Mobile GIS on the Fly for Archaeological Fieldwork

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Abstract

While mobile solutions like *ArcPad* exist, not all companies are willing or able to purchase them. Mobile GIS is perfect for archaeological survey work, as the nature of the work is to collect spatial data and their attributes.

When faced with leveled agricultural fields and over two hundred Native American artifacts in Kern and Tulare Counties, California, archaeologists were able to improvise their own mobile GIS. The survey conditions were poor, and it was impossible to accurately record sites in the field. Using a simple *Garmin* GPS receiver and a paper notebook, the archaeologists were able to quickly collect data in the field and analyze back at the office with *ArcGIS*. Analysis of the artifacts overlaid with historic topographic maps gave them a better picture of what the land looked like in the past, and saved the company time and money.

Introduction

Initial testing of archaeological projects often requires a pedestrian survey of the area of potential effects (APE). The survey is an attempt to acquire the amount of archaeological resources within the project area (Neumann and Sanford, 2001). Techniques may vary slightly from state to state, but the data sought are consistent. In an archaeological context, a survey consists of a field technician(s) walking ordered transects along the APE, scanning the ground for artifacts or other evidence of ancient human presence. If one artifact is found, it is recorded as an isolate. If three or more artifacts are found within ten meters of one another, they are considered a site, and a somewhat elaborate mapping and recording process takes place. Site boundaries are determined either by dissipation of artifacts or change in the environment. For example, three artifacts found within ten meters, with nothing else near, would become a site. If three artifacts are found on top of a mound, and one more at the base, the three would likely be considered a site, while the other would be an isolate.

On a survey project in Kern and Tulare Counties, California, traditional methods were challenged. The parcels were old cotton fields, stripped of the crop. The original topography of the land was long destroyed, and the surrounding fields gave no indication as to what this land originally looked like. If sites were to be found, determining their boundaries and drafting the maps would not be easy.

The first day of work's initial artifact density revealed that a large amount of data would be collected. While the work would be slow with traditional methods, Geographic Information Systems (GIS) could effectively map and study the APE. By collecting data in the field and leaving the analysis for the office, the archaeologists could quickly and accurately record the resources.

GIS has become a useful tool in managing cultural resources. The nature of archaeology is to study humans and societies within their spatial environments. Knowledge of the land and resources surrounding a society is crucial to understanding the society itself (Renfrew and Bahn, 2000). GIS allows for important attributes of artifacts and sites to be looked at in a spatial sense. "It is this ability to link aspatial data to spatial data, as well as the ability to integrate data from multiple sources, and then subsequently perform spatial analysis on that data, that is the true power of GIS (Spencer et al., 2003, pg 18)."

GIS has not been widely addressed in easily accessible California Archaeology literature. Most professional articles and other resources discuss the three dimensional mapping of Mayan settlements or mapping ancient cities in the Near East. Locating information using GIS to map Native American sites was impossible, as was conducting this type of research with a very limited budget.

Although GIS is known to be a valuable tool in conservation, cultural resource firms may not understand the power of GIS as an analysis tool rather than a cartographic tool. This project appeared to be an excellent opportunity to use GIS for answers instead of attractive maps.

Methods

The field work was kept as simple as possible. Every artifact found was recorded as an isolate, unless it was within ten meters of two other artifacts. This kept the crew from spending too much time on defining site boundaries. UTM coordinates were recorded in addition to the physical attributes of the artifacts. When the data were recorded, the crew moved on. General notes were taken on the landscape for use in any future site records. By using this method, the field work went much quicker than expected.

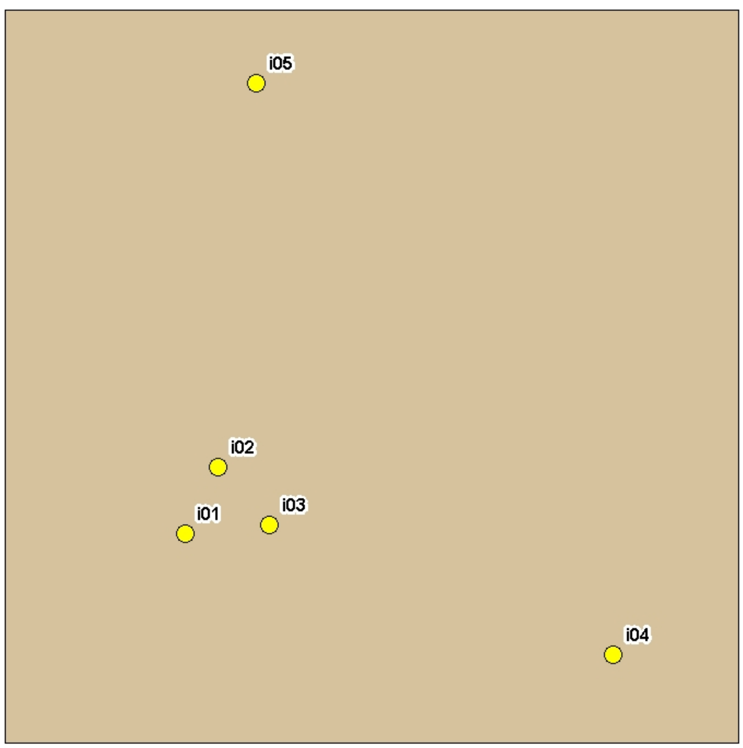

Figure 1. Example of point layer generated from GPS coordinates.

Once in the office, a relational database was created in *Microsoft Access*. One table contained the spatial attributes of the artifacts, while the others contained information on the artifact's typology. The unique isolate number was the primary key, and columns for the artifact's type, northing, easting, and material were added for later queries. The database was converted to a .dbf file and added to *ArcMap 8.3*, as was a layer for the APE. A point layer was created using the artifact UTMs (figure 1), and then was buffered at ten meters (figure 2). Walking at ten meter transects in the field can cause field technicians to miss obvious correlations between artifacts. Transects can be miles long, and it is easy to forget the site from the last transect. The buffer gave a quick check to make sure no obvious sites were missed in the field.

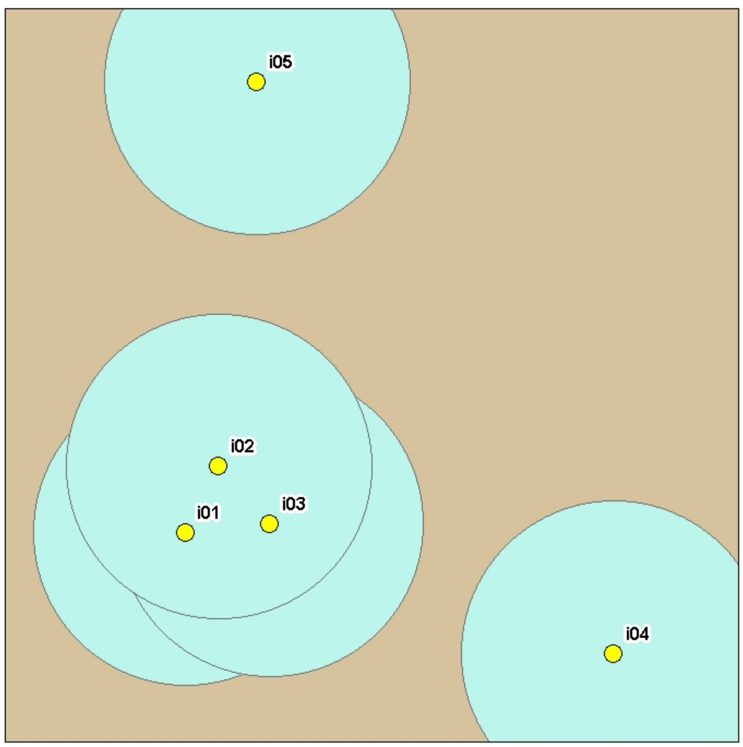

Figure 2. Ten meter buffers are added.

The ten meter rule is a guideline, but artifacts can be farther away from one another and still be in the same site. While this was difficult to see in the field, further spatial analysis revealed the relationships between the artifacts.

Historic *USGS* quadrangles for the APE were scanned and georeferenced. The historic maps were drafted in 1911, fortunately before the introduction of cotton farming to the area. The original topography was easily viewed in the context of the artifacts (figure 3).

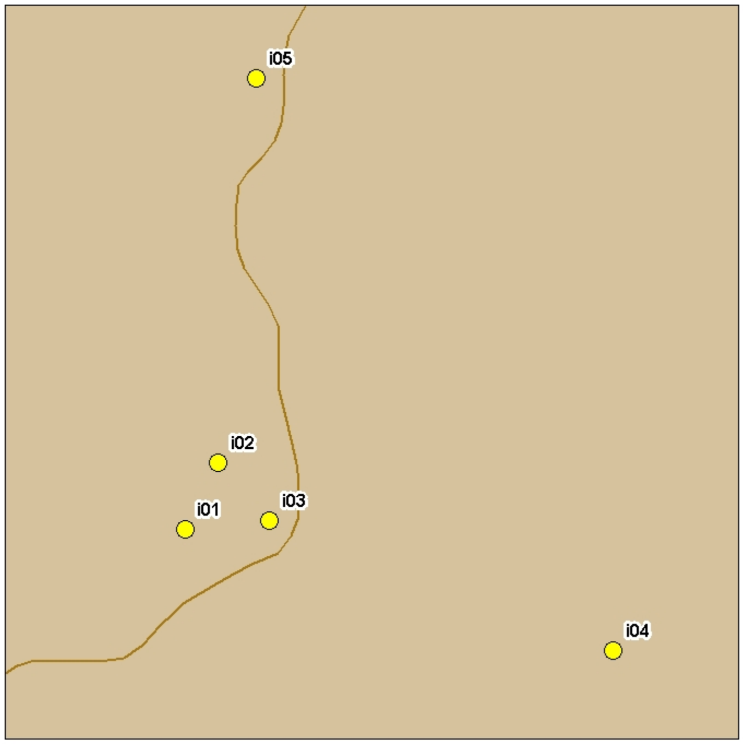

Figure 3. Historic contours reveal what the landscape used to look like.

This information was then given to the principal investigator (PI) of the project to make the final decision on what would be considered a site.

When viewing the data within its spatial context, one previously unnoticed site was found and seven isolates were changed to site artifacts.

The ten-meter buffers revealed the unnoticed site. The isolated artifacts were found on two different transects and their proximity to one another was not recognized in the field.

By overlaying the historic quadrangle and the artifacts, the site boundaries became clear. Archaeological sites are often found on high ground and the topographic contours were able to show the original high spots. Artifacts that were with the same general topography were grouped as a site.

The PI was also interested in the use of the artifacts that were found and their spatial relationship to one another. Fortunately, the database was set up to perform this task. Queries were run based upon the use of the tools. Was it a hunting tool or a domestic tool? A map was made showing the relationships, which further refined the sites (figure 4).

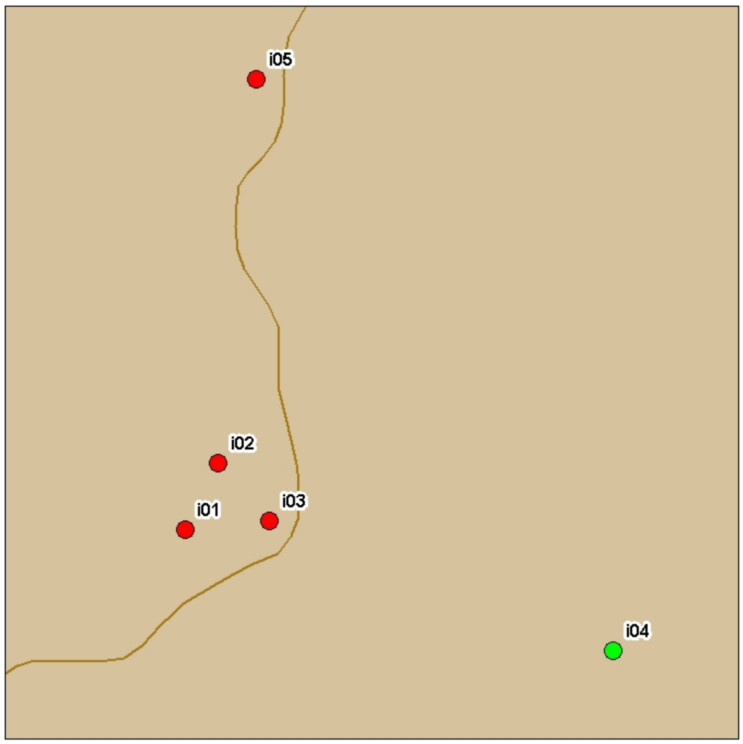

Figure 4. Symbolizing tool use types further refines the mapping of sites.

Once the sites were defined, the database was changed accordingly. Site and artifact numbers were given to former isolates. A feature class for site boundaries was created. When submitting new site records to the *California Department of Parks and Recreation*, a site map is required. With the boundaries and artifacts already made, the maps were easily added to the records.

Analysis

The methods used in the field were good considering the technology at hand. The *Garmin* handheld GPS unit was WAAS enabled, and able to get within three meters of accuracy within the APE. WAAS, or Wide Area Augmentation System, was developed by the *Federal Aviation Administration* and the *Department of Transportation* to make GPS accurate enough for aviation. Ground stations monitor GPS signals and send corrections to WAAS enabled devices (Garmin, 2003).

Unfortunately, the GPS data cannot be further corrected to achieve sub-meter accuracy. A higher quality device would be better suited for the nature of the analysis we conducted. The level of accuracy did not seem to affect the collected data, but more accurate equipment should still be used.

A difficulty in the analysis stage had to do with terminology used in the field. A mano is a tool used to grind seeds and grains. This can also be called a hand stone. The only difference between the two terms is regional. Because the crew of this particular survey had been educated in different schools across the country, both terms were used. The field notes were entered into the database exactly as they had been written, which made a category for manos and another for hand stones. This made for a busy and misleading legend when displaying the data on the map. Using a data dictionary to define terminology would clear up any of these problems in the future.

Intelligent decisions were made based upon the data collected in the field. By analyzing the artifacts by their attributes, as well as their spatial relations with one another, then overlaying the historic topography, the original landscape could be envisioned. Site maps were also easily created; reducing time usually spent digitizing hand drawn maps in *Adobe Illustrator*. Overall, it was a successful attempt to record the results of an archaeological survey.

Conclusions

This method could be used for future surveys. The technology could be used if nothing else was available, though differential GPS should be acquired to ensure accuracy. *Trimble*, a commercial GPS company, offers the *GeoXT*, a rugged handheld computer with a built in GPS antenna. The data can be corrected through post-processing and achieve an accuracy of up to 30cm. Not only would that be accurate enough for fieldwork, the device also comes with *Bluetooth* wireless technology. In theory, a field technician could send data through a cell phone back to the office and have it analyzed before he or she leaves the field.

ArcPad is a mobile GIS program made by *ESRI*, which can be run on the *GeoXT*. Not only can shapefiles be created in the field, and overlaid upon historic base maps, but custom forms can be made and used for data acquisition. Rather than have field technicians entering both "mano" and "hand stone," a pick list (a list that a user can scroll through and select only specific options) could be used with only one term available. All artifact attributes would then be predefined and errors would be reduced tremendously. By using these forms, the possibility of forgetting a measurement or description would be less. Also, the data would be digital, and would not need to be manually entered into a database.

Finally, it should be noted that fieldwork was completed sooner than expected. We had intended to spend fourteen days in the field, but finished in nine. Lodging costs alone were $35 per room for four rooms, or $140 per day. By cutting the field time, the company saved $700 on lodging. This doesn't even include per diem and mileage costs. That amount more than made up for the extra time spent on the GIS. It also justifies future costs for accurate GPS devices and training. ●

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