Evaluation of a Basic GIS for Mapping and Monitoring

Cultural Resources at the River’s End Ranch, Lake County Oregon

by

Mason K. Marker

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Dr. Charles Rosenfeld
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Evaluation of a Basic GIS For Mapping and Monitoring Cultural Resources at the River's End Ranch, Lake County Oregon

ABSTRACT: The use of Geographic Information Systems (GIS) is rapidly expanding in almost every field of inquiry. The field of Archaeology is also learning to use GIS to improve both initial data collection in the field and data analysis in the lab. This paper evaluates the usefulness of the GIS software package "FieldNotes" for mapping and managing cultural resources at the River's End Ranch in South Central Oregon. The objective is to establish the practicality of using "FieldNotes" to map and manage the River's End Ranch Site.

Introduction

Most new technologies are not readily accepted in fields outside of the one that created the technology. This problem is demonstrated in the slow implementation of geographic information systems (GIS) in archaeological studies. It is with the idea of helping to further the use of GIS in the field of archaeology that this project is done. There are two objectives to this project: the first objective is to evaluate the usefulness of a geographic information system for mapping and managing cultural resources at the River's End Ranch located southeast of Paisley, Oregon (figure 1); the second objective is to provide field practitioners a specific example of an application of a GIS to an archaeological problem.

Figure 1 - Map showing the location of River's End Ranch in South-central Oregon.

The archaeological problem that is to be addressed in this study involves a reservoir on the River's End Ranch. In 1994, the owner of the River's End
Ranch constructed a small earth dam on the Chewaucan River for the purpose of irrigating his surrounding farm land. The dam created a reservoir of approximately 560 acres which inundated dozens of Native American burial mounds. These burial mounds were rediscovered shortly before the completion of the dam even though they had been previously mapped by the Bureau of Land Management (BLM). The discovery of these mounds caused concern over how to manage and maintain them in conjunction with the operation of the ranch and the dam. This problem created the need to collect and analyze geographic information about a number of archaeological sites over a wide area. The 560 acre reservoir site contains 64 burial sites that have been previously mapped and an unknown number of lithic scatter sites. In order to facilitate the handling of information it was decided that a GIS system would provide the most efficient means of dealing with the geographic data involved.

A GIS software package called "FieldNotes" from Penmetrics in Corvallis, Oregon was selected for this project. The package was selected because of its perceived ease of use and compatibility with existing data sources. This paper explores the usefulness of the FieldNotes package in addressing the archaeological problem at River's End Ranch. The evaluation was done by creating a GIS with a portion of the data obtained from River's End Ranch and evaluating the positive and negative aspects of the FieldNotes software package.

**Site Overview**

River's End Ranch is located in South Central Oregon three miles Northeast of Valley Falls and approximately eighty air-miles from Klamath Falls (Figure 1). The River's End Ranch is bordered on the southeast by
Figure 2 – Portion of Coglan Buttes SE, Oregon USGS quadrangle showing the location and extent of the River's End Ranch study area.

Approximate boundary of study area. Map scale is 1:24,000.
Abert Rim and to the Northeast by Lake Abert. The ranch itself and the land bordering to the west is flat, Oregon high desert terrain. Access to the site is by highway 31 and highway 395. Both highways merge at the Southwest corner of the site (Figure 2).

River's End Ranch consists of open, flat terrain consisting mostly of sagebrush. The dominate feature of the ranch is the Chewaucan River which flows from the Northwest to the Southeast and empties into Lake Abert. The river has been dammed to create a manmade reservoir and other areas have been cleared for the purpose of center pivot irrigation farming.

Another characteristic of the site is the presence of occupation sites from previous Native American habitation. These sites are dispersed throughout the area and many have been documented by field work done by the Bureau of Land Management. The sites include camp site areas, areas where stone working was done (lithic scatter sites), and burial mounds. The final historical note on this site is the reservoir created by the land owner damming the Chewaucan River. The reservoir covers approximately 560 acres of the site and has become excellent wetland habitat for migrating water fowl and other indigenous wildlife in addition to its agricultural uses.

The historical use of the site by Native Americans and the rancher's present use are currently in legal conflict and provided the need for a research project of this type.

Problem Definition

In 1992, Oliver Spires purchased the River's End Ranch for farming purposes. To aid his farming operation, Spires obtained permits from the United States Army Corps of Engineers and the BLM to restore and modify an existing dam at the ranch [Ulrich, 1996]. Shortly after completion of the
dam, it was discovered that several areas that had been mapped as occupation sites and burial mounds by the Bureau of Land Management had been inundated by the expanding reservoir. This led to the immediate problem of how to identify mounds that were affected and would be affected by the rising waters. In addition to the problem with the burial mounds the area was also known to have many lithic scatter sites that had not been mapped or cataloged. This created a second problem of quickly and accurately mapping lithic scatter sites.

In order to effectively manage the Indian occupation sites and map the scatter sites project managers need a fast and flexible way to store, retrieve, and analyze data about the sites. In addition to this data, additional data about the site will become a part of the database at a later date. Information that might be included later includes hazardous slope conditions, vegetation, soil types, and areas affected by seasonal changes in water height. All of this information must be compiled in a format that is easy to access and maintain.

**Research Objective**

The purpose of this project is to assess the suitability of using the GIS software package FieldNotes (Penmetrics, Inc.) for the mapping and data storage requirements of managing the cultural and natural resources at the River's End Ranch. Implementing the data gathering and analysis phase on computer will allow for quick updates to the data sets both in the field and the office and will allow for the complete integration of a variety of other technologies including digital imagery of the site (both from the air and the ground) and accurate positioning using GPS. This will allow for more rapid data collection and analysis by site managers.
Use of this technology on an archaeological and natural resource management issue will provide an initial source of information for others who are interested in utilizing these technologies on archaeological projects. This project will help demonstrate the usefulness of GIS, digital imagery, and GPS in the solution of archaeological problems.

**Hardware and Software Selection**

Selection of hardware and software for this project was critical. The project is based on the use of only commonly available equipment that can be obtained by most managers. The goal was to develop a system that could be effectively run on a laptop computer using a 486 or higher Intel processor. In addition to constraints on hardware, there were requirements for the software as well. The requirements for the software were:

- Be easy to use and require minimal training to become an effective user.
- Provide compatibility with a Microsoft operating system.
- Allow the handling of vector and raster data sets and database files.
- Allow for transfer of data in common file formats (i.e. .DXF, .TIF, .DBS, .TXT, etc.).
- Allow for the transfer of data to more sophisticated GIS software packages if the need arose in the future. The preferred transfer going to ArcInfo (ESRI, Inc.).
- Provide for the integration of GPS so that the system could be used for field mapping and data collection.

These criteria were met in the FieldNotes software package written by Penmetrics incorporated. FieldNotes meets all of the requirements established for this project. The package includes four applications:
FieldNotes, FieldForms, FieldNotes GPS, and FieldPack. Each application will be used on this project. The FieldNotes package will be used for the storage and handling of drawings, images, and queries to the databases. The FieldForms application will allow project managers to create custom input forms for use of data collection in the field. FieldNotes GPS will allow for the georeferencing of features in the field directly into the GIS environment. FieldPack will be used to query, edit, and modify the database.

In addition to the FieldNotes package other software will be used as well. Since FieldNotes does not provide a good set of tools for digitizing paper map products, Autocad version 13 (Autodesk, Inc.) will be used for digitizing the various paper maps that are available for the site. In addition to digitizing, Autocad will be used for drawing cleanup and enhancement. In addition to Autocad, Photopaint (Corel, Inc.) will be used to do initial manipulation of digital images and to digitally scan photographs for use in FieldNotes.

Construction of the GIS was done on a 166 MHz Pentium computer running Windows NT by Microsoft. Although the development of the GIS was done on a high end personal computer an effort was made to insure that the end products would be usable on a 486 laptop running Windows 3.11. This was done to insure that the GIS would be usable in the field on computers of modest cost.

In addition to the components necessary to construct the GIS, a variety of components were required to capture the digital images needed for the project. Imagery of the site was obtained from a light aircraft, a Cessna 182, flying approximately 900 meters above ground level. Images were recorded on Hi-8 millimeter video tape with each image center being georeferenced with GPS. The images were then transferred from video to computer by...
using Computer Eyes (Digital Vision) image capture software. Each required frame captured from the video source was stored as a .TIF file for entry into the FieldNotes GIS.

Review of the Existing Literature

The application of GIS to archaeological problems is still relatively new and the literature on the subject is not extensive. A quick review of the CD-ROM database at the Oregon State University Library showed only 26 articles published on GIS and its application to archaeology between 1989 and the present. Review of the articles showed most of them to be concerned with the modeling of social phenomena in geographic space or the specific mapping of an archaeological excavation. No articles found in this search dealt with applying GIS to cultural resource management. The following is a brief description of some of the articles that provided background information useful for the planning of this project.

*Developing a Survey System for Archaeological Study of Indian Petroglyphs* by Linda Malcom-Lim is a good analog study that relates closely to the objectives in this project. In Malcom-Lim's paper she discusses the methodology necessary for the field collection of geographic information on petroglyphs in Little Petroglyph Canyon, located on the China Lake Naval Weapons Base in southeastern California. The focus of Malcom-Lim's paper is on the development of the initial control for the project using modern surveying instruments (such as total stations and the Global Positioning System (GPS)) and the recording of the initial field data in a computer system. However, the article does not discuss the implementation of the data into a GIS. Malcom-Lim's paper provides an excellent beginning point for this project since this project is an extension of...
the work done in her paper. In addition to providing archaeologists with a method of obtaining the field data this project will provide an example of how to implement the field data into a usable GIS system. This project is a continuation of the ideas presented in Malcom-Lim's paper at a different site location.

A second article that provided useful background information for this project was entitled "Fundamentals of Airborne Video Remote Sensing". This article, published by Douglas Meisner in the journal Remote Sensing and the Environment in 1986, provided background information in the technology of aerial videography. Although this article was dated in terms of the equipment discussed, it still provided an excellent resource to the basic technologies and techniques necessary for using aerial videography as an effective data gathering tool. Of particular importance to this project was the author's discussion of flight planning. For this project a relatively large area needed to be covered at a high resolution. The author discussed the problem in video imagery of high resolution imagery covering small areas making it difficult to orient each image in the project area. To insure that the high resolution images taken for this project could be oriented small scale still photographs of the area were also taken with a 70mm camera. These pictures later helped with the orientation of the video images.

The search for books on the subject of Archaeology and GIS located two very informative books that turned out to be excellent starting points for the construction of an archaeological GIS. The first text, Interpreting Space: GIS and Archaeology, is a collection of articles written by various author's introducing the application of GIS to archeological problems. The book is divided into four sections: an introduction to the spatial problems in archaeology and the use of GIS in solving them, a look at established
methodologies in solving spatial problems in archaeology, data sources, hardware, and software currently available to the practitioner, and a section covering examples of applications of GIS to archaeological problems. This text is dated (published in 1990) but still provides much useful background information on the use of GIS in archaeology.

The second text that provides a solid introduction to the subject of GIS and archaeology is *Archaeology and the Information Age*. This text is not exclusively devoted to GIS but provides a basic introduction to the application of GIS to archaeology. This text was published in 1992 so it is more current than the previous text. Two chapters in this book are particularly relevant to this project. Chapter one is an introduction to archaeology and the information age. This chapter describes the use of information technologies in archaeology and how these technologies can expand the realm of archaeological knowledge. Chapter nine is also useful as it provides specific background information on the use of GIS in archaeology. Of specific interest in this chapter is a description of the role of GIS in improving the ability of archaeologists to apply quantitative methods to data recording and analysis.

In addition to books and articles specifically on the application of GIS to archaeology a search was also made for background information concerning the project site. Two excellent sources describing the area were located. *Oregon's Big Country* by Raymond Hatton provides an excellent background to the area describing the basic geology, geography, and history. Of particular interest in this source was a description of Indian activity immediately to the east and to the south of the study area. This information lends credibility to the thought that the study area contains Indian burial mounds.
The second source, High Desert Management Framework Draft Plan Amendment and Environmental Impact Statement for the Proposed Lake Abert Area of Critical Environmental Concern (ACEC) in Lake County, Oregon by the Bureau of Land Management, also provides good background information on the cultural resources in and around the study site. Of most importance to this study is a brief discussion of the different types of archaeologically significant structures that have been located in the area. Some items of note in the report were the presence of house pit villages, stone ring sites, lithic scatters, rock art sites, stone fences, trails, and rock shelters. While all of these structures are not currently recorded as being present in the study area it is important to note that they do occur in the geographic area so that evidence of their existence can be looked for while work is being done in the study area. In addition to the list of potential structures that might occur in the study area, this report also indicates that areas in the location of the River's End Ranch have been identified by the Northern Paiute as sacred sites which were used by medicine men. This information serves as an indicator of the importance of the site to Native Americans and to the need for cautious management of the area.

Review of the literature shows that there is a solid background knowledge on which to build this project but that the current literature falls short in enough areas, particularly in relation to rapidly advancing technology, to make additional work in the area a positive contribution to the knowledge base in applying GIS to archaeology.
site. After the data was obtained it had to be placed in a digital format that was acceptable to the FieldNotes software package. The process of creating a GIS for River's End Ranch involved nine steps (figure 3).

The first objective was to clearly define the problem. For River's End Ranch the main problem was to identify Indian burial mounds and their relationship to the reservoir. The secondary problem was to identify and map lithic scatter sites. Once these problems had been identified the project could then move to step two.

The second step was to identify the data sets necessary to aid in solving the problems. For this project it was determined that the GIS would need to contain several different types of information. The GIS would need to contain map layers of the site showing topography, wetlands, hydrology, borders between private and public land, and known archaeological sites. In addition to the map information the GIS would also need to be tied to a database describing the contents of each of the mapped sites. Another data set that was included in this GIS to enhance its usefulness in the field and obtain data on reservoir levels at different time intervals was aerial digital images of the site registered to the map. During this phase of the project it was also necessary to identify a grid system to register the maps and images to. For this project the Universal Transverse Mercator (UTM) coordinate system based on the North American Datum of 1983 (NAD83) was chosen.

After determining which data sets were required a search was conducted for existing data sets that could be digitized and placed in the GIS. Topographic data and various modern cultural features were obtained from the Coglan Buttes SE Oregon quadrangle and the Lake Abert South Oregon quadrangle. Map data and descriptions of the burial mounds were obtained from the Bureau of Land Management.
Identify the problem to be solved using GIS

ID data sets necessary to solve problem

Research to locate existing data sets

Analyze existing data for suitability

Decide on data sets to be gathered in the field

Is Data set complete?

Collect field data

Analyze all data sets for completeness

Create GIS from the data sets

Field verify GIS for accuracy
After acquiring as many existing data sets as possible they were analyzed for suitability to the project and then step five was begun. In step five it was determined what data must be obtained in the field. Digital images were the only data set gathered in the field prior to construction of the GIS.

After all data sets had been gathered and analyzed for completeness, they were placed in the GIS. For the paper map products this involved digitizing the maps using a digitizer. For the digital images gathered in the field it involved transferring the .TIF files into the FieldNotes software package.

The final step in the project development was field verification. In this step the GIS was taken to the field and spot checked for accuracy using a GPS. Errors and omissions were noted and corrected in order to produce a working product.

Using FieldNotes

The last section explored the general outline of how a GIS will be created for River's End Ranch. The specifics of how the GIS will be put together in FieldNotes will be discussed in this section.

The first objective in creating the GIS was to import all of the existing data into FieldNotes. This involved importing the Autocad drawings and the digital images of the project into FieldNotes (Figure 4).

The drawings were originally created in release 13 of Autocad. This was done to take advantage of the latest computer drafting technologies to speed the compilation and creation of base maps. Version 4.0 of FieldNotes will not read an Autocad 13 .DWG file so the drawings had to be saved using the Autocad 13 command to save a drawing in the release 12 format. Once the drawings had been converted they were imported into FieldNotes using that program's ability to read .DWG files.
Figure 4 - The above picture is an example of a typical image/map overlay in the FieldNotes GIS package. In the example the reader can see an aerial image registered to a portion of the topographic map for the site. In addition, the symbols used for the burial mounds and the lithic scatter sites are also shown (a cross and arrow respectively). Clicking on the arrow or the cross will enter the user into a FieldForm for data collected at that specific location.
Once the site drawings had been loaded, symbol drawings were created to be used by FieldNotes as symbols for burial mounds or lithic scatter sites on the drawing. These drawings were also saved as .DWG files and moved to FieldNotes.

After loading the applicable site drawings into FieldNotes the digital images had to be imported. Importing the images involved modifying them from their original 24 bit .TIF file format to an 8 bit greyscale .TIF file. This was required since FieldNotes cannot handle images greater than 8 bits. 8 bit images were created by importing the original 24 bit into Photopaint and then converting the image.

After the images had been converted to 8-bit drawings, they had to be rotated so that the image was aligned within 3° of grid north. This step was necessary since FieldNotes cannot maintain the integrity of the drawing when registering to control points if it is out of alignment by more than 3°. This proved to be a difficult task for this project since the aerial images were taken following the contour of the lake and most of the images were anywhere from 150 to 90° off of grid north. In the full implementation of this GIS this would require the re-orientation of 24 images. The rotation of the images to grid north was accomplished in Photopaint since the ability to rotate images is not incorporated into the FieldNotes package.

Creation of databases for FieldNotes was the next step. Two databases were required for this project. The first database is for the burial mounds and the second is for the lithic scatter sites. Both databases were created in the Microsoft Excel spreadsheet and saved as a dbaselV file readable by FieldNotes.

Once all the files had been properly formatted and imported into FieldNotes they were all opened under a project name so that they all open...
automatically when that specific project is opened. This step saves the user from having to open all of the files every time FieldNotes is started.

Once all of the data had been imported into FieldNotes the GIS had to be customized to fulfill the two initial objectives of this project; map and catalog the Native American burial mounds and the lithic scatter sites. FieldNotes was customized for data entry using the FieldForms package that comes with FieldNotes. A specific data form was created for each of the mapping exercises planned for this project.

**Using FieldNotes to Map Burial Mounds**

One of the key problems associated with this project is the cataloging of artifacts at burial mound locations throughout the project site. The burial mounds at the reservoir had been mapped recently (A map created by the Bureau of land Management in 1995 was used) but the contents of the mounds and their general structure had not been cataloged. In order to facilitate the cataloging of the burial mound's contents in the field a digital FieldForm was created using the FieldForms package. This form is designed to speed data collection in the field, make the collection process more uniform, and help maintain a record of data that was generated at each site but was not included in the GIS.

The FieldNotes FieldForm for mapping the burial mounds contains four pages that the user may select to either view or modify the database from (figure 5). The first page of the FieldForm provides a sheet for a field worker to place basic site data about the mound. Information on this sheet includes several items. The first items include the name of the investigator and the date the investigation was done. The catalog number for the burial
mound is also recorded here. This number corresponds to the number assigned to each mound on the BLM site map.

Figure 5 - Example of the site data sheet created for the burial mound sites.

In addition to the basic data the page also requires the entry of the mounds UTM coordinates (representing the center of the site). Included on this first page is also the basic dimensions of the site and a cross-reference to the outside field books, drawings, and photographs. This space is provided because it is understood that there will be data at each site that will not perfectly fit the FieldForm but will need to be recorded. This information will allow researchers to keep track of paper data as well as digital data using FieldNotes.

The second page of the FieldForm provides a brief data sheet to describe the contents of the mound if it is excavated. This form includes information on whether remains are present, estimated age of the skeleton, position of the skeleton, and its gender. This information is then related to page three which
provides the excavator with a check off sheet to list the numbers of different types of bones found.

The final page of the form contains a photograph taken of the site (figure 6). This page is provided so that office workers can use the information in the GIS and have ready access to a picture of the site. The image included on this page will consist of a 35mm photograph that has been scanned and imported into field notes.

![FieldForm for Mound Data](image)

**Figure 6 - Example of the FieldForm for displaying the digital site image for a cataloged burial mound.**

FieldForms also allows the GIS user to create much more sophisticated forms as the needs of the project grow or change. The FieldForm for cataloging burial mounds can be easily linked to other databases if the user decides that it is necessary to record more information at each site. Recording data using FieldForms will allow field workers to collect data more rapidly and more accurately. The use of the form also helps to insure that no important information is missed at each site.
Using FieldNotes to Map Lithic Scatter Sites

Mapping the lithic scatter sites at River's End Ranch involves an additional step that is not required in the cataloging of the burial mounds. The location of the burial mounds is already mapped in the GIS and the FieldForms are merely a method of cataloging additional data about each site. However, the lithic scatter sites need to be mapped to the GIS and have an inventory done of the artifacts found at each site.

To map the lithic scatter sites the FieldNotes package will be linked to a GPS receiver and taken to the field. Once in the field the researcher traverses the site and records the position of each scatter site found. The position data, UTM zone 10 coordinates, are added to the FieldForm and a symbol is added to the map/image overlay (a red arrowhead for this GIS). The user can then click on the scatter site symbol and begin recording data about the site.

Like the FieldForm for the burial mounds the FieldForm for the scatter sites is divided into different pages for different types of site data. The first page contains a general information sheet like that for the burial mounds. The sheet includes the sites position (which was obtained by GPS), the excavator, the date, outside reference sources, and general information about the site (See figure 7).

The second page of the FieldForm contains data on the site contents (figure 8). This is intended to be a basic catalog of what is found at each site and not a detailed description of the artifacts. It is assumed that researchers will keep detailed notes and photographs on specific artifacts and that these will be referenced in the first page of the FieldForm.
Figure 7 - Page 1 of the lithic scatter site FieldForm prompts the user for general site data.

Figure 8 - Page 2 of the lithic scatter site FieldForm allows the user to enter data about the contents of the site.

Page three contains a ground level digital image of the site. Like the image provided for the burial mounds this image is intended to help orient researchers returning to the field for further study and give office workers a better idea of the site.
Discussion

Any solution to a complex problem will not be completely satisfactory and this is the case with using FieldNotes to manage cultural resources at the River's End Ranch. Although none of the problems encountered in this pilot study detract from considering FieldNotes to be a viable management tool, they do need to be considered when planning full-scale implementation of FieldNotes to the River's End Ranch study.

The FieldNotes software package is a powerful tool for storing and manipulating vector drawings, raster based images, and database files. This software does not, however, provide all of the tools necessary for manipulating the various sets of data. During this study three other software packages were required to make the sets of data acceptable to FieldNotes.

The tools provided by FieldNotes to work with drawings are extremely limited. FieldNotes does provide tools for drawing lines, arcs, and polylines. It also has the ability to work with a digitizer. However, these tools are quite limited and very weak compared to those on most commercial computer aided drafting programs. FieldNotes' weak drawing tools made it necessary to use Autocad release 13 for the initial creation of all drawings and graphic symbols.

In addition to limited drawing tools, FieldNotes also has very limited tools for handling digital images. This proved to be a great inconvenience in this study. As was mentioned earlier, FieldNotes cannot handle digital images that are out of alignment from the drawing the image is to be registered to by more than 3°. To deal with this problem a separate image processing package, Corel Photopaint, had to be used. Each image must be imported into this or a similar package and reoriented to correctly align with the drawing that is to be imported into FieldNotes. Another problem
encountered was that FieldNotes cannot be used to create mosaics out of digital images. This must also be done in a separate software package.

The third software package that was used in addition to FieldNotes in this study was Microsoft Excel. This was used to create the necessary database files for the burial mounds and the lithic scatter sites. Any package that can create and manipulate data in the DbaseIV format can be used for this. An additional database program is useful since FieldPack cannot create databases.

These problems are not difficult to overcome but must be fully understood by any project manager choosing to implement FieldNotes. These additional software packages must be available to create and manipulate the initial data and a manager must have available someone with the expertise to run them. The need to run these software packages also increases the demand on at least one computer associated with the project as both Autocad and Photopaint require more computing power than FieldNotes.

In addition to the need for using other software packages to supplement FieldNotes two additional problems arose during the course of this study.

All of the digital imagery collected for this study was in the form of 24 bit .TIF files. FieldNotes is only able to read 8 bit digital images. This required that all of the images for the site be converted to 8 bit images. For this project this included both the aerial videography and the scanned photographs. In order to convert each of the images it was necessary to import them into Photopaint and use the image conversion tool. During the conversion process the images were also changed from color images to greyscale images. It was found that the greyscale images provided a clearer image with greater contrast than the same image in an 8-bit color format.
The second problem was associated with FieldNotes inability to handle large data files. The original base map for River's End Ranch was a Autocad .DWG file that was 1.8 megabytes in size. When this drawing was loaded into FieldNotes in its entirety it produced fatal errors and FieldNotes would not execute correctly. The only way to solve this problem was to break the drawing down into smaller pieces and create an individual file for each smaller drawing. This problem appears to be software related as the machine running FieldNotes for this project had 64 megabytes of internal RAM which was more than adequate for the memory requirements of both FieldNotes and the drawing file. For the full implementation of FieldNotes to this project the site would need to be broken into grid areas so that the drawing files and images are manageable by FieldNotes.

After discussing the limitation of FieldNotes as a software package it is important to note that these problems are related to version 4.0 of the software. At the time of writing this paper, Penmetrics is completing the beta testing of FieldNotes 32 [Dunn, 1996]. FieldNotes 32 will provide the user with a more advanced tool set, improved capacity to handle large files and the ability to use 24 bit images. When this version of FieldNotes is released it will solve many of the problems mentioned earlier.

The final concern that came up in this study was the use of laptop computers in the harsh environment of south-central Oregon. Two problems arose from the use of a laptop at field sites. The first was power requirements. The battery in a typical laptop will last about three hours if the user is only working with the computer and not accessing the hard drive with much regularity but FieldNotes requires the use of the hard drive which can lower battery life further. In order to insure that a worker can use the computer for an entire eight hour work day while in the field the worker
would need to carry at least four batteries. In addition to carrying the batteries some provision must be made for recharging all of them at the end of the day. This becomes an important consideration for extended periods of field work.

The second concern is the durability of the laptop itself. Most laptops are fairly rugged but are not designed to be used in the rain, extreme cold, or excessive dust. All conditions that occur at the River's End Ranch. To solve this problem field workers must use extreme care to protect their laptop. The second alternative is to purchase field computers designed for outdoor use. This would add a great deal to the startup cost of the GIS system.

Although FieldNotes does not provide the "perfect" GIS solution it does provide a very solid management tool if its shortfalls are fully understood prior to full implementation. FieldNotes has many attributes that make it ideally suited for this type of project.

Although FieldNotes requires a lot of support software to create the initial GIS system it is self-sufficient for field work. All of the tools necessary to add to and modify the drawings and the databases are present in FieldNotes. FieldNotes also has an extremely small learning curve. It takes about 1/2 hour to teach a user with computer experience in Microsoft Windows how to access project files and enter field data using the FieldForms that have been created. These are the only tasks that are required of a field technician. For the person setting up the GIS, FieldNotes is also relatively easy to learn. The first FieldForm I created in FieldNotes took only four hours. Creating forms after that took only about 1/2 hour to 3/4 of an hour depending on the complexity of the database the form was associated with. Overall the package is easy to learn and intuitive for person's with experience in the Microsoft Windows operating system.
In addition to being easy to use, FieldNotes is easy to modify. Adding additional data to the GIS is easy. For example, if a user wanted to create a database for sampling vegetation at various locations in the site only a simple series of steps is required. First, the user must create a database of the information that is to be gathered at each site. Then the user creates a FieldForm to enter the data from FieldNotes to the database. With the addition of a symbol to the drawing file at each location to be sampled the users task is done. FieldNotes can now be used to collect data on vegetation at various sites. The ability to easily modify FieldNotes makes it very versatile and easily adaptable to other management tasks at the site.

Conclusion
FieldNotes is an excellent software tool for mapping and managing the cultural resources and River’s End Ranch. This project has demonstrated that FieldNotes will accept the site data associated with the River’s End Ranch and that it can be used to collect and maintain data on archaeological sites found at the ranch. Although the software did have some limitations it was demonstrated that these could be overcome and, with the new release of FieldNotes 32, may no longer be a problem.

In addition to proving the usefulness of the software, this paper also demonstrated the potential of using GIS to address archaeological problems. The use of FieldNotes to map and catalog burial mounds and lithic scatter sites will provide a useful example for expanding the role of GIS in the field of archaeology.
References


References cont.
