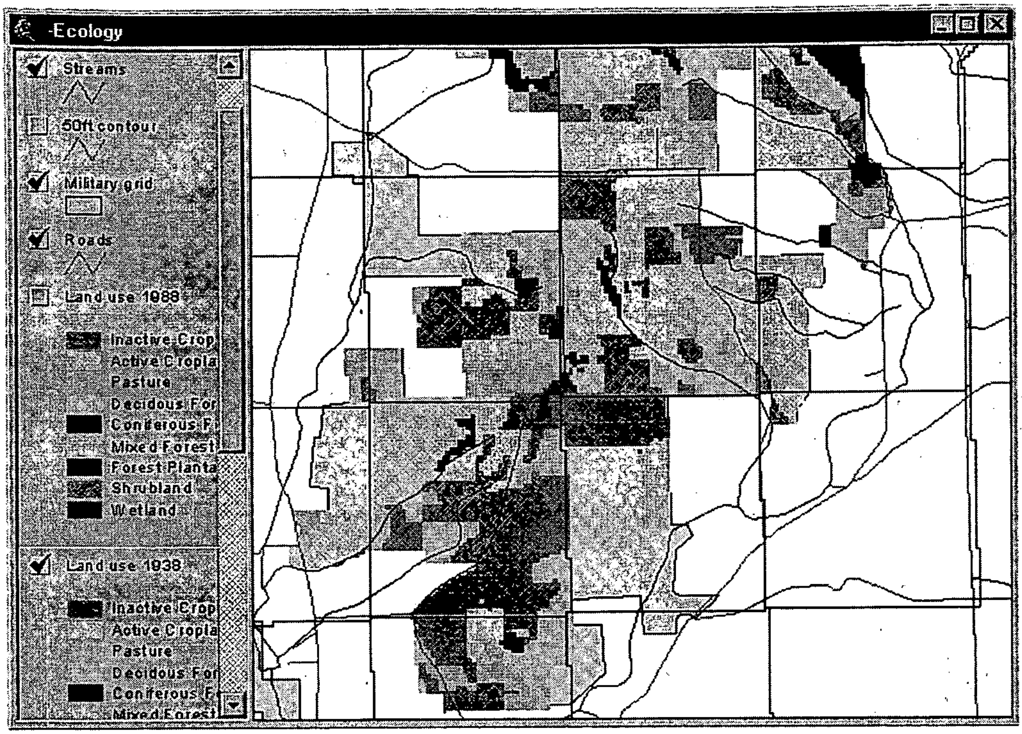

Figure 1. An example of layering, and how themes can be turned on or off. In this case, those themes listed in the left with a check mark are turned on, all others are turned off.

archaeological characteristics be ordered and reordered for easy analysis.

Since the analytical potential of GIS is almost unlimited, one should have a working idea of how GIS manages data in order to exploit its capabilities. The powers of the analytical tools in a GIS project are related to how the database is organized. GIS links tabular data to spatial features, and classifies features by themes. Collections of data in GIS analyses are managed around common themes. The process is analogous to having different types of transparent images layered over top of each other. The researcher adds data to a project by adding a thematically organized layer. A single GIS project may have many layers of data, each with a common theme that associates the features. The multiple layers in a project can be turned on or off as desired (FIG. 1). In an archaeological project, for example, one layer (called a "theme") may be architectural remains from a discrete temporal phase, another the location of all recovered ceramics, and still another architectural remains dating to a later period. These layers can all be viewed at once, superimposed on each other, to see the total dispersion of cultural features. Alternatively, they can be turned on and off, and utilized selectively by the researcher to examine the changes from one period to the next. Layering of features is especially helpful when multiple classes of information are used in the same project, such as images, drawings, and pin-maps (these concepts and terms are discussed more thoroughly in the appendix). Thematic layering provides structure to the spatial (map) data, allowing features to be viewed and analyzed selectively. At this simplest level, GIS can be used to visually analyze the relationships between such kinds of data.

GIS can also analyze the relationships between spatial features within a single layer, as the software links database information to these features. For example, specific points on a GIS theme can be linked to tabular data. In our case study we created several themes, each dating to a different decade, in which the property boundaries of farmsteads were depicted as polygons. Each polygon was then linked to a table indicating property values for the parcel according to tax records. GIS can take this tabular data, recorded using Microsoft Excel spreadsheet software, to compare changes in property values over time for the entire sample. In doing so, the GIS software imports the tabular data from independent spreadsheet files each time such a query is made. The spreadsheet data remains independent, thus can be constantly updated without necessarily accessing the GIS program. This results in great flexibility, as GIS can access files in an astounding array of formats, including database files, spreadsheets, jpeg, gif and other graphic files, and AutoCAD files.

Archaeological Applications of GIS

The use of geographic information systems in archaeology has had a longer history than many suppose, reaching back to the early 1980s when affordable micro-computers first became available to academic institutions and cultural resource companies. The history of GIS in archaeology has been discussed in depth by Kvamme (1989; 1999) and Aldenderfer (1996). While we do not wish to replicate these thorough reviews of archaeological applications of GIS, a general overview of the ways in which archaeologists have utilized the technology is valuable in contextualizing this study.

Among the earliest uses of GIS in archaeology was the creation of regional databases, a tradition we follow in this project. Archaeologists quickly grasped that GIS could combine the capabilities of digital database programs with advanced graphic output, creating maps with a linked body of data. Regional databases could then be created which combined such factors as spatial distribution of sites (i.e. the map) with listings of cultural information and environmental data. The construction of such databases had obvious benefits to government agencies charged with managing large areas of land, and many of the early uses of GIS for this purpose involved cultural resource management projects across large expanses of publicly owned land (see Brown and Rubin 1982; Overstreet et al. 1986; Westervelt, Thomas, and Bettinger 1986; Calamia 1986). Within the framework of historical archaeology, the study of settlement patterns within what is now Fort Hood, Texas stands out as one of the earliest uses of GIS (Jackson 1990). Besides well illustrating the steps of constructing a historical database in GIS, Jackson's study reveals how the large amount of documentary data with which historical archaeologists deal can be integrated into these programs. Also, Jackson emphasizes how GIS is useful in the study of historical settlement patterns as the use of space becomes increasingly complex with the inclusion of transportation means that were unknown in the prehistoric period (Jackson 1990: 275). GIS is ideally suited to applications such as these, and many state agencies have begun to construct large databases to manage their efforts at historic preservation (e.g. Aldenderfer 1996; Armstrong, Wurst, and Kellar 2000). Likewise, European countries have recently become interested in creating large computerized storehouses of their archaeological sites, a process intricately described in Bosqued, Preysler, and Expiago (1996). The goal of this latter project is to create a database for the Spanish government that would not only contain information on all of the archaeological sites in the country, but would aid the rescue of sites in danger of being destroyed by development.

GIS has successfully been used to control and interpret satellite and aerial photography collections. The powerful mathematical transformation abilities of GIS are quite capable of correcting the complex geometry involved in rendering remotely sensed images and applying them to larger datasets (Custer et al. 1986; Loker 1996). The large areas recorded in these images and the frequency with which they are updated can provide enormous amounts of information on the regional environment. Combining this with small scale studies of local settlement and environmental patterns have enabled multi-scalar analyses that were previously quite difficult to undertake. These remote sensing applications of GIS have also included the analysis of geophysical prospection data, which benefits greatly from the spatial transformations and mathematical filtering of GIS (Boyle and Schurr 1997; Boyle 1998). The ability to combine information from geophysical surveys with regional archaeological and environmental data in one GIS program allows for a meaningful contextual interpretation of prospection results.

Often these regional analyses involve correlating specific environmental factors with the spatial patterning of archaeological sites. For this reason, many of the large regional databases created with GIS have a number of environmental factors built into their structure to reflect the environment in which archaeological sites are found. Until the advent of GIS, it was difficult to compare multiple variables, such as ground slope, proximity to water sources, soil characteristics and vegetative cover to the local settlement patterns; few studies that did so were very convincing (Kvamme 1989: 168). Researchers have found correlations between specific environmental factors and site locations using GIS, such as in Kvamme and Jochim's (1989) study of Mesolithic sites in Germany. This data set enabled the investigators to conclude that Mesolithic sites were located predominantly on level ground, at higher elevations, and in areas of greater local relief. Similar studies have been performed in a number of different areas using vastly different types of environmental and biophysical data (see Hasenstab 1996; Kvamme 1985). As this approach has come under criticism for its dependence on quantifiable environmental variables (Wheatley 1993), recent studies have attempted to more closely integrate social factors into the analysis of spatial patterning. This is admittedly a much more difficult and contentious enterprise, but recent work has shown a promising future for the use of GIS in this regard. For example, Allen (1996) combined factors of environmental variability, namely data reflecting agricultural suitability, with archaeological and ethnohistorical sources to describe the changing patterns of land use among the Iroquois of northern New York. Her conclusion shows how understanding environmental variables helps to explain the selection of particular sites for Iroquoian villages without supplanting equally important cultural factors.

Perhaps the best known application of GIS within archaeology, predictive modeling, is a direct outgrowth of early regional analyses. By examining the environmental conditions characteristic of sites found within a particular area, predictive models have been constructed in GIS using multivariate methods, log-linear modeling, and spatial statistics that predict the unsurveyed areas where archaeological sites are most likely to be found. This process has been reviewed by Kvamme (1989; also see Kvamme 1983, 1984, 1986, 1988; Parker 1985). As was the case with ecological analyses, the use of GIS to create predictive models has been heavily criticized by a number of archaeologists as being too environmentally deterministic. For example, Wheatley (1993) argues that by focusing exclusively on environmental factors in these predictive models, researchers have adopted an outdated ecological framework to explain human action, resulting in a simplistic systems theory approach which views humans as but single components in an ecologically determined world. Wheatley argues for the use of a contextual approach to the understanding of past landscapes, one in which the cultural perceptions of the people in question are included in the analysis. This is not meant to imply that environmental factors do not play a role in settlement patterning, instead a more complex reading of the past is needed to move beyond a purely functionalist framework (Wheatley 1993: 137).

In response to criticisms like those leveled by Wheatley, recent work in locational modeling and regional environment studies has attempted to incorporate more contextual information, often in the form of cost-surface and viewshed analyses. These two techniques have added a further dimension to the study of past landscapes by analyzing terrain in terms of accessibility and including first-person perspectives of the environment. Cost-surface techniques of landscape analysis have the ability to extrapolate the cost of traveling over certain types of terrain by analyzing slope, ground cover and any other variable deemed significant by the investigator. This has resulted in attempts to study archaeological space as it was experienced by the people who moved through it. Combining terrain slope with ritual avoidance of long barrows in Neolithic England allowed Wheatley (1993) to create a cost-surface analysis that showed a very different landscape than one perceived solely through topography. Madry and Rakos (1996) have analyzed the variables involved in Celtic road construction in France by combining environmental factors such as ridgelines and slope with cultural factors such as the ability to see a hill-fort while traveling, which involves both cost-surface analysis and a viewshed calculation. A viewshed is, in a sense, a cumulative line-of-sight calculation, in which everything on a map that can be seen from one point is calculated and rendered graphically. This has become a common way to envision past landscapes, particularly those with a presumed spiritual or religious character. For example, Gaffney, Stancic, and Watson (1996) have analyzed the visibility of barrow cemeteries on the island of Hvar to determine whether their placement was determined by geographic prominence or other cultural factors. They also investigated the relationship between a number of Neolithic monuments in Kilmartin, Scotland to determine if intervisibility affected their placement. A similar study in Scotland by Ruggles and Medyckyj-Scott (1996) describes the role of GIS in analyzing "ideological landscapes" through a Bayesian, as opposed to statistical, approach. Delle (2000 and 2002) has similarly used viewshed analysis in the Negro River Valley of Jamaica to model how historic landscapes were used to reinforce plantation-based social hierarchies. These studies have shown both that GIS is quite capable of tackling "fuzzy" data sets that are not necessarily empirical or exclusively ecological variables and that GIS can be used for analysis as well as predictive modeling.

It is apparent that GIS has become a theoretical as well as a methodological tool used with increasing sophistication by a number of archaeologists. In the past fifteen years of use, the kinds of data that archaeologists have analyzed through GIS have grown immensely from simple environmental data to complex issues surrounding perception and cognition. Nevertheless, the utility of GIS has not been realized by many historical archaeologists; very few published studies in this field have utilized any aspect of GIS. This is somewhat surprising considering that GIS excels in handling exactly the types of data with which historical archaeologists most frequently deal, such as historical maps, census data, probate inventories, and spatially recorded archaeological data. The inherent flexibility of GIS enables archaeologists to set their own parameters of study—to define what it is one is looking for in a particular region and gather information in a quick and convenient manner. The data structure of GIS (see Appendix) allows multiple data types to be compared and analyzed, allowing a level of analysis that was unknown or difficult before the advent of these programs. In this organizational respect alone, GIS has the potential to revolutionize the practice of historical archaeology.

Archaeology in The Finger Lakes National Forest

With past applications of GIS and their critiques in mind, the Finger Lakes team set out to design a study that incorporated not only ecological, but also cultural and economic variables into a GIS database. Before discussing how such variables were integrated into the study, we provide some context for the project through a brief overview of the Finger Lakes National Forest Archaeology Project.

The Finger Lakes National Forest is a multiple use land management area created out of over 130 agricultural properties purchased by the federal government over the course of the past six decades (FIG. 2). Consisting of 16,176 acres of forest and pasture, the national forest straddles a formation known as the "Hector Backbone," a large ridge running north-south, approximately halfway between Seneca and Cayuga Lakes, the two largest of New York's Finger Lakes; the southern extent of the Backbone is a formation known as Burnt Hill (FIGS. 3 and 4). The Hector Backbone is a glacially formed ridge of sandstone bedrock,

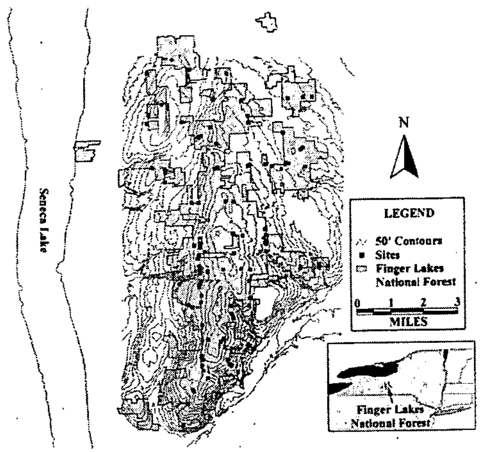

Figure 2. Map of the Finger Lakes National Forest generated by ArcView. The shaded area delimits the boundaries of the forest; each black square represents the georeferenced location of a farmstead site located during the survey.

covered by a thin veneer of clay and clay-sand topsoil of relatively poor agricultural potential. The land within the boundaries of the national forest was classified according to the 1929 New York State Reforestation Amendment as Class I and II agricultural areas: "sub-marginal" farm land.

The forest is managed by the USDA Forest Service through the Hector Ranger District, and is presently used for public recreation, cooperative livestock grazing, wildlife and timber management, education, and research (USDA 1987). Prior to its becoming federally managed land, the territory making up the Finger Lakes National Forest was a patchwork of privately owned farmsteads. These farmsteads originated in the early- to middle-19th century, and were abandoned and sold to the government in the 20th century. The remains of these farmsteads constitute an archaeological record of cellar holes, barn and outbuilding foundations, artifact scatters, and field boundary walls readily visible on the landscape.

The majority of the land now comprising the Finger Lakes National Forest is located in two townships encompassing parts of two counties: Hector township to the south, in what is now Schuyler County (once part of Tompkins County), and Lodi township to the north, located in Seneca County. As the Finger Lakes National Forest was constructed out of farmsteads purchased one by one from individual landowners, it is not a fully contiguous property. The US government has been able to acquire significant portions of contiguous land on and around Burnt Hill. As one travels to the north, the slope of the ridge eases and the farmland improves in quality; the government has been less successful in acquiring contiguous properties to the north. As a result, the northern third of the Finger Lakes National

Figure 3. The Hector Backbone, as viewed from the East (photograph by James Delle).

Figure 4. Burnt Hill, as viewed from the South (photograph by James Delle).

Forest is a patchwork of properties, some owned by the Forest Service, others still in the possession of private landowners and farmed to this day. This project was limited in scope to government land. Though our database encompasses the entire forest, our analysis is restricted to 51 formerly independent properties and 25 recorded archaeological sites, situated in the most contiguous part of the National Forest. This area comprises approximately the southern third of the current federal land, referred to throughout this volume as the Burnt Hill Study Area (FIG. 5).

Project Methodology

Because our project received little outside funding, the scope of our investigations had to be limited to those sources of data most readily available. Acquisition of documentary data was largely limited to those sources curated in the Hector District Ranger Station, which primarily consist of the records of federal acquisition of specific properties. The majority of the properties which became the Finger Lakes National Forest was acquired as part of a New Deal program to buy out farmland from impoverished farmers. As the government acquired properties, Soil Conservation Service employees conducted title chain research to establish the extent of encumbrances on the farms. To establish the value of the properties, the government conducted inventories to assess the value of improvements on the farmsteads. The records of these transactions contain abstracts of these title chains, many of which trace ownership back to the original 18th-century allotments. The inventories of improvements often contain brief descriptions and valuations of the houses, barns, and outbuildings located on the property, and occasionally include manuscript survey maps identifying the boundaries of the property and the locations of structures. Unfortunately, the quality of these documents is far from consistent from case to case; Patrick Heaton details other types of documents used in this study in his article on the finances of farmsteads (this volume). In addition to these documents, several 19th-century county maps exist for both Seneca and Schuyler Counties; Karen Wehner and Karen Holmberg discuss these in more detail in their analysis of settlement patterns of the Burnt Hill area (this volume).

Locational Methods

As financial and labor constraints prohibited us from conducting a new comprehensive survey of the forest, the archaeological survey conducted in the Finger Lakes National Forest used the long abandoned locational data from Crane and Perry's 1977 report as a starting point to re-locate historic farmsteads. While their information was generally useful, it was usually very brief. Most sites were described in a sentence or two; many were referenced to

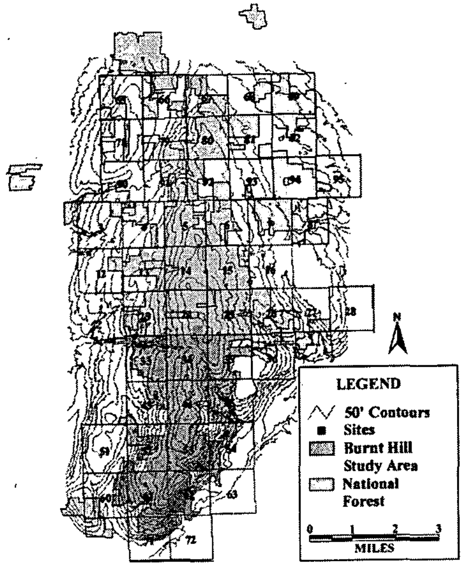

Figure 5. Several layers of data generated by ArcView. The darker shaded region to the south represents the Burnt Hill Study Area and the numbered squares represent the Military Tract compartments initially surveyed in the late-18th century. Note the county line approximately one-third of the way from the northern limits of the forest; this is the area where the compartments seem to be offset by one-half mile.

landmarks no longer visible on the landscape and all were referenced to a forest service map upon which site locations were imprecisely scrawled in pencil. All of the sites were located either in secondary forest, and thus required significant clearing of underbrush before we could map them, or in pastures leased by the Forest Service to a local grazing cooperative. On more than one occasion the archaeologists had to interrupt their work at the insistence of a bull! Many of the sites located in pastures were visible from the road, but the cellar holes of both the houses and the outbuildings were filled in; no surface scatters were located in any of the pasture sites. Crane and Perry's descriptions often recorded the presence only of house foundations. Whenever a cellar hole was re-discovered, the archaeological team spread out to locate and map any evidence of barns and other outbuildings. Numerous sites that Crane and Perry missed completely were also discovered, both in pastures and the woods.

In all, we located and mapped 104 sites in the Finger Lakes National Forest. In order to spatially relate these sites to each other, and to other physical and cultural geographical features, UTM (Universal Transverse Mercator) coordinates were collected using a handheld Global Positioning Systems (GPS) receiver, a device which receives coordinate data from 24 U.S. Department of Defense satellites orbiting the earth (Hofmann-Wellenhof, Lichtenegger, and Collins 1993; Leick 1995: 1). In theory, GPS can provide constant position determination anywhere on the globe at any time. In practice this is limited by the type of receiver used to pick up the GPS signals and assorted environmental factors, such as cloud cover, overhead vegetation and restrictive terrain.

While a very useful tool GPS has a number of limitations. The most accurate GPS systems can cost upwards of $10,000, and currently require specialized software to compensate for natural degradation in the satellite system and for what the Department of Defense calls "selective availability," intentional mis-measurements recorded by the system as a measure to prevent precision placement of explosives by terrorists and other miscreants. While handheld systems are very affordable, they do not compensate for these factors which result in minor, but significant, reductions in accuracy. At the time of our survey, government encryption of GPS readings resulted in our handheld unit receiving data with a 5-15 meter interference (margin of error), that is generated randomly when each point is taken. Thus, every UTM coordinate taken had a different margin of error. To compensate for this, we took two to three readings for each coordinate, and averaged them. While this simple technique could not compensate for the entire margin of error, we felt this reduced the error significantly enough for our purpose of georeferencing site locations within the GIS database.

When determining how we would collect this locational data, GPS seemed the logical choice, as the 104 sites are dispersed across 16,176 acres and the process of getting precise relative data from conventional surveying methods would have been too time consuming. By using GPS to provide UTM coordinates for each site, the location could be linked to pre-existing GIS layers already in use by the Forest Service. Our approach to mapping depended on the accuracy of the GPS unit available to us. We were confronted with the question of whether it would be cost effective to use a large, multiple receiver system to measure all the archaeological remains to the nearest fraction of a meter or utilize a cheaper and less accurate receiver to only place the site at its relative position within the forest and use conventional means to map the sites. We opted for the latter choice—to utilize a less expensive (and more portable) GPS receiver to record one measurement that would represent the base point for the site and take all measurements of the observable archaeological remains using tapes and a compass from that point (see Ladefoged et al. 1998 for information on the alternate method). We would then have one relatively accurate position within the site to apply to the GIS and a site map created with conventional tape and compass measurements. In practice, measuring the foundations of buildings by tape and constructing the maps at the same time was no more time consuming than taking multiple GPS readings and transferring them to paper later. Furthermore, the "pin-points" locating sites on the GIS maps at most of the scales we generated proved to be greater than 20 m in diameter, making the 5-15m margin of error moot. We thus felt comfortable choosing a less expensive, though less accurate, handheld GPS receiver.

The Garmin GPS receiver used in the project required less than 15 seconds to calculate the site's position and save the UTM coordinates in memory, quickly collected by one researcher while the site's visible features were mapped by several others. Although the satellite signal was downgraded by brush and tree growth, there were no sites where the vegetation was too thick to achieve a viable reading. Heavy cloud cover seemed to disrupt the signal, though this proved to be a minor inconvenience. The UTM coordinates were then used to link the site plans drawn in a computer aided drafting (CAD) program to the GIS, allowing researchers to quickly pull up a digital map of the site with a single mouse click on a hot-linked point on the GIS map.

Mapping Methods

The site record plans are the result of basic compass and tape surveys of features visible on the surface of the site. During some surveys a sonic distance-measuring device was also used to facilitate the quick, accurate production of these plans. In most cases the site plan includes all the visible components of a single farmstead. Typically, this consisted of the remnants of a house, a barn and various outbuildings. In most cases only visible surface scatters, significant topographic features, and architectural features were recorded. These latter included house cellars, the foundations of house extensions and ells, barns, barn extensions, wells, privies and various other outbuildings. The spatial relationships between these features and roads and streams were also recorded. Drawn at various scales, the site plans are not greatly detailed, but are adequate to record the size and configuration of a site's visible features, in addition to the spatial relationships between them.

From the beginning of the Finger Lakes National Forest Archaeology Project, even before the GIS implementation had begun, the field drawings of the site plans were digitized using AutoCAD. While AutoCAD is a standard application used generally by the archaeological community, a further advantage to our project is the fact that AutoCAD drawing files are a format widely supported by GIS programs. However, before AutoCAD drawings could be integrated into the GIS database, we needed to make several key decisions. The site plans can be imported into a GIS database in two conceptually different ways, each with its advantages and disadvantages regarding a site plan's utility as a tool for spatial analysis and/or presentation. The first method is to incorporate the AutoCAD site plan directly as a series of features on a layer or theme in the GIS project. As briefly mentioned above, we used this technique to incorporate property boundaries, originally drawn in AutoCAD, to the regional maps in the project database. The second method is to import the site plans as their own layer or view and then link them to a specific point in the regional view. This was the method chosen to add the AutoCAD site plans to the GIS project. The primary advantage of this method lies in the fact that the CAD drawings are linked to the project, rather than being imported and directly incorporated into a GIS layer. The very real benefit to this feature is that when changes are made to the original CAD drawings (additional information is added, corrections are made, etc.) these changes will automatically appear in the GIS the next time the project is opened, as the AutoCAD drawing remains an independent, though linked, component of the database.

Recovery and Deposition of the Artifact Assemblage

Our fieldwork included surface collections conducted at 11 of the 25 sites located within the Burnt Hill Study Area (FIG. 6). The collection of materials from these sites was not based on a rigorous sampling strategy; rather, sites were selected for collection based on the presence of large quantities of diagnostic artifacts. None of the sites was systematically sampled, as artifact recovery was not a priority of the project. The materials recovered from these sites were collected in order to establish a preliminary understanding of the archaeological potential of sites within the forest. All of the artifacts recovered were catalogued within the GIS database in order to inform future, more detailed, investigations of these sites.

The artifacts recovered during the project came from sheet refuse in the yard areas surrounding architectural features. Ceramic sherds, broken glass vessels, and occasionally agricultural implements were identified at many of the sites in the forest. Given the history of these sites, particularly their abandonment and subsequent demolition by the government in the 1930s and 1940s, these garbage scatters likely represent refuse disposal by the site's occupants immediately prior to or during their removal, though some undoubtedly are the residue of later dumping and bottle collecting activity. Early-20th-century dates assigned to many of the recovered objects tend to support these assumptions. Artifacts dated to the 19th century are assumed to have originated from earlier periods of occupation, but may have been discarded by residents at the time they left their

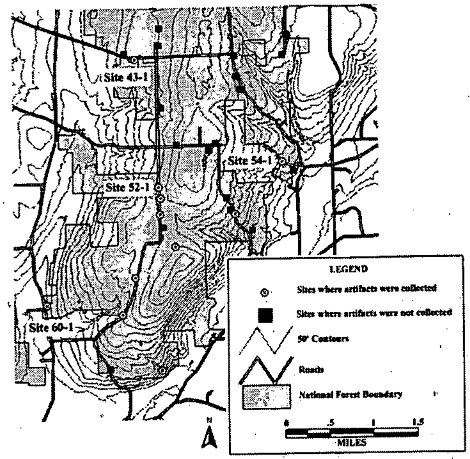

Figure 6. Map depicting the Burnt Hill Study Area of the Finger Lakes National Forest, with the location of sites where artifacts were collected. Sites referred to in the text are labeled by site number.

homes. The presence of numerous mid-19th-century artifacts in these scatters may suggest the financial limitations of the sites' residents to purchase newer consumer goods in the 20th century.

Constructing a GIS Database for the Finger Lakes National Forest

Our methodology resulted in the collection of an enormous amount of data on the 104 sites located in the 16,176 acres of forestland. However, before any of the information could be put to active use, the data needed to be integrated into a GIS format in an organized and accessible manner. Creating the structure of the GIS database thus needed to satisfy three organizational concerns: 1) managing a great deal of information from divergent sources; 2) keeping this collection of information interactive, versatile, and accessible so that it could be used and amended by the Forest Service staff; and 3) keeping the enormous data set well organized and accurate. The Finger Lakes National Forest covers an area of 16,176 acres, and it is still growing as the Forest Service acquires additional properties. The scope of information related to the historical archaeology of the area is accordingly large. GIS afforded the most systematic and effective means of integrating data from this vast area. Modern desktop GIS software allows informa-

Attributes of Ca1940prop.shp

Shape	ID	Tract #	Owner	Year sold	Acreage	Land value	Improvemen	Total valu
Polygon	1	53-95	Chesley, Jabez	1936	100	515.00	550.00	1065.00
Polygon	2	53-94	Creighton, Georg	1936	100	530.00	70.00	600.00
Polygon	3	53-89	Stachurski, John	1936	96	400.00	400.00	800.00
Polygon	4	53-90	Smith, Henry M.	1936	76	517.00	590.00	1107.00
Polygon	5	62-93a	Palmer, John G.	1936	95	635.00	600.00	1235.00
Polygon	6	61-97	Mattison, Frank	1937	130	1040.00	250.00	1290.00
Polygon	7	61-102	Dunham, Minor	1935	130	1132.00	215.00	1347.00
Polygon	8	61-265	Jennings, M. Del	1941	100	762.00	925.00	1687.00
Polygon	9	61-98	Fish, Eugene	1935	52	184.00	20.00	204.00
Polygon	10	61-94a	Creighton, Georg	1935	83	557.00	600.00	1157.00
Polygon	11	53-85	Hawkins, Anna	1937	122	675.00	625.00	1300.00
Polygon	12	53-83	Fraboni, Rinaldo	1936	55	300.00		300.00
Polygon	13	52-93	Palmer, John G.	1936	63	512.00	100.00	612.00
Polygon	14	52-253	Keep, Caleb M.	1939	20			0.00
Polygon	15	52-92	Williams, Mrs. W	1935	85	440.00		440.00
Polygon	16	53-84	Chesley, Jehiel	1939	120	1275.00		1275.00
Polygon	17	52-91	Van Scoy, Earle	1935	40	250.00	250.00	500.00
Polygon	18	52-104	Patterson, Georg	1936	40	200.00		200.00
Polygon	19	44-50	Voorheis, Willia	1936	21	88.00		88.00

Figure 7. Example of a table generated by ArcView. In this case, ArcView queried a number of tables linked to property ownership data at time of purchase by the US government.

tion from the survey, documentary research, site drawings, and artifact photographs to be accessed and manipulated easily. GIS was the only conceivable way to bring all this information together in a single format. The design of the GIS database is discussed more thoroughly in the appendix, but we briefly explain the basic terms used throughout the volume below to familiarize the reader with the rudiments of our GIS database.

The software used for this project, ArcView, consists of a graphic icon working environment similar to Windows, making it accessible to those with basic PC-based computer skills. For example, our project is organized such that the entire Forest layout can be viewed as a map (see FIG. 5). The software allows the user to see either a map of the entire forest, or to zoom in on any particular area of the map. ArcView allows the user to link tabular and graphic data to specific points on the map; tabular data can also be queried to generate new tables (FIG. 7). In our case, we created points for each of the sites we located, using the GPS data to position the sites by their UTM coordinates. We linked each site point to the relevant title chain data, CAD drawing of the site plan, the artifact catalog for that specific site (in tabular form), and scanned drawings and photographs of the recovered photographs from each site. By clicking a mouse on any of the sites, the user is able to view any or all of this data. Additionally, data can be linked to larger segments of the map. Because the area was divided into one-mile-square compartments in the late-18th century, and because the historic and modern road configuration based on that grid is visible both in historic maps and on the landscape (each compartment is numbered, as is often identified by number in historic maps and documents), we decided to use the compartments as an organization tool. To allow immediate access to some of the primary sources we used to create our GIS project, users can click on a military compartment and choose to see any one of the several historic maps we used, scanned and saved in the database by compartment number (FIG. 8).

Using ArcView is as easy as connecting to links on the world-wide-web. In fact, the application actually works by making links to pre-existing files and importing them into the GIS environment. Thus, if an archaeologist has created data files (either spread sheets or databases) or image files (like AutoCAD, jpeg, or Surfer images) ArcView can easily import these pre-existing files. The ArcView GIS reads its information in a linked format. The soft-

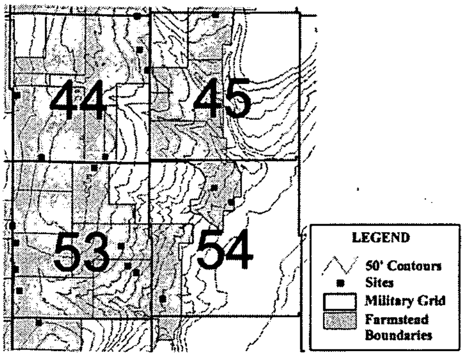

Figure 8. Zoomed in view of four Military Tract compartments located in Seneca County. This image depicts boundaries of farmsteads purchased by the US government, as well as archaeological sites located during the survey.

ware manages a project by accessing numerous files. It is like a translator, which can use the information, but keep it in its original format. The researcher can use a database file in a GIS analysis, and still have the original file available for use by a database software program if necessary. Say, for example, an artifact catalog is incorporated into the GIS. Because ArcView links directly to the file, the database can be updated in its original software package. Without telling ArcView that any changes were made, each time ArcView is opened, it will automatically open the updated database file. The GIS project can thus be continually updated without recreating links. GIS is therefore interactive to the end user and the researcher, providing versatility in analysis, long-term archival considerations, and general use. It is crucial, however, to maintain a consistent data structure on your computer; once links to files are created, the GIS will automatically search for the integrated files.

Conclusion

Piecing together the information on the historic settlement of the Hector Backbone required hundreds of person hours of research. Not only did the team need to collect project data from the field and from libraries across the State of New York, but investigating applications of GIS and creating the various elements of this GIS database required a separate attention and labor. As mentioned previously, the Finger Lakes Project was used as part of a graduate course at New York University to advance not only the project but also the professional development of graduate students. Because GIS is a burgeoning technology, there was a practical opportunity for students both to learn how to use the software and to explore the theoretical concepts involved with using GIS to model historic spatial phenomena.

The course was originally conceived as a way to explore spatial techniques in archaeology, primarily using GIS. The course content included some background readings on how spatial theory has developed in archaeology (e.g. Clark 1977; Delle 1998) but focused on a review of how GIS has been applied to archaeological questions. This required two things of the students: familiarization with GIS as a concept and archaeological tool and synthesizing past uses of the technology to our own research objectives and field methods. Some uncommon aspects of data collection and information management were employed specifically for GIS. For example, we used the GPS unit to collect satellite positioning data and constructed the artifact catalog specifically with the intention of using the information in the GIS database.

Students in the course took up the Finger Lakes project as a rare opportunity to engage in applied archaeology. Seminar participants acquired skills in desktop GIS that will become increasingly important as its use in archaeological investigation widens. Management and analysis of data using GIS has proven efficient, and a number of other computer applications to archaeological information were acquired along the way. CAD and imaging software, as well as the capabilities of modern relational database programs enhanced the knowledge of how information could be stored, processed, and manipulated.

The theoretical aspect of the Finger Lakes National Forest Project took shape as seminar participants found each of the course readings to be insufficient in one way or another. Part of the challenge was to take those critiques into consideration when designing the Finger Lakes GIS. Although under-utilized in historical archaeology, GIS lends itself well to the study of interesting historical issues. Time and space can be readily managed and manipulated. These tools have been exploited in various types of prehistoric archaeology, the most common being the development of locational models (Brandt, Groenewoudt, and Kvamme 1992), addressing cognition through the built environment (Zubrow 1994; Llobera 1996), and using GIS as an information management system (Lang 1993; Bosqued, Preysler, and Expiago 1996). As historical archaeologists, the seminar participants deliberately avoided the kind of environmental determinism which has traditionally limited the utility of GIS to historical archaeology.

Because the Continental Army had forcibly removed the indigenous Seneca and Cayuga Indians during the Revolutionary War, white settlement on the Hector Backbone did not involve frontier encounters with resistant Native Americans nor did it require novel ecological adaptations. The success and failure of American settlement on the ridge derived from the interface of the prevalent mode of production and the changing economic patterns of central New York during the 19th and 20th centuries. By the first quarter of the 20th century, the Hector Backbone had become so depressed that the national government initiated a buy-out plan. The end of successful settlement on the Hector Backbone was clearly a contrived economic maneuver—one that may have ultimately benefited the region and the country as a whole, yet was an orchestrated act which had a profound impact on the lives of the residents and of the area.

Using GIS, this project has attempted to track the circumstances and conditions in the Hector Backbone which led to such drastic government intervention. Although this project used environmental data to define the study region, we hoped to expand beyond simplistic ecological modeling, applying GIS to this historically interesting problem. Our project effectively allowed for the modeling of political economy in the area for a period spanning a century. Utilizing data from historical documents, the GIS allowed the information to be recreated in its spatial extent. Viewing the historical data for its spatial attributes allowed for increased control and insight in its analysis. With this methodology, correlations in the material could be isolated, and settlement progression across time easily modeled and explored.

The US Forest Service will benefit from the class and its efforts to learn and apply GIS technology. The Finger Lakes National Forest will now be managed with proper consideration of its archaeological remains. In addition, the Forest Service staff can use this resource to incorporate information on the historical archaeology of the Forest into recreational activities for the public and can easily add new data as it is discovered. Our collaboration with the Forest Service staff on various parts of the research demonstrates that joint efforts between university education and federal land management facilities can increase the knowledge and preservation of cultural resources throughout the United States.

Every project has its limitations. Although the Finger Lakes National Forest Archaeology Team collected and digitized data from the entire forest, time limits imposed by the semester-long seminar prevented the participants from completing a comprehensive analysis of the entire Finger Lakes National Forest GIS database which we had assembled. As we were constrained by the time limits of an academic semester, the team collectively determined that the best course of action was to collect and enter the entire data set, but to concentrate analysis on the Burnt Hill Study Area. Now that the entire data set is complete, it is the hope of our team that future students of historical archaeology in central New York can complete similar analyses on other abandoned neighborhoods within the Finger Lakes National Forest.

This volume is organized to demonstrate how a regional archaeological GIS database was constructed and how the database was used to interpret the historical and archaeological record of the abandoned farmstead community once located on Burnt Hill. In the following article Patrick Heaton augments this introduction to the project with an overview of the Euroamerican settlement history of the

Hector Backbone. Heaton follows this presentation with an account of how archival materials were used to interpret the changing nature of the agricultural political economy of rural New York in the 19th and early-20th centuries. Mark Smith and James Boyle use archaeological evidence to analyze the layout of farmsteads in the Burnt Hill Study Area. Karen Wehner and Karen Holmberg describe the various ways historic map data were used to analyze change in the rural settlement pattern of the Burnt Hill Study Area. The following article, by Janet Six, Patrick Heaton, Susan Malin-Boyce, and James Delle, analyzes the artifacts recovered during the surface collections of sites located in project area. The last article, by Thomas Cuddy, is an exploration of how one of ArcView's modules, the Spatial Analyst, can be used to help interpret various kinds of archaeological data. The appendix, by Thomas Cuddy, discusses the "how-to" element of the project, introducing those elements of ArcView integrated into our project and using our example to suggest guidelines on how to create a GIS project in ArcView. One goal of the appendix is to familiarize readers with GIS and ArcView terminology as well as the various elements of the application discussed in successive articles. Readers unfamiliar with the technology and terminology might wish to refer to the appendix from time to time.

It is the hope of the Finger Lakes National Forest Archaeology Team that this volume can be used as a model to be emulated by others using GIS to control and interpret archaeological data on a regional scale. It is also our collective hope that our project will encourage other historical archaeologists to develop new ideas about how to incorporate GIS technology into their work. As a means of concluding this introductory chapter, the entire team (James Delle, James Boyle, Tom Cuddy, Patrick Heaton, Karen Holmberg, Susan Malin-Boyce, Janet Six, Mark Smith, Noah Thomas, and Karen Wehner) would like to thank all of those who assisted in the completion of this project, including Dave Lacy, Lizzy Martin, Will Burdick, Corey McQuinn, Micah Monez, Jack Rossen, Mary Ann Levine, Rae Ostman, Kurt Jordan, Laurie Tedesco, and the staff and volunteers of the Hector District Ranger Station of the US Forest Service. Without their help this project would never have been completed.

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