

## 2 Recreating vanished mound groups in the upper Mississippi river valley (USA): integrating historic documents, CADD, and photogrammetric mapping

*Clark A. Dobbs*

### 2.1 INTRODUCTION

The Red Wing Locality is a dense concentration of Native American village and mound sites along the Mississippi River in Minnesota and Wisconsin (U.S.A.). The Locality encompasses 58 square miles and contained more than 2,000 mounds and earthworks, eight major villages, and dozens of smaller sites dating to the 11th and 12th centuries A.D. (Figure 2.1). These sites are associated with the emergence of corn horticulture in the Upper Mississippi River Valley and are related to the complex Mississippian cultures of the lower Midwest, most notably the premier site of Cahokia and other sites in the American Bottom of southwestern Illinois some 500 miles down river (see Baereis & Porter 1984).

The relationship between the Locality, situated on the northern frontier of Mississippian culture, and the American Bottom in the Mississippian heartland, remains unclear. Although it is obvious that there were strong ties between the occupants of the Locality and Cahokia, the character of this relationship and its evolution remains problematic. At present, there are several competing hypotheses that attempt to explain this situation. These include the suggestion that actual groups of people moved northward from Cahokia to settle in Red Wing, resulting in "site unit intrusion", the argument that the sequence at the Locality is the result of an "in-situ" development of local cultures and that the sites in the region were the result of Mississippian influence on a local population, and various permutations of these basic themes (see Griffin 1961; Gibbon 1974,

1979; Stoltman 1986; Dobbs 1989; Gibbon and Dobbs 1991; Stoltman 1991).

In 1983, the Institute of Minnesota Archaeology initiated a long-term program of research to address three broad questions based on these hypotheses: the character of the trade and interaction between the Red Wing Locality and Middle Mississippian cultures farther to the south; the transition from hunting and gathering to horticulture in the region; and the nature of human/land interaction during a period of climatic instability between ca. A.D. 900 and 1300.

Most of the earlier studies in the region were based on analysis of ceramics and other artefacts (e.g. Wilford 1945, 1952; Gibbon 1978, 1979) and it was apparent that a continued emphasis solely on artefact studies would not resolve the questions in which we were interested. After some consideration, we selected the methodology of settlement pattern studies to structure and guide our investigations. We hypothesized that if there had been "site unit intrusion" into the region, the settlement plan of one or more sites at the Locality would be similar to those in the American Bottom. Conversely, if there was an in-situ developmental sequence in the region over a period of time, the settlement plan and physical setting of the major village sites should be different from one another as well as those in the American Bottom.

The major villages in the Red Wing Locality are quite large and are situated on high, glacial outwash terraces overlooking a major stream. Each village was surrounded by a group of mounds on the landward side of the village. It is

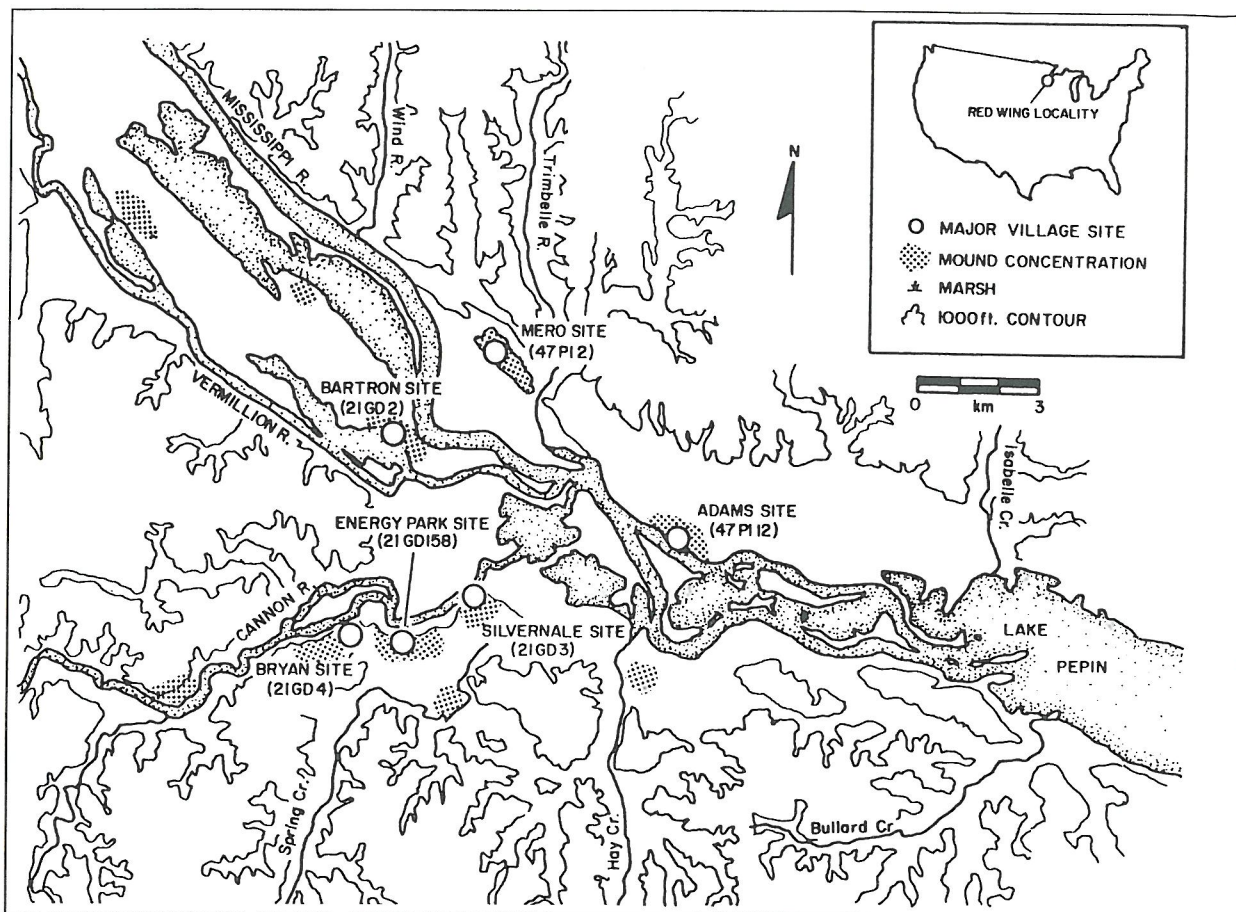


Figure 2.1: The Red Wing Locality.

not possible, and probably not desirable, to completely excavate each village. Therefore, we have been using a suite of remote-sensing methods, controlled surface collection of artefacts, and excavation of selected areas to develop settlement models of each site (Dobbs 1991a).

Nineteenth century survey documents contain detailed descriptions of the various mound groups. Unfortunately, the majority of these mounds had been either obliterated by cultivation or completely destroyed by modern development. Although we could use the survey notes to create maps of the mound groups as they were in the 1880's, it appeared that it might be impossible to link these maps precisely to the modern landscape and to features within the villages. It would therefore be difficult to apply sophisticated analytical techniques to our settlement models.

In 1988, one of the major sites was purchased as an archaeological park. As part of the planning for this park, our consultant had a detailed contour map of the site prepared from aerial photography, using stereoscopic mapping techniques. The technician preparing the map was aware that

mounds had been present at the site, although they had been destroyed by cultivation. While working with the stereoscopic model of the site, the technician observed a number of small irregularities on the ground surface where the mounds had been. Although these were too low to map as distinct contours, he did mark them on the map. We overlaid a map of the mounds prepared from the 19th century data on the modern map and discovered that these anomalies were indeed remnants of the mounds that had existed at the site. We also observed several discrepancies between the locations of the mounds and their description in the survey notes.

We immediately realized that this type of mapping might provide us the tools we needed to link the location of the mounds with topographic data, remote sensing information, and excavated materials. We have since prepared base maps of three major village complexes and are completing a fourth. Although this approach is not without difficulties, we believe it is an important new methodological approach to the study of ancient settlement patterns in the midwestern U.S.

## 2.2 DATA SOURCES

We use three different types of data in preparing our maps. These include records of the Northwestern Archaeological Survey, historic aerial photographs, and ground control information obtained by land surveyors for each mapping project.

### 2.2.1 Northwestern Archaeological Survey

Between 1880 and 1895, the Northwestern Archaeological Survey mapped more than 12,000 mounds in seven midwestern states. Based in St. Paul, MN., the survey was privately funded by Alfred J. Hill, who had become wealthy investing in land in Minnesota. His younger collaborator, Theodore Hayes Lewis, was a trained surveyor. Both men shared a passion for the antiquities of the Midwest and both realized that many sites were being destroyed as the land was cleared for cultivation. The Northwestern Archaeological Survey was based in their desire to preserve for posterity a record of a landscape that was already vanishing before their eyes (see Dobbs 1991b; MHS 1991).

Each year, Lewis was sent out to map mound groups that he and Hill had learned of. Hill remained in St. Paul, organizing the notes Lewis submitted, preparing maps of some groups, and funding the project. During the course of the survey, Lewis travelled more than 10,000 miles on foot and mapped hundreds of mound groups. Many of these sites are now destroyed and his records are the only source of information now available for them.

Hill and Lewis had planned that the Survey would be published after it was completed. However, in 1895, Hill unexpectedly died of typhoid. Although he had supposedly left a will providing funds to complete and publish the survey, this will could not be found. Lewis subsequently lost all rights to the Survey records, which were transferred to Hill's heirs in England and Canada. Lewis vanished shortly after 1900 and the records ultimately were transferred to the archives of the Minnesota Historical Society. Maps from the Minnesota portion of the Survey were published in 1911 by Newton Winchell (Winchell 1911), but the remainder of the survey, constituting more than 50% of the work, remains unanalyzed (however, see Dobbs 1985; Haurie 1990, Mallum 1976, Peterson 1984, Svec 1986).

Because Lewis was trained as a surveyor and was widely read in archaeology, his field notebooks provide detailed information on the size, form, and height of each individual mound

within each group. He also conducted open traverse surveys providing a bearing and distance from each mound to the next. It is possible, using Lewis' notebooks, to recreate the configuration of individual mound groups, even though the mounds are no longer visible. Lewis also provided some information on the landscape and in many cases marks distances from individual mounds to the edge of bluffs, streams, and so forth. This information provides additional checkpoints when working with his materials.

Lewis' data are an invaluable source for examining earthworks within the Red Wing Locality. However, there are two significant problems with his material. First, the surveying instruments he used were considerably less accurate than those available today. The open surveyor's compass he employed had an accuracy of perhaps plus or minus one degree. Therefore, there is the potential that there may be considerable accumulated error over the course of one of his traverses. Second, he does not indicate that he routinely closed or backsighted his traverses. Therefore, we have no way of evaluating the accuracy of mound locations computed from his bearings and distances without on-the-ground inspection of the groups. For groups that have been destroyed or badly damaged, such inspection is difficult if not impossible.

### 2.2.2 Aerial photography

Aerial photography has been used for mapping and planning purposes in the Upper Mississippi Valley since the early 1930's. A variety of photography is available from the U.S. Army Corps of Engineers, the Minnesota and Wisconsin Depts. of Transportation, the Soil Conservation Service, and other sources. The photography varies in quality, scale, and coverage. Stereo pairs are often, but not always, available. Photography taken during the early spring or very late fall is best, since heavy forest and crop cover obscure many of the features of interest. Fortunately, in the Red Wing region, there is extensive small-scale photography available for much of the area taken for highway planning and construction. Much of this coverage was shot during the 1950's, 1960's, and early 1970's prior to the advent of very heavy cultivation equipment in the region. Thus, photographs of sites exist which can be used to recreate their configuration, even though the sites themselves have been destroyed.

### 2.2.3 Horizontal and vertical ground control points

Photogrammetric mapping of each site requires precise horizontal and vertical control for selected

points on each photograph of a stereo pair. Obtaining ground control for recent (e.g. within 5 years) photographs is not difficult. However, for older photography, ground control can be difficult to obtain. Key landmarks may have changed or been destroyed, and even subtle changes like repaving a road can create problems. All ground control for this project has been obtained by Johnson and Scofield, a professional land surveying firm in Red Wing with extensive experience in the region.

## 2.3 METHODS

The preparation of our base maps involves several different steps:

- 1) All available aerial photography is reviewed to determine if suitable photography is available for a particular site. To be useful, at least some mound remnants must be visible when stereo pairs of the photographs are examined with a hand stereo viewer. Photography taken during "leaf off" conditions is required and photography taken prior to the emergence of crops is best. Light conditions and light angle vary, and affect the suitability of the photography for our purposes. We select the oldest photography available, preferably prior to 1970. Although the earliest photography is preferable, it is not always possible to obtain acceptable ground control for very early photography.
- 2) Our mapping contractor (Horizons, Inc.) reviews the photography, provides a cost estimate for the project, and identifies needed ground control points. Horizons uses expensive and highly sophisticated modelling equipment to generate their maps.
- 3) Ground control is obtained by licensed land surveyors. Since the maps may be used for legal and management, as well as scientific purposes, the maps are prepared to meet National Map Accuracy Standards. High precision is required in obtaining ground control to meet these standards. Therefore, we feel it is best to retain professional surveyors rather than conduct the work ourselves.
- 4) Ground control is forwarded to Horizons, Inc. who then prepare a rectified and precise stereoscopic model of the landscape. A map showing contours (normally at 2 foot intervals), all other landscape features (e.g. roads, buildings, etc.), and mound remnants are prepared. Hard-copy plots of these maps are forwarded to the Institute. The maps are also provided in digital form using the AUTOCAD DXF format.
- 5) The Horizons maps are translated in GENERIC CADD format. Different types of data are plotted on different layers, allowing easy modifications or additions to the map.
- 6) Plots of the mounds as they existed in the 1880's are prepared from the Lewis notebooks. Since Lewis provided angle and distance measurements for each mound, this is a relatively straightforward task. We note that because of the vagaries of angle formats in CADD systems, it is necessary to enter all angle measurements as negative numbers and rotate the map 90 degrees after it is completed.
- 7) The Lewis map is then fitted to the Horizons map, using mound remnants and other control points. Depending on the level of error in Lewis' data and the number of mound remnants, this can become complex.
- 8) If necessary, the co-ordinate system on the final map is reset to our co-ordinate system used in remote sensing, excavation, and surface collection. This ensures that other types of data may be easily incorporated into the map.
- 9) The final map is verified on the ground. Examination of visible mound remnants, soil resistivity, and other methods are used in this process.

The final product of this process is a scaled map, prepared to National Map Accuracy Standards, in digital format, that shows the relationship of various cultural and natural features with as much precision as the available data allow. Additional information from other sources – soil resistivity, excavation, crop marks, and so on – can be incorporated into additional layers on the map. All, or part of this information can be displayed and analyzed at any given time. All or part of the drawing may be exported to other application packages via DXF format.

## 2.4 TWO CASE STUDIES

### 2.4.1 The Silvernale Site (21GD3/GD17)

The Silvernale Site is a large mound (21GD17) and village (21GD3) complex situated on a low glacial terrace immediately adjacent to the delta of the Cannon River near the confluence of the Cannon and Mississippi. The mound portion of the site encompasses roughly 40 acres and the village covers some 10 acres. We suspect that Silvernale is roughly contemporary with the early Stirling Phase at Cahokia.

The site itself has been cultivated for more than 100 years and a large portion of the mound group and village site was destroyed by construc-



Figure 2.2: 1967 aerial photograph of the Silvernale Site.

tion of an industrial park in the mid-1970's. No modern, comprehensive map of the site has been prepared and there are difficulties relating the Lewis data to the modern landscape. Because the site is so large, is probably early in the Red Wing sequence, and is the type site for the Silvernale Phase, it remains particularly important.

The mound portion of the site was originally mapped on August of 1885 by T.H. Lewis, who identified 226 mounds. He also noted that there were 50 to 75 more mounds in the cornfield covering the site that he did not map.

The village portion of the site was first identified by Lloyd A. Wilford who excavated there in the 1940's (Wilford 1945). Salvage excavations

were also conducted by Minnesota archaeologists at the site in the 1970's.

The Minnesota Department of Transportation took a series of aerial photographs of the site area in 1967, prior to the time when most destruction at the site occurred. This photography clearly shows numerous mound remnants on the site (Figure 2.2). Although the ground surface had changed significantly since 1967, we were able to obtain appropriate ground control points and Horizons, Inc. prepared a map of the landscape and mound remnants for us. On this map, 80 mound remnants were visible. We prepared a digital map of the mound group using Lewis' 1885 field notes (Figure 2.3).

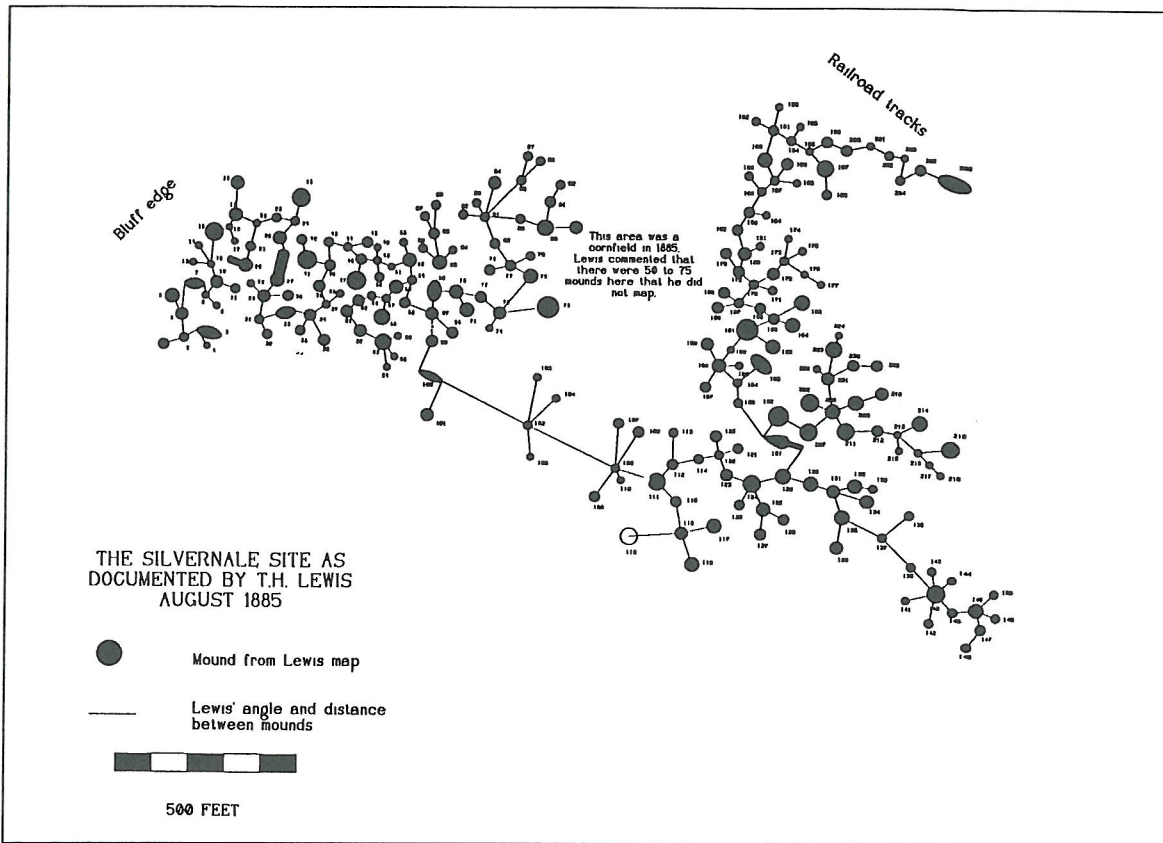


Figure 2.3: Silvernale Mounds recreated from NWA data.

After examining both maps, we determined that Mound 15 corresponded with a specific mound remnant visible in the aerial photography. We then merged the Lewis map with the Horizons map and rotated the Lewis map to obtain a fit between his mounds and the mound remnants visible in the photography.

We initially fit Lewis' map to the Horizons map by using the mound remnants as control points. We observed that mounds taller than 4 feet in 1885 were particularly noticeable on the Horizons map and these were used as control points. Further, Lewis had taken measurements from several of the mounds to the bluff edge and a railroad that is still present. These points provided an additional way to align the Lewis map with the Horizons map.

It quickly became apparent that there was considerable divergence between Lewis' map and the Horizons map. Although mounds shown by Lewis in the westernmost portion of the site aligned very neatly with the Horizons map, this correspondence deteriorated in the central and eastern portions of the site. For example, Lewis indicated that Mound 206 was 25 feet from the centre of the nearby railroad tracks. In aligning his map to the

Horizons map, this mound was more than 90 feet from the tracks and none of the other remnants in the area aligned with his map (Figure 2.4).

After a careful examination of both maps and the Lewis data, we identified the probable sources of this error. First, Lewis' measurements were consistently about 50 feet short per 1,000 feet measured. Second, he measured the angles between Mounds 100 and 111 in two readings over a distance of more than 1,000 feet. These types of long surveying "shots" can be notoriously inaccurate and in this instance Lewis' readings deviated from the actual angle by about 3.5 degrees.

Using this information on Lewis' error, we were able to move blocks of mounds into positions where they corresponded with mound remnants and other control points. In some instances, a single mound remnant was the result of several smaller mounds that were plowed together. In general, the largest mounds were represented by individual remnants, while the smaller ones were either not visible or were visible only as conglomerates.

The result is a map that shows in detail where mounds were actually located on the ground surface (Figure 2.5). Even though many of the mounds mapped by Lewis are no longer visible,

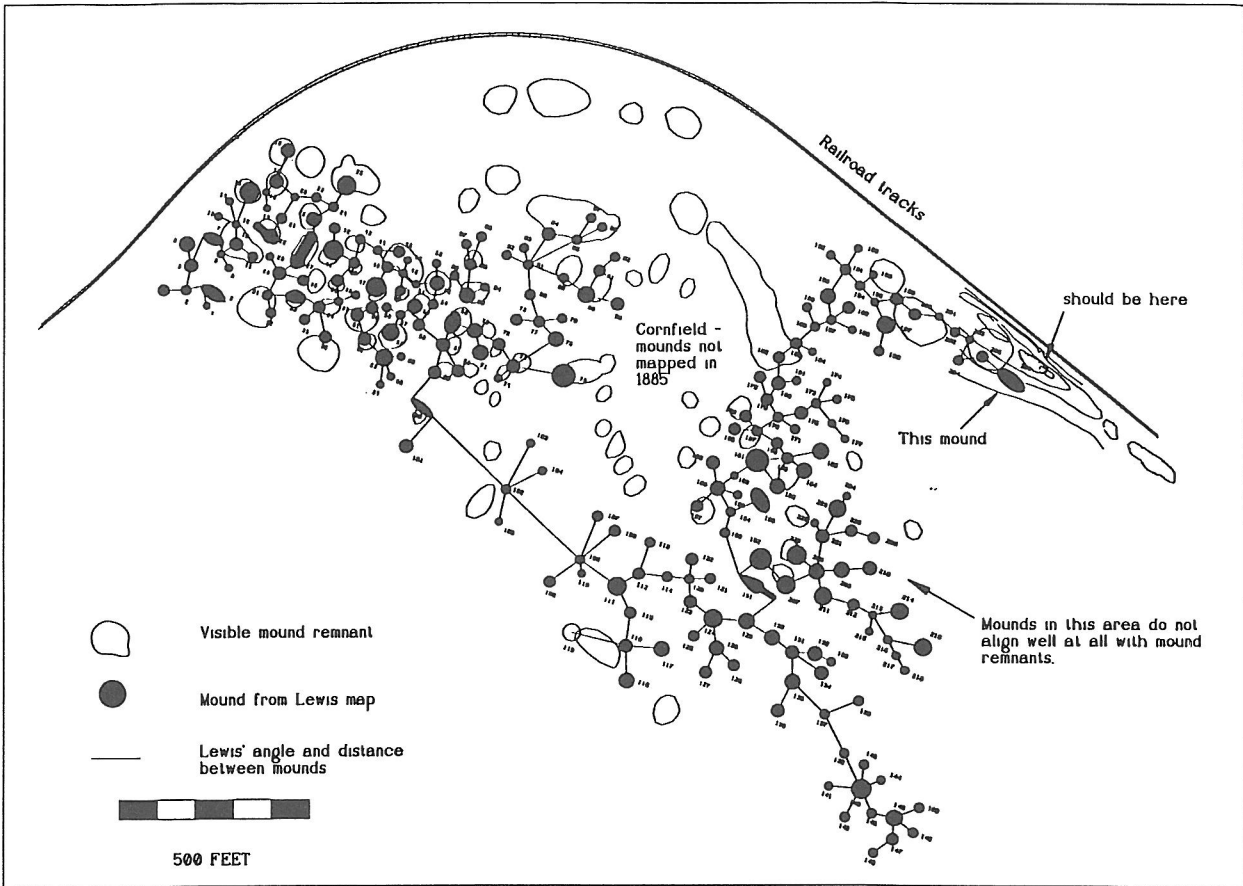


Figure 2.4: Initial overlay of NWAS and Horizons Maps (Silvernale Site).

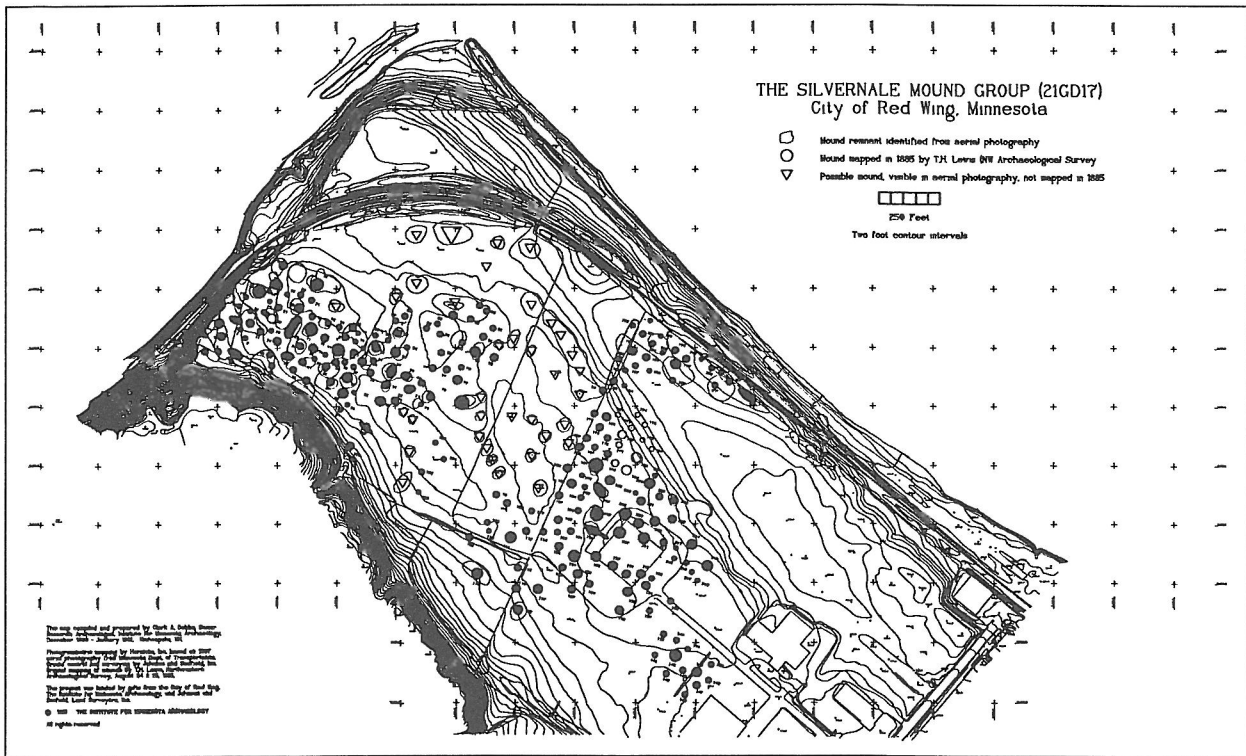


Figure 2.5: Composite map of the Silvernale Site.

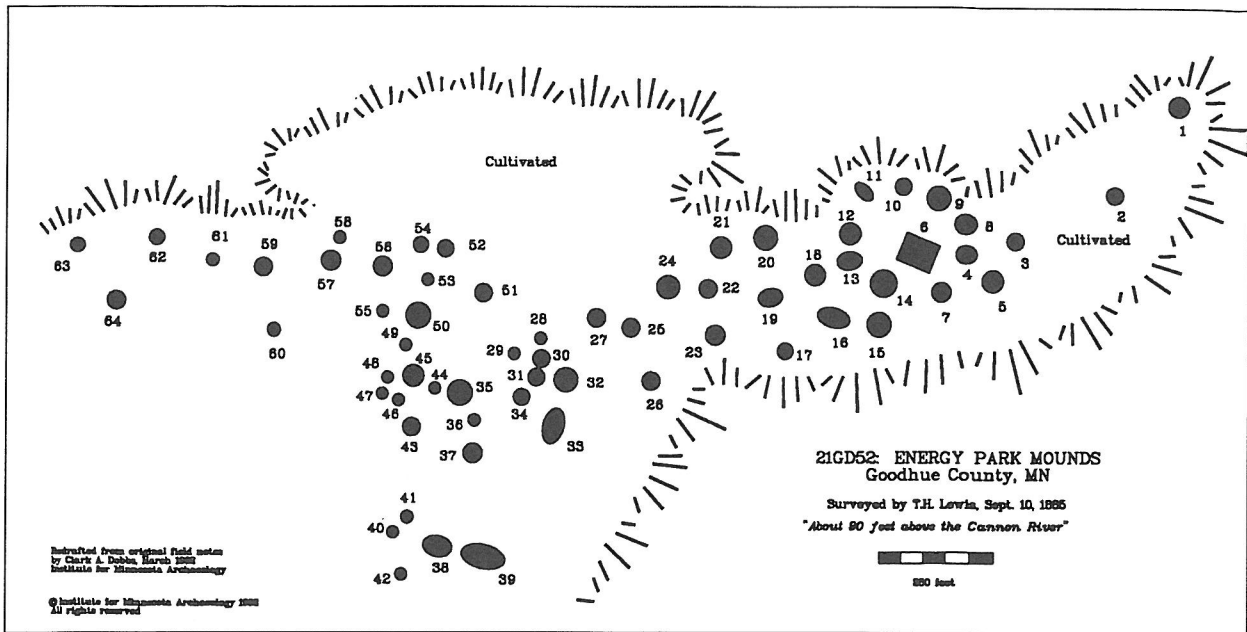


Figure 2.6: Red Wing Archaeological Park (21GD52/158) recreated from NWS data.



Figure 2.7: Composite map of the Red Wing Archaeological Park (21GD52/158).



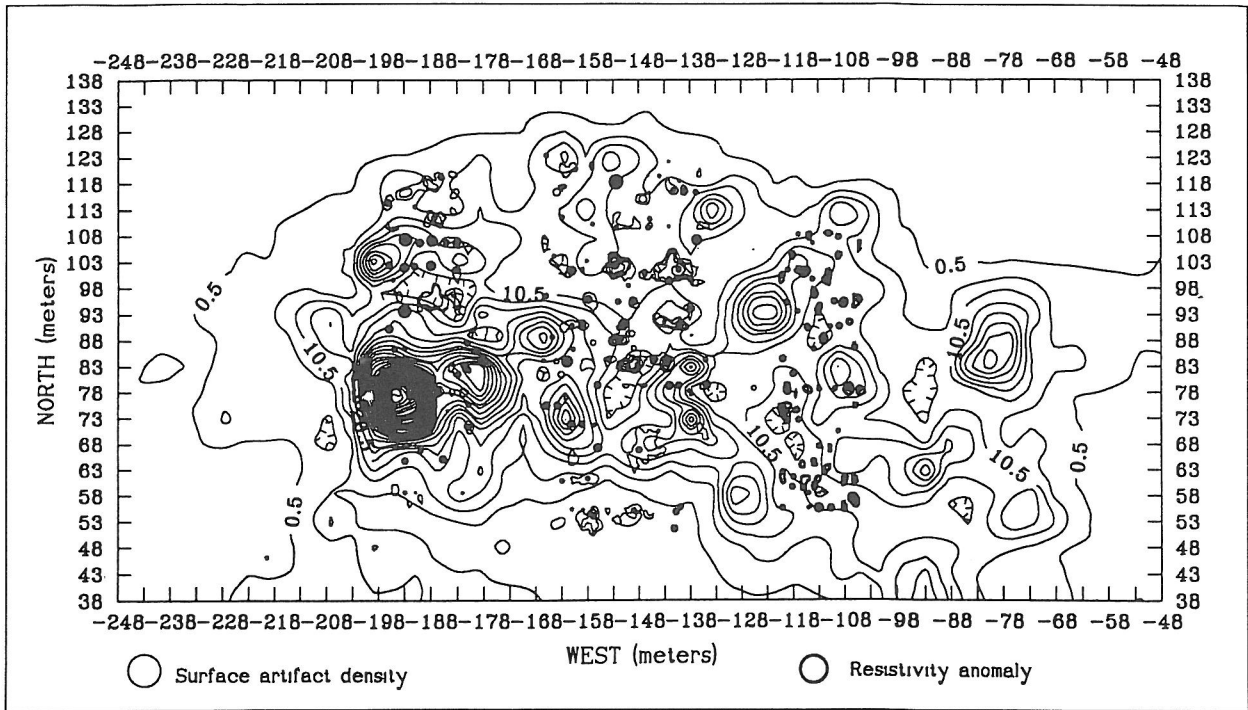


Figure 2.8: Soil resistivity and controlled surface collection data at Red Wing Archaeological Park.



Figure 2.9: Composite map of Red Wing Archaeological Park (mounds, topography, remote sensing data).

their locations can be plotted with some confidence. Further, Lewis noted that there were 50 to 75 mounds in the cornfield that he did not map. We had assumed that the location of these mounds would never be known. However, many of these mounds were visible as mound remnants in the 1967 photography and we were able to plot them. The end result is a base map, in digital form, that can be used to delineate and evaluate the internal settlement pattern at the Silvernale site. It will be possible to incorporate past excavation information onto the map, as well as any future excavation that may take place.

#### **2.4.2 Red Wing Archaeological Park (21GD52/GD158)**

The Red Wing Archaeological Park is a mound (21GD52) and village (21GD158) complex that overlooks the Cannon River. The mound area covers approximately 15 acres and the village covers approximately 7 acres. The mound group is of particular interest since it contains the only flat-topped pyramidal mound in the Red Wing region. This mound form is characteristic of the Middle Mississippian cultures to the south and has been interpreted as direct evidence of contact between Red Wing and the southern area.

The site has been under cultivation for more than 100 years and only a very few mound remnants are visible on the ground surface in the western portion of the site.

Lewis mapped this site on September 10, 1885 and described 64 mounds, including the pyramidal structure (Figure 2.6).

Horizons, Inc. prepared a map of the site area using photography from 1978 and identified 11 mound remnants.

We were able to successfully fit the Lewis map to the Horizons map and the results are acceptable (Figure 2.7). However, Horizons identified fewer mounds than we had anticipated, and it was somewhat more difficult to fit the entire group to their map. In part, this was because the light conditions and scale of the photography were not as good as for the Silvernale group. Also, it became apparent that the problems with accumulated measurement error were present at this site. Likewise, it appears that Lewis may have made a small error in turning angles in the vicinity of mounds 16, 19, 20, and 21.

## **2.5 EVALUATION AND DISCUSSION**

The study of intra-site settlement patterning in the upper midwestern United States has always

been difficult, in large measure because of the ephemeral character of the archaeological remains in this region. Structures were made of wood, not stone, and preservation of structures at most sites is poor compared to other parts of the world. Further, rapid urban development and agricultural practices during the last 150 years have damaged or destroyed the majority of sites in this region. As a result, studies of cultural change and process have of necessity focused on only a few aspects of past societies, particularly artefact traits and typology. Often, although not always, artefacts characterizing an entire site are derived from a relatively small number of excavation units. This can be particularly misleading when sites consist of several temporally and/or spatially discrete occupations.

In some instances, entire sites have been stripped of their overburden and it has been possible to examine the entire layout of such sites. Such studies have reinforced the value of studying archaeological properties as complex, functioning entities rather than simply as artefact assemblages. However, it is rare when entire sites can be excavated, and such an approach destroys the entire site. Moreover, such strategies destroy many types of data that may be difficult to collect or of which we are currently unaware. The use of remote sensing and mapping is increasing our ability to delineate internal settlement patterns at sites in the midwest without destroying the entire site by excavation. It is also possible to partially reconstruct sites that have been destroyed in the past. The integration of computer-assisted drafting, historic aerial photography, and historic aerial photographs described in this paper is one example of this approach.

### **2.5.1 Weaknesses of approach**

It is somewhat expensive. For example, the combined cost for two of the mapping projects was more than \$7,000.

Delineation of mound remnants in the stereoscopic model is, in part, dependent on the skill of the photogrammetric technician. Also, the scale of the original photography constrains the ability of the technician to identify such remnants. While new photography at an appropriate scale can be obtained, this is of little help in studying sites that were destroyed 10 or 20 years ago.

A certain level of skill and intuition is also required to fit the Lewis maps to the aerial maps. It is rare that there is a precise 1:1 correspondence between the Lewis and aerial maps — and it is essential to understand that the Lewis maps are far from perfect.

Finally, appropriate photography and historic records — either from the Northwestern Archaeological Survey or other sources — must be available for a given site. This is not always the case, and often there may be Survey records for a site and no photography, or vice versa.

### 2.5.2 Strengths of approach

As we have pointed out, there are numerous problems in using the Lewis data alone to reconstruct mound groups on the landscape. Lewis was a meticulous observer — but he was working alone using equipment that is inadequate by today's standards. Similarly, using only the Horizons maps would present a thin and misleading picture of any given site. While the natural features of the site would be adequately presented, the cultural features would not. By combining these two types of data, it is possible to achieve more accurate and comprehensive results than either would produce alone. Moreover, by using computer-assisted drafting programs, it is possible to add, combine, and reanalyze different types of datasets within a single map.

An example of this approach is at the Red Wing Archaeological Park, where we have used soil resistivity data and controlled surface collections of artefacts to delineate the internal pattern of settlement within the village area of the site (Figure 2.8). By combining this map with topography and mound maps, we have an initial portrait of a 12th century Native American village (Figure 2.9) that may then be used to guide future excavation, hypothesis, spatial analysis, and other types of investigation.

Because all of the data is integrated into a single computer drawing, it is possible to export the data into a Geographic Information System via the DXF format. Such GIS systems have powerful analytic capabilities and some also have strong three dimensional modelling capacities. We have recently acquired ARC-INFO and TINN and will in the coming months be working to generate three dimensional models of the vanished mounds of Red Wing. Such reconstruction's would be impossible without the extensive survey and photographic archives available to us and the computer applications we have been developing.

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**Author's address**

Clark A Dobbs  
 The Institute for Minnesota Archaeology  
 3300 University Avenue SE, Suite 202  
 Minneapolis, MN. 55414 U.S.A.  
 612/623-0299  
 612/623-0177 (FAX)  
 email: imadobs@vz.acs.umn.edu