THE USE OF MOBILE MAPPING TECHNOLOGY TO AUTOMATE SURVEYING AND MONITORING OF SOUTHERN PINE BEETLE INFESTATIONS

A Thesis

by

SAUL DAVID PETTY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2005

Major Subject: Forest Science

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Approved as to style and content by:

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May 2005

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ABSTRACT

The Use of Mobile Mapping Technology to Automate Surveying and Monitoring of Southern Pine Beetle Infestations. (May 2005)

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Co-Chairs of Advisory Committee: Dr. Robert N. Coulson
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The USDA Forest Service, Forest Health Protection, is responsible for maintaining an ORACLE database named the Southern Pine Beetle Information System (SPBIS). SPBIS was designed to store survey data for Southern Pine Beetle (SPB) infestations on federal land across the southern United States.

The main purpose of this project is to improve the SPBIS database to aid in management of SPB infestations to reduce losses, to harvest compromised timber while it still has value, and to assist resource managers in preventing further infestations from becoming established. The SPBIS mobile mapping system addresses current problems with the database and offers viable solutions to each.

Mobile mapping technology is a versatile tool, which is used to collect field data, with unique geospatial time tags and attributes, for integrating into or updating a GIS (Rasher 2001). The ability to efficiently collect data is essential to developing a useable database.

The time required to manually enter data into the database is substantial. Ranger district personnel often do not have the time or the desire to enter data. Currently, the database is lacking years of survey and infestation data due to these negligent data entry practices, limiting the usefulness database.

Currently, SPBIS data is recorded on a paper survey form. This system introduces a digital version of this form. A time study conducted to define the efficiency of each survey showed that the digital form to be more efficient with a Mann-Whitney p-value of 0.004. A comparative study was conducted to define the difference between currently estimated SPB infestation acreage and those measured using GPS. A Mann-Whitney p-value of 0.000 shows the significant difference between the two acreage values. GPS measured acreage proved to be more accurate thus promoting the use of GPS for measuring acreage. Navigation using GPS coordinates was successful and will greatly decrease the time required to locate a SPB infestation on the ground.

This thesis describes a mobile mapping system designed specifically to remedy the problems associated with SPBIS. This system eliminates the need for manual entry of field-collected data, while improving field data collection in terms of efficiency and accuracy.

DEDICATION

I would like to dedicate this thesis to my family, for all their love and support.

ACKNOWLEDGMENTS

I would like to thank the following people for their help with this project: Robert N. Coulson, Forrest L. Oliveria, Crawford W. Johnson, James R. Meeker, Chris A. Steiner, William Bruce, Alexander C. Mangini, Stephen R. Clarke, James D. Smith, Valli Y. Peacher, Timothy J. Haley, Anthony W. Courter, Judy Adams, Maria Tchakerian, Sindhu M. George, Audrey Bunting, Jaehyung Yu, Robert A. Smiley, Jay P. McClain, and Ray C. Henderson

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CHAPTER I

INTRODUCTION

Goals and Objectives

The specific objectives of this project are to; (i) develop a digital version of the Southern Pine Beetle Information System (SPBIS) field data collection form; (ii) develop an interface between the SPBIS database the Trimble© GeoXT™ mobile unit to facilitate seamless data upload; (iii) conduct comprehensive field testing of the Trimble© GeoXT™ mobile unit and the digital form; (iv) develop a SPBIS mobile mapping training manual for USDA Forest Service personnel at the Ranger District level and; (v) streamline SPBIS data collection and entry process in order to make real-time data available for operational purposes.

Purpose

The main purpose of this project is to improve the SPBIS database to aid in management of SPB infestations to reduce losses, to harvest timber killed by SPB while it still has value, and to prevent additional infestations from becoming established. Current problems with the SPBIS data entry and collection process have prevented the database from being a useful tool. Negligent data entry practice is the primary problem. The new data collection system developed with this project will correct many of the current problems and aid in developing SPBIS into a useful tool for operational resource management decision-making.

This thesis follows the style of Environmental Entomology.

Approach

This thesis is organized into six chapters. Chapter I provides goals and objectives and a description of the project. Chapter II provides background information for each component of this project. Chapter III details the methods and materials used to achieve each objective. Chapter IV provides all measured results. Chapter V provides discussion of each objective. Chapter VI provides conclusions and potential future applications. Appendices to this thesis will include a hard copy of the VB Script code for the SPBIS data form, the VB Script code for the SPBIS data upload application and a SPBIS Data Collection User's Manual. See Figure 1 for a complete thesis outline.

Technologies Involved in Mobile Mapping and Automated Data Collection

Mobile Mapping

Mobile mapping can be defined as "the ability to collect field data, with unique geospatial time tags and attributes, for integrating into or updating a GIS" (Rasher 2001). Mobile mapping allows for the collection of a variety of data types at any time and place. The differences between mobile mapping and automated data collection are subtle. Automated data collection can be done from a stationary position, while the term mobile implies that data is collected on the move. Mobile mapping systems are designed to facilitate automated data collection in the field. Mobile mapping was initially developed by NASA's Center for Mapping and the University of Calgary, Canada (Gajdamowicz as in Xiao and Zhang 2002). Three major components comprise a mobile mapping system: GPS, a GIS and a hand-held mobile device for data collection.

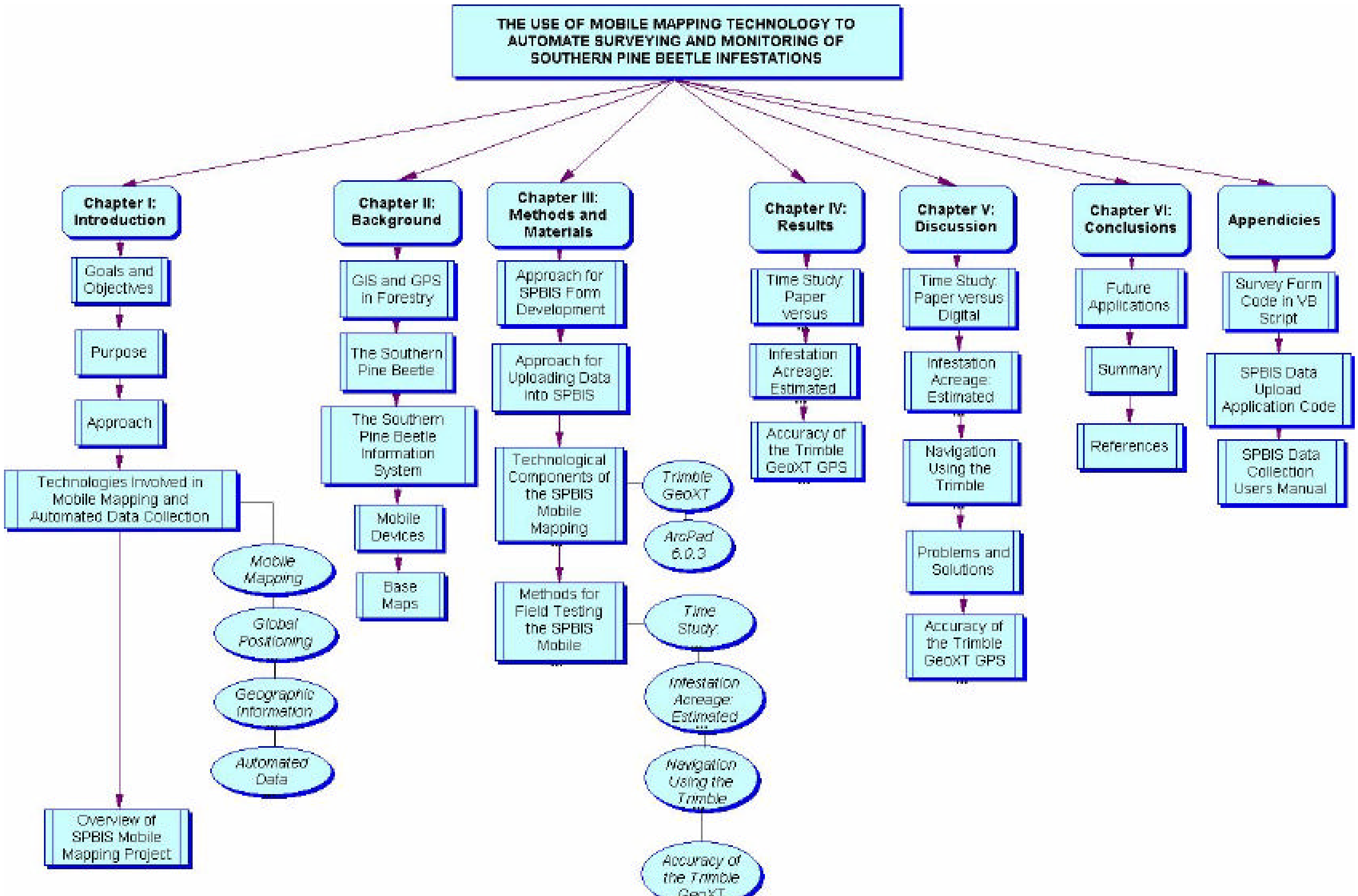


Figure 1. Thesis outline

Global Positioning Systems (GPS)

Current uses for the Global Positioning System (GPS) range from recreational to military applications. GPS was developed by the United States Department of Defense in the 1960s. The original satellite positioning system, developed in 1964, was called the Navy Navigation Satellite System. It was comprised of seven satellites orbiting the earth and was used by ballistic missile submarines to update their internal navigation systems. Current GPS technology can achieve sub-centimeter accuracy with high-end receivers, which proves sufficient for most applications.

The GPS constellation consists of 30 Block II, Block IIA and Block IIR satellites. The name block refers to the fact that the satellites were deployed in groups, or blocks. The subsequent number refers to the design model. The Block IIs were the first fully operational GPS satellites. These satellites were designed to operate 14 days without contact from the Control Segment (USNO BLOCK Satellite Publication 2004). The Control Segment consists of a Master Control Station located at Schriever Air Force Base in Colorado Springs, Colorado and monitoring stations located on Hawaii, Kwajalein, Diego Garcia and Ascension Island (NAVSTAR GPS Joint Program Office 2003). Nine of these satellites were launched between February 1989 and October 1990. BLOCK IIAs are second-generation GPS satellites. They were designed to operate 180 days without contact from the Control Segment. Over this 180-day time period signal degradation becomes evident. Nineteen of these satellites were put into orbit between November 1990 and November 1997. Both the BLOCK II and IIA were developed by Rockwell International and have a projected life of 7.3 years. Each satellite contains four atomic clocks and has Selective Availability capabilities (USNO BLOCK Satellite Publication

2004). The BLOCK IIR satellites are the newest generation of satellites utilized by the GPS. First launched in January 1997, these satellites have a projected life of 7.8 years. They were developed by Lockheed Martin and were designed to "provide at least 14 days of operation without contact from the Control Segment and up to 180 days of operation when operating in the autonomous navigation mode"(USNO BLOCK Satellite Publication 2004).

GPS receivers utilize triangulation of satellite navigational signals to obtain a position. When GPS was first introduced users were limited to certain "windows" in which satellite signals could be acquired. The increased number of GPS satellites allows users to have an extended period of time in which a signal can be acquired.

Geographic Information Systems (GIS)

GIS can be defined as "an arrangement of computer hardware, software, and geographic data that people interact with to integrate, analyze, and visualize data; identify relationships, patterns, and trends; and find solutions to problems. GIS are designed to capture, store, update, manipulate, analyze, and display the geographic information" (Kennedy 2002). GIS is being integrated into a variety of fields and is the preferred method of manipulating and displaying spatial data. GIS technology has become more readily available to consumers on both a technical and economical basis.

GIS technology was developed as its own entity, completely independent from the workings of the organizations that utilized its output. The use of a GIS was limited to relatively few, highly trained experts. GIS professionals generally carried out tasks on behalf of others within an organization (Harrington and Lauer 2004). These professionals performed operations on powerful stand-alone computers. Today users have access to

GIS software on their personal computers, and with relatively little training a user can produce viable output.

GIS allows users to easily manipulate and display geographical data. The term data is used to describe "any collection of related facts arranged in a particular format; often, the basic elements of information that are produced, stored, or processed by a computer" (Kennedy 2001). Quality data is essential to creating a useable GIS application.

There are three main ways in which GIS data can be obtained: public domain, commercially, or self-produced. An abundance of GIS data can be accessed via the Internet for little or no cost. Data that are considered public domain often includes census information, public roads, public waterways, municipal boundaries, and many other common features. This data are often made available by government agencies at the local, county, state, or federal level. One drawback to public domain data is the fact that the data are only available "as-is".

Commercial data provides the user with more options, but at a higher price. Some commercially collected data can be extremely expensive. Reasons for high costs include the seller's need to offset collection costs, and the desire to limit use of the data to serious users only. Commercially collected data are often of a higher quality than that of public domain as the collectors often have a wealth of resources at their disposal. In certain cases it is possible to obtain customized data sets from commercially gathered data as it is often more comprehensive, thus catering to a greater range of needs.

The third method of obtaining GIS data is self-production. The major advantage of this method is the data will be collected to the user's exact specifications. While this would be the preferred method of collection for most, it is an extremely expensive endeavor. Data collection, whether done by ground personnel or by remote sensing equipment, is time consuming. Equipment and man-hour costs are extremely high making this method ideal but often not feasible. As far as data acquisition is concerned, “if the data you need for a project exists, use it; don’t take the time to replicate it” (Srinivasan 2003).

GIS data come in many different forms. Current software packages can read a variety of file formats. GIS data file formats include shapefiles, digital orthoquads (DOQ), digital raster graphics (DRG), multi-resolution seamless image database (MrSID), and bitmaps (BMP), among others. These file formats can be obtained using all of the methods mentioned above. GIS files, if they are created correctly, have an information file associated with them known as metadata. Metadata is defined as information about the content, quality, condition, and other characteristics of data (Kennedy 2001). Metadata is used to document how, when and where data were collected, as well as, its projection, scale, resolution and accuracy. Metadata consists of two features: properties and documentation. Properties are derived from the data source and include coordinate systems and projections. It is important to have metadata files for all data sets. When trying to combine data from many different sources, it may become necessary to make transformations to ensure all the data combine properly. In order to make certain transformations, information about a data file is needed. This information is also contained in the metadata.

Automated Data Collection

The evolution of field data collection has increased exponentially in recent years. Traditional data collection often consists of a field technician manually recording observations. Advances in hand-held mobile device technology have increased the opportunities for automated data collection. Hand-held mobile devices are personal computers designed for field use. For mobile mapping applications, they integrate a user-friendly operating system, GIS software, and GPS capabilities to allow for efficient and accurate data collection. Mobile devices come equipped with many different software and hardware configurations to suit the needs of the individual user. It is important to consider the environment in which the mobile device will be used. Field conditions are more variable and often much harsher than those in an office environment. It is important to consider the functionality of the device in the field and, most importantly, protection of collected data. The memory capacity and processor speed of the device are also important. The device must have enough memory to sufficiently store data, while being able to efficiently operate GIS software, which is often graphically intense. The software utilized by the device must also be compatible with the software on a desktop computer in order to facilitate data transfer. Mobile devices are constantly changing, becoming more compact yet more diverse in their capabilities.

This brief overview of the components of a mobile mapping system is intended to show that these technologies, while having several inherent drawbacks, will continue to improve. This thesis will discuss in depth one specific mobile mapping application in the field of forest entomology.

Overview of the SPBIS Mobile Mapping Project

The USDA Forest Service, Forest Health Protection Unit is responsible for surveying and monitoring all insect and plant pathogen problems on national forests in the southern United States. The SPB is the most extensively monitored insect pest in southern pine forests.

The sequential steps in surveying and monitoring the SPB are illustrated in Figure 2. The survey begins with aerial sketch mapping. The traditional method of aerial sketch mapping involves manually marking the location of SPB infestations on a paper map. Digital aerial sketch mapping is a new technology that utilizes GPS and GIS technologies to allow the surveyor to mark areas on a digital map, which are in turn converted into a data format that can be used in a GIS. Each location marked on the map has GPS coordinates associated with it. This data can then be uploaded into a hand-held device and used for navigation purposes. It is often difficult to locate infestations on the ground using traditional navigation methods. GPS coordinates allow the surveyors to reach the desired location more quickly.

Once a spot has been located, a survey form is completed. The current form consists of a single sheet of paper containing blank fields for each desired data type. The data are collected on the paper form and manually entered into the SPBIS database.

It has been determined that the primary restriction in the current SPBIS data collection process is data entry. Entry of data into SPBIS is a time consuming process and is often neglected. When SPB outbreaks occur during the summer, district personnel have limited time in which to enter survey data into SPBIS. In order for SPBIS to be used as an operational management tool data must be entered in timely manner. Given the current situation SPBIS data are not used for operational forest management decision-making. The database serves as storage for historical outbreak records. The combination of a mobile GPS unit and a digital upload interface between the unit and SPBIS will allow surveyors to collect data in a digital format and upload it directly into the database. This will eliminate much of the need for manual data entry.

The shortcomings of the SPBIS database will continue to be compounded if the development of a dependable system for data acquisition and processing is further delayed. With little or no data entry occurring, information for decision-making is limited. This severely limits the ability of managers to develop plans for prevention and suppression.

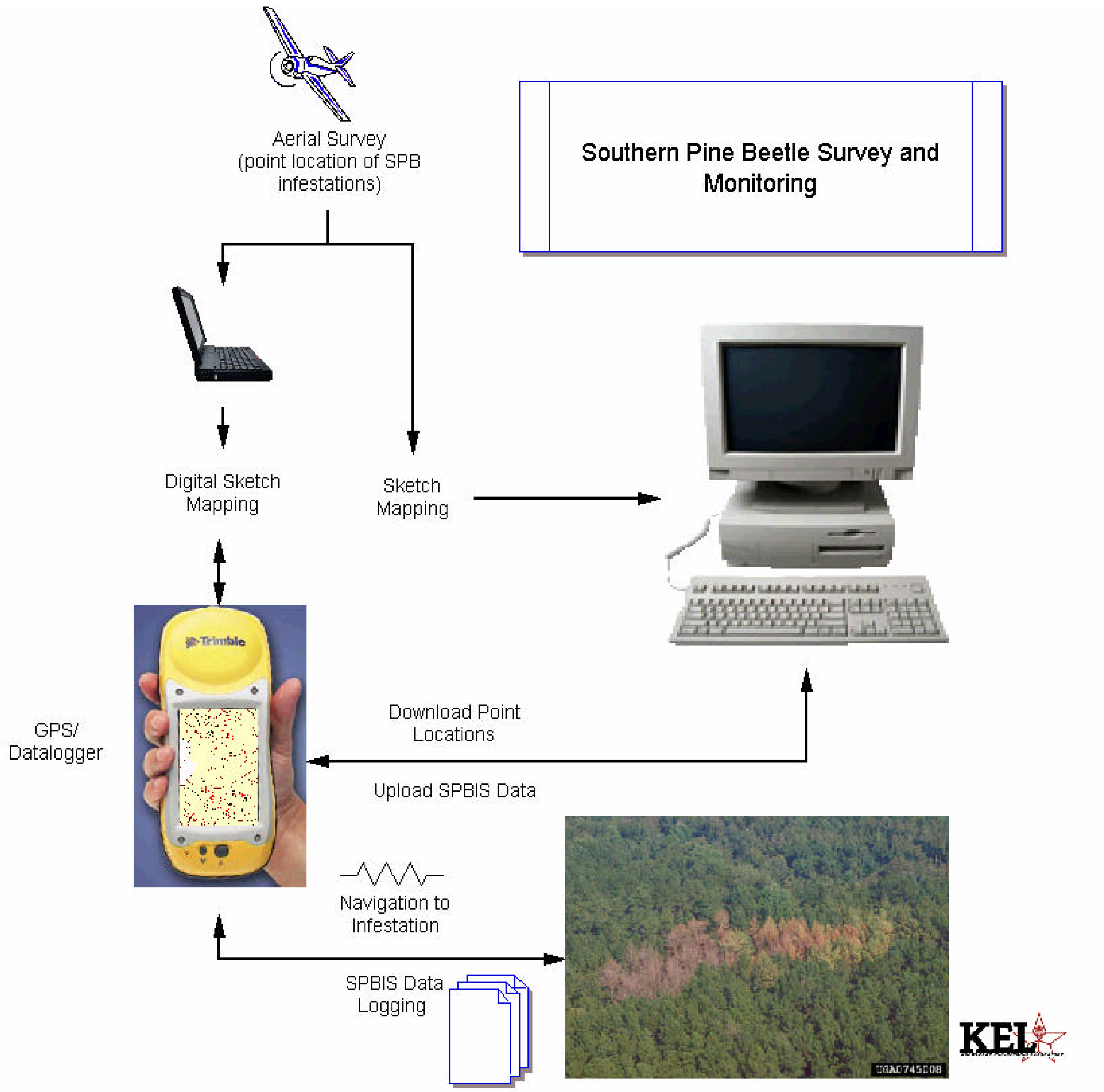


Figure 2. SPBIS mobile mapping project flow chart

CHAPTER II

BACKGROUND

GIS and GPS in Forestry

Applications of mobile mapping in forestry are among the most diverse of any field of study. One general example of the utilization of a GIS is in forest management. The world over, forested lands are being managed for a variety of objectives, from traditional timber harvest to aesthetic value for visitors. No matter what the objective, a management plan is required. One option that is becoming more prevalent is spatial forest planning. The term spatial refers to "any information about the location and shape of, and relationships among, geographic features" (Kennedy 2001). Spatial forest planning can serve as a means of guidance for management within an increasingly complex framework of regulations, voluntary program guidelines, and the need to efficiently manage forest resources in a changing management environment. Many regulatory, environmental, and economic factors can be addressed using this method of planning (Bettinger and Sessions 2003). Spatial forest planning is a dynamic process that requires some degree of database development and maintenance. Once a working database has been established, researchers can utilize outputs to aid in making management decisions.

A more specific example of the use of a GIS in forestry is the digitizing of national forest land in the United States. In recent years changing attitudes toward national forests have increased demands to manage forests in a socially acceptable and ecologically sustainable manner (Wiley and Weih 1997). GIS provides an easy way to develop and maintain a management plan to meet these objectives. One of the first objectives of national forest systems across the country was to create digital files of all the geographic features that comprise the forest. Each National Forest was faced with the enormous yet necessary task of digitizing all of their data.

When considering database development, it became necessary to determine what types of data were being collected and devise methods to store, view, integrate and evaluate many different data formats. Some of the data formats that were being digitized were tabular records, tables, charts, analyses, color slides, color and black and white photographs, stand maps, and plot diagrams to name a few (Wiley and Weih 1997).

The most prominent digitized geographical features include compartment boundaries, stands, water, and road networks. Some secondary features may include wilderness areas, landmarks, specific wildlife habitats, and controlled burn areas. Several of these features are dynamic in nature and require continuous updates. For example, features such as compartment boundaries do not change very often, but features such as burn areas are likely to change from season to season. These features are often converted into a digital format known as a shapefile. In general, shapefiles are delineated as points, lines or polygons. They are easily created and manipulated within GIS software packages and provide a digital view of any geographic feature. Once data are integrated into a GIS it is possible to develop timely, real world models for planning and management.

In recent years several technological developments have had a significant impact on how data are collected, manipulated and displayed. Identification and cataloging attributes such as species, size, health, and location are important to developing a successful management plan. The use of mobile mapping technology makes this task easy to accomplish. GIS allows for the “rapid access, processing and updating of large amounts of data” (Kane and Ryan as in Adnan et al. 2001). The combination of GIS and

GPS for forest management allows the manager to quickly produce accurate maps, which can display a wide variety of information.

The Southern Pine Beetle

SPB is the most destructive insect pest in southern pine forests. The beetles range from the southeastern United States to parts of Mexico and Central America, as shown in Figure 3. The beetles are an indigenous species and damage reports date back to the late 1700s (Payne 1980). Due to the destructive nature of this pest, millions of dollars are spent annually on control, monitoring, and research in an attempt to curtail losses.

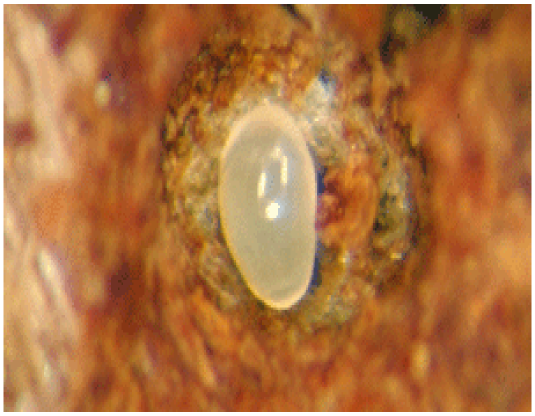
The SPB is a very aggressive species of bark beetle that can kill many acres of healthy forest when populations reach substantial numbers. The preferred hosts of this insect include loblolly pine, *Pinus taeda*, and shortleaf pine, *Pinus echinata*, though the beetles will attack several other pine species, as well (Payne 1980).

The SPB is about the size of a grain of rice. Figure 4 illustrates the life stages of the beetle. Adult beetles attack living trees by boring into the bark and feeding on the phloem tissue. Eggs are also deposited in the phloem. The new generation feeds in the phloem, emerges through the bark and disperses to colonize new trees. The ability of the beetle to kill a healthy tree is attributed, in part, to their mass attack of trees over a relatively short period of time. The mass attack process is initiated by adult females, which bore into the tree and release pheromones that in combination with volatiles from the damaged tree attract large numbers of beetles.

Figure 3. Southern Pine Beetle distribution area (Payne 1980).

If a sufficient number respond they overwhelm the defenses of the host tree, and then begin attack on adjacent trees. Infestation scale can range from one tree to hundreds of acres. The duration of each generation of beetles ranges from 26 to 54 days, with three to nine generations occurring per year depending on geographic location (Payne 1980). To illustrate the magnitude of loss caused by these insects, an estimated $901.8 million in damage was reported during the period from 1960 to 1990 (Price *et al.* 1992).

Despite years of research, there are currently no effective short-term control measures for this pest. In order for this problem to be remedied in the future an accurate historical record, as well as, real-time data must be made available. The Southern Pine Beetle Information System (SPBIS), which will be discussed in detail in the next section of this chapter, has the potential to meet both of these needs. Current problems with the database have limited its utility. This thesis deals with a tool that will streamline the data acquisition and storage process thus making SPBIS a functional tool.



Egg

Larvae

Pupa

Callow Adult

Adult

Figure 4. The life stages of *Dendroctonous frontalis* Zimmerman, the Southern Pine Beetle (Payne 1980).

The Southern Pine Beetle Information System

The Southern Pine Beetle Information System (SPBIS) is an ORACLE® database that was developed for and is maintained by the USDA Forest Service State and Private Forestry Region 8 Forest Health Protection. The Southern Region (Region 8) encompasses 13 states from Texas to Virginia, including Tennessee and Kentucky to the north and Puerto Rico to the south. The SPBIS database is “a Ranger District based system for the storage and retrieval of information about the location of individual SPB infestations, scheduled activities, and accomplished activities” (SPBIS Installation Guide 2002).

The primary purpose of SPBIS is to store SPB infestation records that can be later used for suppression and monitoring activities. Under ideal conditions, personnel on each district enter data on a weekly basis. If data are entered on a regular basis, then the database reflects real-time status of all current SPB activities as well as historical spot records. Users can then produce status reports on a regular basis allowing them to make informed decisions concerning monitoring and suppression activities. While this process appears to be simple, SPBIS has seldom, if ever, been a useful tool. The following is a brief history of the development of SPBIS.

SPBIS was originally developed in the late 1970s and resided at the Ft. Collins Computer Center as a group of FORTRAN computer programs. In 1983, SPBIS was revised and placed on Apple II computers at the District level. In 1988, SPBIS was released utilizing the Forest Service Data General computers. SPBIS 2.0 was released January 1999 and was designed to run on the IBM RISC 6000 computers at Forest Service Regional, Forest, and District offices. SPBIS 2.0 uses the ORACLE® database management system, and ORACLE® Forms. SPBIS 2.1 was released in December 1999. It moves the forms from Exceed to PC. SPBIS 3.0, released in March 2002, included a new graphical user interface (GUI). The new GUI was developed in Visual Basic, and provides the user with more assistance and functionality. Data entry has been streamlined to minimize the need for training, and data integrity has been improved through a new, supplemental error checking routine (SPBIS Installation Guide 2002).

The SPBIS database catalogs SPB infestations, which are commonly referred to as spots. A unique number catalogs spots comprised of at least 10 trees. “Data fields in SPBIS include national forest, district, spot number, detection date, ground-check date, number of infested trees, acres affected, and suppression date, among others. Each spot is assigned a primary treatment: cut-and-remove, cut-and-leave, cut-and-hand-spray, pile-and-burn, inactive, or monitor. This primary treatment can be changed when the database is updated based on subsequent management of the spot. Most monitored spots are subsequently reclassified as inactive, because they typically contain very few or no freshly attacked trees at the initial ground check. Saw timber and pulpwood volumes are included for spots treated by cut-and-remove. Numbers of trees treated are recorded for cut-and-leave and cut-and-hand-spray treatments. Treatment breakouts (missed infested trees) were tracked by adding a letter to the end of the spot number, starting with *A*” (Clarke and Billings 2003).

Since its initiation, SPBIS has been plagued with problems. The database has evolved continuously since the 1970s but documentation of the code for ORACLE® based version is not available. The code for the SPBIS database is of significant complexity and without documentation of the structure it becomes extremely difficult to manipulate.

SPBIS has several problems that need correction. These problems coupled with the lack of knowledge of the code structure led to a period of time in which few changes were made to the database. This lack of improvement led to widespread frustration among the users of the database ultimately leading to almost complete abandonment of data entry.

SPBIS data was traditionally collected in the field on paper forms. Each year data were collected for each SPB infestation but, with the exception of a few districts, were never entered into SPBIS. This backlog of data further compounded the problem of retrieving usable data from the database.

In recent years, employees of the Forest Health Technology Enterprise Team (FHTET) in Fort Collins have slowly mapped out the code structure allowing them to make the needed improvements to the database. With SPBIS currently up to date, the issue of historical data becomes important. The extensive collections of SPBIS data sheets are in the process of being manually entered into the database.

When used properly, SPBIS can be a valuable tool for monitoring and suppression activities on a district. In the event of a SPB epidemic, SPBIS allows personnel to easily monitor the status of all infestations on the district. At times there can be hundreds of infestations that are in some stage of being controlled or monitored and the SPBIS system will produce reports that can assist in the rapid direct control of these infestations (SPBIS Installation Guide 2002).

The future of SPBIS lies in the ability of data to be effectively entered into the database. Negligent data entry is the primary hindrance to the utility of the database. Efficient data entry is not only attainable but is one of the primary objectives of this thesis project. The ability to upload data directly from the mobile device into the database will eliminate the backlog of datasheets and transform the SPBIS database into a useful tool for making management decisions.

Mobile Devices

In the past, hand-held mobile devices have had several drawbacks that made them unavailable for many applications. The foremost drawback was the price of these units. Many potential users simply could not afford to purchase these devices. The software used by these early units was often complicated and difficult to learn. Early software packages were also vendor specific, which meant they could not be used with any other technology for other applications. Early mobile devices often had very slow processors, which made data manipulation and processing very difficult (Wadhwani 2004). Other drawbacks included small displays, inadequate battery life, and awkward, bulky construction.

Developers of the new generation of hand-held mobile devices have sought to remedy the problems of the old devices. In most respects they have succeeded. The new devices range in price from $300 - $6000 (Wadhwani 2004). Familiar names such as Windows® and Palm® have developed operating systems that run on these units, making use of these devices much easier than before. The newer units have faster processors, longer battery life, larger displays with improved color, and are much more compact than their predecessors. These improvements make mobile devices a feasible addition to many field data collection applications.

Base Maps

A base map is defined as "a map depicting background reference information such as landforms, roads, landmarks, and political boundaries, onto which other, thematic information is placed" (Kennedy 2001). Base maps are used to orient the user to a specific area. Each layer that comprises a base map must be geo-referenced alike. This ensures the positional accuracy required while navigating on the ground. The accuracy of a location garnered from a base map is only as good as the map itself. The layers used to construct base maps are often shapefiles or data from remote sensing equipment.

Base map packages are an important part of any data collection project. In the case of SPBIS data collection, these packages often consist of compartments, stands, water features, roads, and wildlife habitats. Layers ranging from topographical maps to points of interest can be utilized to meet the needs of any application. These layers can be manipulated in any GIS software package such as ArcGIS® or ArcView®. Both of these ESRI® products contain an extension that allows the user to prepare the maps for use in ArcPad®. Within ArcPad®, maps are delineated by the extension (.apm), which stands for ArcPad® Map file. This file contains information regarding the map layers, map extent and settings specific to the map. Several base map packages can be saved within the GeoXT™ for use in several different areas. The composition of a base map package is entirely decided by the user and can be tailored to meet the needs of any project.

CHAPTER III

METHODS AND MATERIALS

Approach for SPBIS Data Form Development

One of the main objectives of this project was to develop a digital version of the SPBIS data collection form. The final version of the form consisted of five pages, which contained all the fields needed for initial spot data collection. Figure 5 shows the form pages as they appear on the mobile unit. Data entry associated with each page is described below.

The form was developed using ArcPad® Studio within ArcPad® Application Builder. ArcPad® Application Builder is a development environment for creating custom GIS applications. Custom applications developed within this environment can be used on any ArcPad® software-based mobile device. For tasks such as development of the survey form for this project, “ArcPad® exposes an extensive object model that can be accessed by writing VBScripts” (ESRI® ArcPad® White Paper 2004). The VBScript code for this application was written by S.M. George and is available in Appendix A.

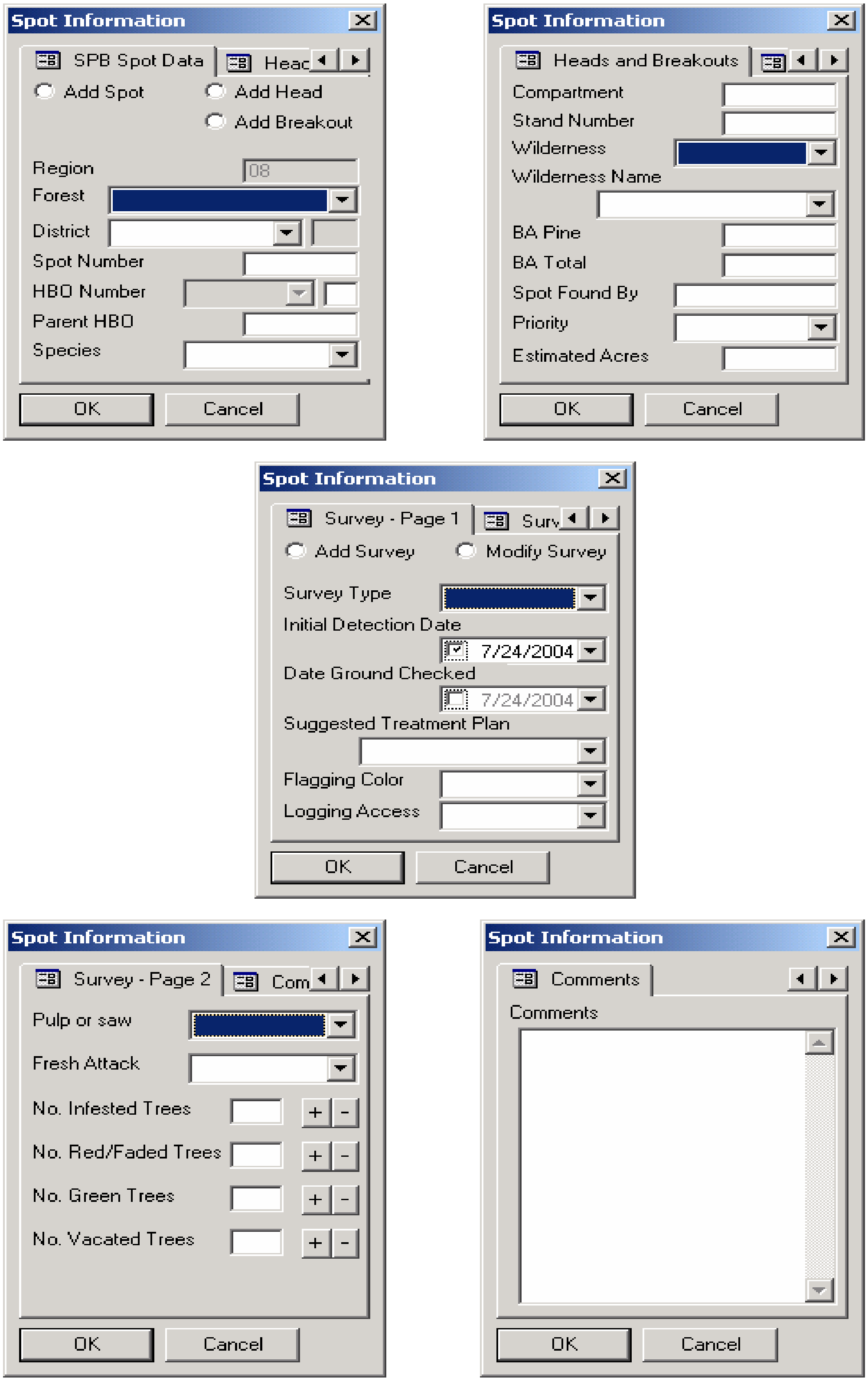


Figure 5. The digital SPBIS survey form, pages 1-5

The SPBIS database is designed to keep a record of all survey information. All data are collected into a primary database file (DBF) table and a backup DBF table, which is associated with a shapefile. Each field within the form has a column in the DBF table. Each column in the DBF table corresponds to a field in the SPBIS database by name. The backup DBF table is the record that is uploaded into SPBIS. Several fields can be edited. Anytime a spot is edited any previous information is overwritten. Radio buttons for adding a spot, a head, or a breakout are located at the top of the first page. One of these choices must be made in order for data to be recorded. If a choice is not made no data will be recorded.

SPB Spot Data is the heading on the first page. The fields on the first page include the region, forest, district, spot number, head or breakout number, parent head or breakout, and species of pest. The region, forest and district fields each have drop-down menus that contain all the possible location choices. The head or breakout number and parent head or breakout fields have default values if the user enters no value. Secondary heads and breakouts rarely occur, therefore default values must be available in order for the data to be uploaded into the database. The drop-down menu for pest species field contains three choices: Southern Pine Beetle, any of the several species of *Ips* sp. beetles that attack pine, and Black Turpentine Beetle, *Dendroctonus terebrans* Olivier. These three pests are not the only species that will be encountered while conducting a survey but they are the most prevalent.

Heads and breakouts are the heading for the second page. This page contains fields for the compartment number, the stand number, wilderness identification, wilderness name, pine basal area, total basal area, spot locator identification, spot priority, and the estimated area. The wilderness identification field contains a simple yes or no option. If a spot is in a wilderness area it greatly affects the treatments that can be applied. If the spot is in a wilderness area the wilderness name field is activated. It contains names of wilderness areas that correspond to the forest and district chosen on the first page. The pine and total basal area are determined for the stand in which the spot occurs. The spot locator is the name of the person who found the spot. The priority field contains three choices, high, medium and low. An option is chosen based on spot activity and the value of the material contained in the spot and surrounding areas. The acreage that is determined by traversing the spot with an activated GPS is entered into the estimated area field.

Survey: Page 1 is the heading for the third page. This page contains fields for the survey type, the initial detection date, the ground check date, the suggested treatment plan, flagging color, and logging access. The survey type field contains the following choices: aerial, ground, and video. These choices correspond to the manner in which the spot was detected. The initial detection date is the date the spot was found, while the ground check date is the date the spot is first visited on the ground. These dates can be the same but often are not. The ground crew that conducts the initial spot survey recommends the suggested treatment plan. Treatment recommendations are based on current spot activity and value of the stand in which the spot is located. The flagging color field has a drop-down menu that contains several common flagging colors. Flagging color is important to know for revisiting the spot. The final field on this page is logging access. The initial ground survey crew also determines logging access based on the possibility that the spot will be logged and its location. This field has drop-down menu with the choices poor, fair, regular, and good. The poor choice is made when the spot is not a candidate for logging. Fair access is chosen when a logging decision cannot be made during the initial survey. Regular is chosen when the site can be accessed at most anytime. Good is chosen when the spot can be easily accessed and the logs easily hauled from the site.

Survey: Page 2 is the heading for the fourth page. This page contains fields for timber type, fresh attack determination, number of infested trees, number of red or fader trees, number of green infested trees, and number of vacated trees. The timber type choices include pulpwood, saw timber, and mixed. A choice is made based on the composition of the spot. The fresh attack field contains a simple yes or no. This aids in determining what actions should be taken for control of the spot. The subsequent four fields are used to determine the composition and size of the spot. The number of infested trees will equal the number of red and fader trees plus the number of green infested trees. Each field has an increment counter that allows the user to add one tree at a time while walking through a spot.

The final page of the form is for comments. Anything concerning the spot that the surveyor would like to remember can be recorded here.

Approach for Uploading Data into SPBIS

Seamless upload of data into the SPBIS database is the most important aspect of this project. One of the major problems with the current data collection system is data entry. Manually entering data into the database is time consuming and impractical at the degree required during SPB epidemics.

In order to streamline the data collection process, an application for uploading data directly from a mobile device was developed. The Forest Health Technology Enterprise Team (FHTET) in Fort Collins, CO and Forest Health Protection in Pineville, LA in conjunction with the Knowledge Engineering Laboratory at Texas A&M University developed an interface between the SPBIS Oracle tables and the backup database file (DBF) table associated with the digital SPBIS data form. This application was created in Visual Basic 6.0 and is embedded in SPBIS Version 5.0. The code for this application is contained in Appendix B. The complex structure of the SPBIS database did not lend itself to the development of a simple data upload interface. Fields within the database are interconnected with one another. Therefore fields within the DBF table of the data form must be connected to a corresponding field within SPBIS in order to have successful routing of data.

The upload application reads data from each record on the mobile device in DBF form and writes them to five individual SQL statements that insert the data into the ORACLE® tables. After data has been uploaded the ORACLE® tables are queried to determine what control number (CN) Oracle has assigned each record so the origin or "parent" of each record can be tracked. The CN for a specific record is required if any modifications are to be made. The CN allows the database to search for the parent record and add newly collected data or overwrite existing data.

The mobile unit is linked to the SPBIS via a Universal Service Bus (USB) connection. Once the unit and the database are in sync, data is automatically extracted from the mobile unit and stored in the database. Figure 6 shows the initial graphical user interface (GUI) and subsequent screen prompts, as they will appear on a desktop computer.

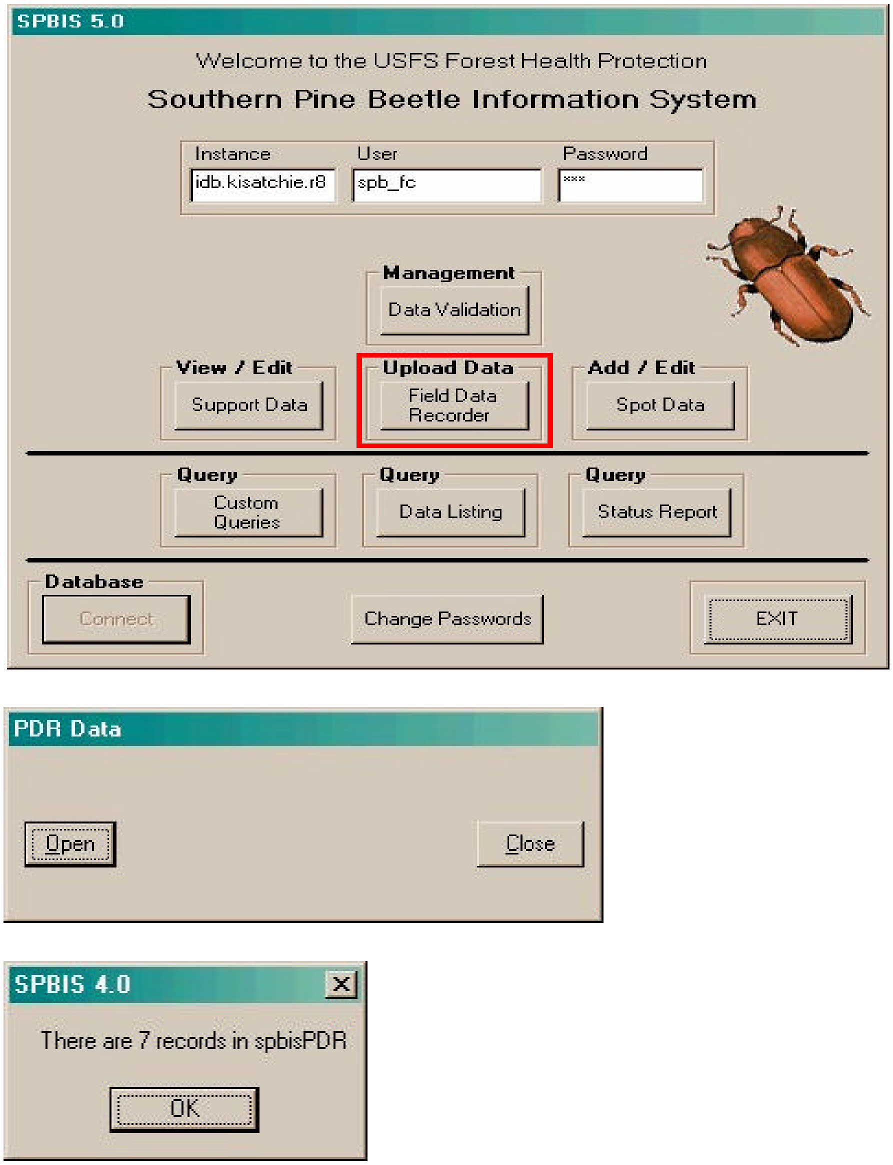


Figure 6. The SPBIS User interface with the screen prompts for uploading data from the mobile unit (Screen shots courtesy of Anthony Courter, FHTET, Ft. Collins, CO).

Technological Components of the SPBIS Mobile Mapping System

Trimble® GeoXT™

The hand-held mobile device being used for this project is the Trimble® GeoXT™. The unit is advertised as providing "sub-meter accuracy required for professional GPS/GIS data collection and data maintenance and EVEREST™ multipath rejection technology for tough GPS environments, which will be discussed in detail in Chapter IV. This device is ideal for working under forest canopy, in urban canyons, or anywhere you need high-accuracy data collection and maintenance" (Trimble Customer FAQ 2004).

The units being employed by this project utilize the Windows CE® 4.2 operating system. This operating system has many of the same features as a typical Windows desktop PC operating system, but it is designed for use on a mobile unit. The use of a Windows product promotes more efficient training of field personnel, as most people are familiar with Windows products in some capacity.

For this application, the GPS controller housed within ArcPad® is used for gathering position information. The physical characteristics of the GeoXT™ also make it an ideal candidate for this application. The unit can operate in a temperature range from 14°F to 122°F, while also being dustproof and shock and moisture resistant. The display screen on this unit allows for use in direct sunlight and overcast conditions. High screen resolution allows the user's data to be displayed clearly, while a multi-stage light allows for nighttime use. When fully charged, the unit battery has a life of 10 hours with the GPS activated, which allows for an entire day of work to be done with a completely charged unit. The unit is charged via the support module or charging cradle. An AC adapter that plugs directly into an ordinary wall outlet powers the charger. It is important to recharge when the battery is depleted below 50% of its maximum voltage. Trimble® also recommends that the unit be charged for no more than four hours at a time. A classic flaw of many mobile units is the loss of data when the battery is completely depleted. With this unit any information saved to the disk is not lost. The unit is linked to a desktop computer via a USB connection. This allows for the rapid and dependable exchange of data. Microsoft ActiveSync® facilitates data transfer (Trimble® Datasheet and Specifications 2004). Each component of the Trimble® GeoXT™ package is illustrated in Figure 7.

ArcPad 6.0.3®

The GIS software package used for this mobile mapping application was ESRI® ArcPad 6.0.3®. This program is very similar to ESRI®'s desktop ArcGIS® package in terms of user interface and basic functionality, but it is specifically designed for use on a mobile unit. ArcPad® allows the user to import both vector and raster data types such as shapefiles and DOQQs. ArcPad® is software for mobile GIS and field mapping applications. This software provides an integration of GIS and GPS to field users via a hand-held mobile device. ArcPad® has traditional GIS functionality such as map navigation, layering, and querying. Data collection with ArcPad® is fast, easy and improves field-based data validation and availability (ESRI® White Paper 2004). ArcPad® supports almost every common data format associated with GIS. For this reason, there is rarely a need to convert data formats between the desktop computer and the mobile device.

Figure 7. Components of the GeoXT™ version of the Trimble® GeoExplorer® CE system

Methods for Field Testing Components of SPBIS Mobile Mapping System

Field-testing of the SPBIS mobile mapping system was conducted in eastern Mississippi, on the Chickasawhay Ranger District of the DeSoto National Forest. This area was chosen for its abundance of Southern Pine Beetle spots. Each aspect of the field-testing was limited to two people in order to minimize possible deviations in the data due to varying degrees of survey experience. The time required to conduct a survey by a veteran employee at the district level would likely not be comparable to the time required by a graduate student with limited survey experience.

For the sake of uniformity and time management each spot was visited after the initial survey had been done. This approach allowed confirmation of spot locations by number, as well as, access to data for comparisons. The testing objectives were to define the difference in the time required to complete each version of the survey, to define the difference in estimated spot acreage and measured spot acreage, to define the utility of the navigation features on the Trimble GeoXT™, and to define problems that could be encountered in the field and how to correct them.

Time Study: Paper vs. Digital

A time study was used to define the amount of time necessary to accomplish a unit of work, using a given method, by a surveyor possessing sufficient skill to do the job properly (Mundel 1947). Project coordinators are continually striving to maximize the level of quality at which a task is completed while minimizing the amount of time required for completion of the given task. While this delicate balance is often hard to achieve, technological advances provide a range of options to streamline almost any process.

Using a stopwatch, the action of completing each version of the SPBIS survey was measured and recorded at each spot. The timing commences when the surveyor begins assessing the spot and ends when the entire survey form is complete. The time required to obtain a GPS position for the digital survey method was not considered, as we did not obtain a GPS position for the paper survey. The time required to traverse the spot for determining acreage was also not considered because it is not an aspect of the paper survey. Only actions common to both surveys were included in the recorded time. District surveyors using the paper survey method often use recreational GPS units, such as those designed by Garmin®, to obtain positional information for each SPB spot. The surveyors also mark the perimeter of each spot to aid in determining size and direction but the time to do this is not recorded. The primary goal of this procedure was to measure the time required to complete each survey type under field conditions. Times were recorded for both form types on a total of 54 infestations.

Infestation Acreage: Estimated versus GPS

To determine acreage, an individual polygon was created for each spot. Under normal operating conditions, the surveyor would determine the extent of the spot then walk the perimeter to create a polygon and obtain the area. A useable polygon of each spot was created by the continuous collection of GPS points. The attribute table associated with each polygon has a record of the spot area. The area is reported in square feet. A conversion must be made to determine the area in acreage if the spot area is displayed in square feet. This conversion may be a slight inconvenience but can be done quickly with the GeoXT™ built-in calculator. The step-by-step process for creating a spot polygon is available in Appendix C.

As mentioned at the beginning of this chapter, the spots for this study were ground checked by district personnel before we arrived. It is common procedure for the district surveyors to flag the perimeter and the head(s) of the spot. This practice allows the surveyor to make an educated estimate of the acreage and to learn the dynamics of the spot. In order to make a comparison between the estimated acreage and measured acreage the polygons were created using the flagged perimeter of the spot. Acreages were measured for a total of 44 infestations.

Navigation Using the Trimble® GeoXT™

Aerially gathered GPS coordinates were not available for the area being field-tested, therefore coordinates gathered during the initial ground check were used to test the utility of the navigation features on the Trimble® GeoXT™®. The initial GPS coordinates were entered into a Microsoft Excel spreadsheet, saved as a DBF file and imported into ArcView® desktop GIS software and converted into a point shapefile. This shapefile was added, as a layer, to the base map package. Using the point shapefile, a district roads shapefile, and the GPS receiver activated we were able to navigate to SPB spots.

Accuracy of the Trimble® GeoXT™ GPS Receiver

A small-scale accuracy test was preformed to determine the accuracy of the GeoXT under less than optimal conditions. Two tenth-acre (4,356 ft^2) plots were traversed 30 times each using the GeoXT™. Both plots were 66 x 66-foot squares. They were measured by hand using a logger's tape. Transects were measured to ensure accuracy of the area. Plot 1 was set-up in an open field with no land-based obstructions to skew the GPS signal. Plot 2 was set-up in a post oak stand with a basal area of approximately 70 ft^2 and an average height of 35 feet. GPS signal received while measuring this plot were subject to substantially more obstructions than with Plot 1. The plot measurements were taken on January 28 and 29, 2005. The weather for both days included overcast skies, high relative humidity and an average temperature of 55º F. The satellite geometry was adequate for receiving a GPS position fix.

CHAPTER IV

RESULTS

Time Study: Paper versus Digital

The data collected for this objective were analyzed using the Mann-Whitney U test. The results of this test indicate with 95% confidence that the time required to complete each survey type are significantly different. Table 1 contains the results of the statistical analysis. The average time required to complete the paper form is 10 minutes and 37 seconds while the digital form averages 8 minutes and 29 seconds. The digital survey took an average of 2 minutes and 8 seconds less to complete than did the paper form. While the time required to complete each form has the potential to vary significantly between users, with proper training the digital system should prove to be less cumbersome than the traditional paper method.

Table 1. Means, standard deviations, sample sizes (N) and p-value from Mann-Whitney *U* test comparing the time required to complete the paper SPBIS survey form and the digital SPBIS survey form. The p-value of 0.004 indicates a significant difference at a = 0.05.

	Paper Form		**Digital Form**		
	Mean ± std dev	**N**	**Mean ± std dev**	**N**	**Mann-Whitney *U* P-value**
Time	10.622 ± 4.795	54	8.481 ± 4.256	54	0.004

Infestation Acreage: Estimated versus GPS

The data collected for this objective were analyzed using the Mann-Whitney U test. The results of this test indicate with 95% confidence that the total estimated acreage of the spots in this sample group is almost twice the total measured acreage. Table 2 contains the results of the statistical analysis. The average estimated area was 1.0455 acres while the average measured area was 0.5745 acres. This significant difference should prove the need for a means of measuring acreage.

Table 2. Means, standard deviations, sample sizes (N) and p-value from Mann-Whitney *U* test comparing the estimated and measured acreage of 44 southern pine beetle infestations on the DeSoto National Forest, Chickasawhay District in Mississippi. The p-value of 0.000 indicates a significant difference at a = 0.05.

	Estimated Acreage		Measured Acreage		
	Mean ± std dev	**N**	**Mean ± std dev**	**N**	**Mann-Whitney *U* P-value**
Acreage	1.0455 ± 0.2107	44	0.5745 ± 0.5164	44	0.000

Accuracy of the Trimble® GeoXT™ GPS Receiver

Table 3 illustrates the accuracy of the GeoXT™ under less than optimal conditions. Table 3 gives the mean area for each plot under the given conditions. The relation of these values to this project are found in the next chapter.

Table 3. Trimble® GeoXT™ accuracy test under less than optimal conditions.

	Plot 1 (Open)	**Plot 2 (Under Canopy)**
Actual Area (0.1 acre)	4356 sq ft	4356 sq ft
GPS Mean ± std dev	4207 sq ft ± 126.35	4082 sq ft ± 458.63
N (sample size)	30	30

These are the results of the each quantitative field test conducted for the SPBIS mobile mapping system.

CHAPTER V

DISCUSSION

Time Study: Paper vs. Digital

A major concern surrounding the implementation of SPBIS mobile mapping system was the time required to complete the digital form in relation to the current paper form. The utility of any tool is reduced if its use is more time consuming than the tool it is proposed to replace.

The major difference in the comparison of these two survey formats and a typical time comparison is the additional aspect of data processing after collection. This is where the digital method becomes more efficient than the paper method. Due to the cumbersome nature of data entry and negligent data entry practices, the paper survey forms accumulated and were often forgotten. The digital system allows for the seamless upload of data. The time saved by not having to manually enter data is one of the major advantages of using a digital system. The results of the time study show a two-minute advantage when using the digital system. This value was measured using only those data collection steps common to both survey types. If the time required to locate a spot, data collection time and data entry time were considered the total time advantage of the digital system would be substantially increased. These factors were not included because they are not easily measured.

In addition to an advantage in operating time, the digital system has several other advantages. The use of a paper survey form has long been a standard operation for collecting field data. The obvious problems associated with using paper outdoors include damage from the elements, physical deterioration enhanced by field activities, and increased chance of the forms being lost. The digital system utilizes the weatherproof Trimble® GeoXT™ mobile device for data collection. The device stores all records in a location designated by the user and can only be lost if not saved to the system disk. The mobile device can be added to a user's field gear as easily as a hard hat.

Infestation Acreage: Estimated versus GPS

Each year thousands of acres of pine forest across the southern United States are destroyed by southern pine beetle. Many of the infested acres occur on national forest land. Each ranger district is responsible for identifying infestations and implementing measures to control them. In recent years, however, there has been a significant reduction in SPB populations in the majority of southern states. In 2003 the estimated mortality due to SPB was 2,403,000 acres. While this is still a significant damage area, the total was down from13,455,900 acres in 2002. (USDA Forest Service 2004). Figure 8 illustrates the trend of beetle-infested acres 1979 through 2003.

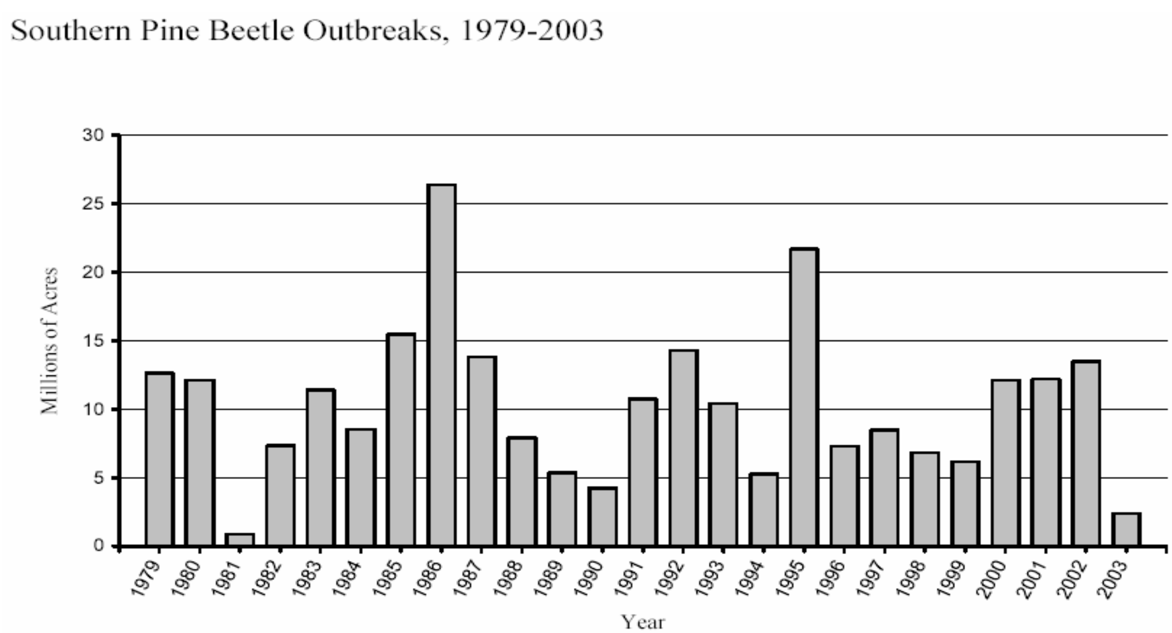


Figure 8. Southwide trend of acreage infested by SPB from 1979 through 2003

This trend continued in 2004 with “populations declining dramatically from those of 2003 throughout the South. Only South Carolina, Tennessee, Alabama and Mississippi reported substantial activity, and most of that dropped sharply as late summer approached. Elsewhere, southern pine beetle populations were low to immeasurable” (USDA Forest Service 2004). Research shows that SPB adhere to somewhat uniform cycles in terms of population density and outbreak duration. Most outbreaks last a relatively short time period usually from 2-3 years. This has led to the belief that “the beetle is cyclical in nature, particularly since major epidemics seem to occur about every 10 years” (Payne 1980). Accurate and comprehensive data collection and storage are essential to learning more about beetle populations. The need for an improved data collection system will become more evident as the beetle populations begin to increase.

Federal suppression funds are allotted for each district as needed. While it is difficult to predict the exact amount of support needed for the next year, each district is given money based on data collected in the current year. These funds are rarely enough for districts that are surprised by an epidemic. One factor that goes into determining the amount of money given to a district is infested acreage. Estimation is the current method for determining the acreage of a spot. Many of the ground personnel who conduct these surveys have been doing so for many years and are quite proficient. In these cases the estimated acreage can be fairly accurate. Despite the work of these veteran employees, the margin of error with this method of determining acreage is too great. A second problem lies with the SPBIS database. Past versions of SPBIS rounded acreage values to the nearest whole acre. Surveyors would often record spot areas in tenths of an acre but the database would round the value up to 1 acre if the spot were greater than half an acre.

If a spot were recorded as being less than half an acre it would be assigned acreage of zero. This procedure of rounding in whole acre increments causes the total infested acreage value to become substantially skewed. While this problem has been addressed in the most recent version of SPBIS all the historical records reflect these errors. The need for a more accurate method of determining acreage is evident and this mobile mapping system will remedy this problem.

Navigation Using the Trimble® GeoXT™

One of the most time consuming aspects of ground checking SPB spots is site location. The predominant method of locating a SPB spot is known as aerial sketch mapping. Traditional aerial sketch mapping requires the surveyor to mark the spot location on a paper map in reference to surrounding geographic features such as roads and waterways. If a spot is marked incorrectly from the air it can be very difficult to locate the spot on the ground. Increased use of GPS to mark the location of spots from the air has aided in reducing the time required to find spots on the ground. The GPS coordinates gathered in the air can be entered into most handheld GPS units for navigation purposes.

Digital aerial sketch mapping is a new tool being used by Forest Health Protection for pest surveying. This tool allows surveyors to have a digital representation of the area they are flying and to mark problem spots directly on the digital map. There is a set of GPS coordinates associated with each spot marked on the map. The coordinates will be entered into the GeoXT® handheld device and used to navigate to each spot.

Another issue to consider when using the navigation feature on the Trimble unit is the projection. Shapefiles are commonly used as layers in a base map package. In order for various shapefiles to be displayed simultaneously they must have the same geographic projection. A projection is defined as “a method by which the curved surface of the earth is portrayed on a flat surface” (Kennedy 2001). All files, with the same projection, are displayed at a scale relative to each other. Therefore if a water feature shapefile is displayed over a compartment shapefile the water features will appear at a realistic scale based on the given projection. This is important for data collection, as well. As mentioned before, the SPBIS survey form has an associated point shapefile that is created with each new survey. This file must also be projected the same as other layers of the base map. This ensures that the data are collected and displayed in a realistic manner. In order to use other data types, such as DOQQs, all files must be projected alike. It is possible to display shapefiles and raster data simultaneously, but they must be projected alike. Due to the size of most raster data files, very few can be displayed on the GeoXT™. While more than one raster image can be displayed at a time, the use of two or more with different resolutions at a given time is unlikely. The accuracy of the collected data is dependant on the projection not the scale or resolution of the base map.

The scale of the base map display is also important to consider. If the map scale is too large the point may seem closer to your position than it actually is. The “zoom” tool allows the user to manipulate the map to achieve the desired scale. Another feature available on the GeoXT™ that will aid in navigation is the addition of a waypoint to the map. A waypoint can be placed directly over the destination point. Once this has been done the compass on the unit will display the direction you are traveling in relation to the point and the distance you are from the point. This feature is particularly useful when you are in an unfamiliar area or if visibility is reduced.

The layers chosen for the base map are also very important to the utility of the navigation feature. Layers such as roads, water features, and stand boundaries are invaluable if the user is not familiar with the area. If the user is familiar with the area labeled roads and water features aid in determining bearings. While GPS navigation is a very useful tool it is important to have another means of navigation while in the field, as GPS is not available in every situation.

Problems and Solutions

Problems are inevitable with any new tool. This mobile mapping system is no exception. Many of the problems experienced during the field-testing of this tool were the product of inexperience and lack of knowledge about the equipment. The majority of the problems had very simple, easy to implement solutions. As with any new technology, a certain amount of training is required to use the equipment proficiently. While most devices and software packages come with ample documentation for proper use of the product, the best way to become familiar with a product is to learn by trial and error. The remainder of this section deals with the problems experienced while field-testing the SPBIS mobile mapping system and the solutions to these problems.

The first problem experienced during testing was with the Trimble® GeoXT™. A faulty connection was formed while attempting to connect the unit to the charging cradle resulting in the unit “freezing-up”. This mistake led to the discovery of several other problems. The unit required a system re-boot. With the Trimble® GeoXT™ there are two ways to re-boot the system, a soft and a hard re-boot. The difference between the two re-boots is the level at which the unit is restarted. A soft re-boot, in effect, restarts Windows CE. This is usually sufficient to fix the problem. It the unit suffers a major software or hardware conflict a hard re-boot is required. To perform a soft re-boot the power button is held down for 5 seconds. Holding the power button down for 15 seconds results in a hard re-boot.

An additional problem discovered when the unit was re-booted was the loss of data. When the unit was restarted all data that was not saved to the system disk was erased. To remedy this problem all data must be saved in the disk folder on the unit. It is also advisable to have a backup copy of base maps and any other required data on a lap top computer so it can be reloaded.

One of the major limitations to using GPS is the signal availability. As mentioned in Chapter 1, a 24-satellite constellation makes up the global positioning system. These satellites are each in a unique orbital pattern, which means they are constantly changing position throughout the day. This constant position change causes fluctuations in signal availability. Due to signal availability variations on a daily basis, many GPS users consult the almanac available on the unit to determine the best time to obtain a signal. The almanac shows the user the times of peak signal availability. The GPS receiver within ArcPad® has a feature called Satellite Skyplot. This feature displays all satellites overhead at a given time. The various satellites are delineated by color based on their current operational status. Satellites displayed in black are available and being used to determine a position. Satellites displayed in blue indicate the satellite is available but not currently being used. Satellites displayed in red indicate the satellite is not available. This color-code allows the user to determine the likelihood of obtaining a “fix” in a timely manner. Likewise the ArcPad® GPS receiver features a signal chart which displays the relative signal strength from each satellite in the form of a horizontal bar chart. Each of these features aid in determining the optimal time for receiving a GPS signal. Another element of a GPS signal that has to be considered is dilution of precision (DOP). DOP is defined as “an indicator of satellite geometry for a constellation of satellites used to determine a position. Positions with a higher DOP value generally constitute poorer measurement results than those with lower DOP. Factors determining the total geometric dilution of precision (GDOP) for a set of satellites include PDOP (Positional DOP), HDOP (Horizontal DOP), VDOP (Vertical DOP), and TDOP (Time DOP)” (Kennedy 2001). For this project the PDOP value is the main concern. By increasing this value the GPS signal becomes more readily available, but at the expense of accuracy.

Depending on the amount time allotted for collecting field data, it may not be possible to wait until the GPS signal is at its strongest. This was the case with field-testing the SPBIS mobile mapping system. A major field-testing objective was to survey as many spots as possible for statistical analysis and to increase chances of identifying problems with the system.

When testing began the GPS receiver was activated at each spot, the survey was conducted and the receiver was deactivated. This was done, initially, to conserve battery life. When doing this it became increasing harder to obtain a GPS fix due the constantly changing satellite geometry. After several frustrating hours of waiting for a signal, it was decided to leave the GPS receiver activated throughout the entire workday. This easily solved the problem. Even though the signal was not constant the entire day a fix was much easier to obtain when the receiver maintained communication with at least a few satellites. Leaving the GPS receiver activated during the entire day did not affect the life of the battery any more than if the receiver was turned on and off. The unit can also be configured to conserve power by going dormant after a set period of inactivity. In order to be able to run the unit continuously for 10 hours the battery must be completely charged on a daily basis.

Another problem that arose was with the GPS receiver. When using a unit for the first time the GPS receiver within ArcPad® would not activate. It was determined that the COM port settings on the GeoXT™ were not properly set. The Trimble® GeoXT™ has a total of four COM ports to which various applications are assigned. COM 1 is the standard serial port for the connection of all external devices. The remaining three COM ports support different communication protocols. COM 2 outputs NMEA-0183 messages. The National Maritime Electronics Association or (NMEA) has "created a standard that defines an electrical interface and data protocol for communications between marine instrumentation that has been adopted as the standard by the GPS industry. The NMEA-0183 standard "defines electrical signal requirements, data transmission protocol, timing and specific sentence formats for a 4800-baud serial data bus" (Kennedy 2001). This is the protocol utilized by the GPS embedded in ArcPad®. Therefore, if COM 2 is not selected the GPS receiver within ArcPad® will not activate. COM 3 outputs and receives Trimble Standard Interface Protocol (TSIP) messages. This protocol is utilized exclusively by Trimble GPS applications with the exception of a few others. This is the default COM port on the Trimble® GeoXT™ and must be changed to operate the GPS receiver within ArcPad®. COM 4 is used to receive real-time correction messages (GeoExplorer® CE Getting Started Guide 2002).

Another potential problem with this system deals with locating and manipulating map layers on the unit. In several instances users asked where to locate the maps.

Navigating to a file within ArcPad® is essentially the same as navigating to a file on a desktop computer. Locating a file presents a temporary challenge if the user did not load the map layers or if the user is unfamiliar with ArcPad®. This problem will be addressed in the User's Guide and file navigation will be incorporated into several practice exercises conducted during the training course.

Each data layer has several files associated with it that ensures that they function properly within a GIS. There is a core group of required files and several other secondary files that may be associated with a single layer. Shapefiles are actually a collection of at least four other file types. The four essential files that make up a shapefile are a spatial data format file, an index look-up file, a spatial index file, and a projection file. Every shapefile must have these files or it will not function properly in a GIS. A shapefile might also be associated with a variety of other files that have a specific function. A shapefile attribute table file and a DBF file both serve as information storage files. One file essential to the use of a data layer in ArcPad® is an application library file. This file is required to enable the edit option of a data layer. A data layer must be able to be edited in order to add waypoints, to change the appearance, and to add data such as points created when a SPB survey is added to a map. Another file that is created when a map is created in a desktop GIS environment and exported to ArcPad® is the ArcPad® map file. This file can be created in two ways. The most obvious way is when a map project that is built in ArcPad is saved as a whole in ArcPad®. The second method is by using the ArcPad® extension in ArcGIS® or ArcView® on a desktop computer.

Shapefiles were not the only data type used for this project. Several raster data formats were also used. Raster data files are also composed of a collection of other files similar to shapefiles. When working with raster data it is important to make sure the data has a world file. A world file is defined as "a text file containing the coordinate and scaling information for converting the coordinates in an image (which usually start at [0,0] and extend to the image's size in pixels) to map coordinates such as latitude–longitude or State Plane" (Kennedy 2001). A world file is needed to lay vector data over an image of the same geographic area. No matter what data type is being used, it is important to have all required files to ensure the data is displayed properly in the GIS.

These potential problems are easily remedied and can be avoided with proper training. This is not a comprehensive description of all the possible problems with this mobile mapping system. Additional problems will be dealt with as they arise.

Accuracy of the Trimble® GeoXT™ GPS Receiver

While the results of this test show a significant variation between the known area and the area each test plot, the accuracy of the unit is still sufficient for this application. As stated in the results, this accuracy test was conducted in less than optimal conditions and serves to illustrate the lower limits of the unit's accuracy. Field conditions are rarely the same on a day-to-day basis, and urgency to complete surveys will take precedence over less than optimal conditions. The intent of this exercise was to illustrate the possible range of data accuracy and precision based on field conditions. Also, many of the accuracy errors that are overlooked by the GPS unit can be corrected with desktop position correction software such as Trimble® GPS Pathfinder Office®. The utility of this unit for navigation purposes has been proven. While there is some discrepancy in accuracy, this unit is sufficient to locate and record the position of a SPB spot.

One question that was not addressed during field-testing was the effect of elevation on accuracy of the collected data. This project was developed for and will be used primarily on flat land districts, though there are several areas in the southern region that have a variety of changes in elevation.

Objects such as trees, buildings and mountains can obstruct GPS signals. Although SPB infestations on National Forest land, while varying slightly in size, host species, and geographic location, are all surveyed in a similar manner, varying geographic features can have an effect on GPS accuracy. To address these potential errors many of the latest GPS units, including the Trimble® GeoXT™, are equipped with real-time position correction technology and are Wide Area Augmentation System (WAAS) enabled.

Real-time corrections are transmitted to the hand-held unit from a ground-based GPS receiver. The corrections from the ground-based unit are applied to each position as it is recorded (Trimble Customer FAQ 2004). WAAS operates in a similar fashion. It is a system of satellites and 25 ground stations that were originally developed by the Federal Aviation Administration (FAA) to provide differential position correction for aircraft. Both of these systems can be used to gain better position accuracy.

The GeoXT™ is also equipped with EVEREST multipath rejection technology. Multipath occurs when a GPS signal is reflected off of an object before being recorded by the GPS receiver. This technology is designed to reject the random errors caused by multipath (Trimble Customer FAQ 2004). While most multipath errors are rejected by the EVEREST system some are missed introducing a slight degree of error.

The Trimble® GeoXT™ is advertised as having “sub-meter accuracy”. This can be achieved under optimal conditions such as clear skies, relatively few obstructions, and favorable satellite geometry. However, optimal conditions are rarely available. It is often necessary to conduct surveys under overcast skies, in dense stands, and at times when fewer satellites are overhead. Each of these factors has an effect on the accuracy of the collected data.

The manufacturer, Trimble, has tested the GeoXT™ for accuracy. It can be assumed that the advertised accuracy can be achieved under optimum conditions. It was not the purpose of this project to determine the accuracy of the unit, but to test its utility as a survey tool. The Trimble® GeoXT™ proved to be sufficient for this application.

VB Script and Custom Form Development

Visual Basic is a programming language developed by Microsoft based on an object-oriented form of the BASIC language and intended for application development. VBScript is an extension of the Visual Basic language (Microsoft VBScript User’s Guide 2004). ArcPad® Application Builder allows the development of custom applications that “match functionality and usability with the skill level and processes of field-workers.” Mobile GIS applications built within Application Builder ensure accurate data collection and streamlined workflow (ESRI® ArcPad® White Paper 2004).

CHAPTER VI

CONCLUSIONS

Future Applications

As seen with this project and others described within this thesis, mobile mapping technology has many potential applications. In the field of forest entomology there are an abundance of insect pests that are surveyed and monitored on a continual basis. Many of these pests rival the Southern Pine Beetle in terms of time and resources allocated for study.

One such pest is the gypsy moth, *Lymantria dispar* Linnaeus. The gypsy moth is serious pest of hardwood trees in the eastern United States. Currently there is a joint effort between Forest Health Protection of the USDA Forest Service and various state and local agencies to control the spread of and minimize losses to gypsy moth. These pests are surveyed in a manner similar to that of southern pine beetle. The data collected is unique to this pest but many of the methods used in the field are the same. This fact makes gypsy moth surveying a prime candidate for a mobile mapping system similar to the one described by this thesis.

A joint project between the Texas Department of Agriculture and the Knowledge Engineering Laboratory at Texas A&M University is being conducted to survey gypsy moth in the Dallas, Texas area. A custom form containing the required data fields for gypsy moth surveying has been developed and deployed on a hand-held mobile device.

Some of the other pests that are actively surveyed are indigenous species such as the mountain pine beetle, western pine beetle, and red oak borer and exotic species such as hemlock woolly adelgid, emerald ash borer, and the Asian longhorned beetle. These insects represent only a small portion of the insect pests that are monitored in this country.

Various forest pathogens also represent opportunities for the development mobile mapping applications. Similar to forest insect pests, pathogens problem are often encountered in the forest. Diseases such as oak wilt and sudden oak death have become major problems in recent years. As a result of increased possibility of spread, wide ranges of resources are being utilized to combat these problems. As with insects, surveying plays an integral role in the study and prevention of diseases. Unique mobile mapping applications can be developed to improve surveying efficiency.

Other governmental entities such as the Animal and Plant Health Inspection Service (APHIS), who are responsible, in part, for monitoring all exotic pests in the United States, could find custom mobile mapping systems very useful in their activities.

Digital aerial sketch mapping, which has been mentioned several times throughout this thesis, is another technology that will improve the SPBIS data collection process. When used in conjunction with the SPBIS mobile mapping system, digital aerial sketch mapping serves to further improve the efficiency of the system. The ability to collect GPS ground locations and spot polygons in a format that is easily transferred to the mobile device is invaluable to the utility of this system. Another aspect of digital aerial sketch mapping that complements the mobile mapping system is extensive distribution at the district level. With the sketch mapping system in place on each district, the integration of the mobile mapping system will be much easier. Both systems incorporate GIS and GPS technologies making training on one system complement training on the other.

ArcIMS® is a software package that allows dynamic maps and GIS data sets to be published on the Internet. It provides "a highly scaleable framework for GIS Web Publishing" (ESRI ArcIMS® Brochure 2005). With this software, geospatial information can be shared worldwide via the Internet. Currently, an ArcIMS® application is being developed by the Knowledge Engineering Laboratory at Texas A&M University to publish dynamic maps created from data contained in the SPBIS database. This application will give USDA Forest Service employees in the Southern Region access to real-time SPB data, which can be used to make informed management decisions.

Summary

The intent of this thesis project was to develop an automated data collection process using mobile mapping technology. This system will be used to increase the utility of the SPBIS database as a decision making tool.

The shortcomings of the SPBIS database are discussed in detail throughout this thesis. Data entry has always been the crux of the problem. With the successful implementation of an automated data collection process and a seamless data upload application, data entry will no longer be a problem.

Training will be a key element in the success of this system. The technologies being implemented have a history of not being user-friendly. It has been a goal of this project, from the onset, to design a system with the user in mind. While some basic knowledge and training are required, the implementation of this system at a Ranger District level should go smoothly.

Within the Forest Health Protection unit of the USDA Forest Service, real-time data has not often been available to managers in decision-making roles. Decisions are often made based on delayed data or historical trends. With the proper adjustments, the SPBIS database has the potential to remedy this problem.

Once the SPBIS mobile mapping system has been implemented and data becomes available, the true advantage of this system will be seen. It will then be possible for each district to better manage its resources and reduce losses due to SPB attacks.

Currently, there are very few operational mobile mapping systems specifically designed for data collection. The technology exists to facilitate automated data collection in any field of study. This thesis will serve as a template for others to use when designing a custom mobile mapping system.

The major advantage of this system is having an automatic data upload application connected directly to the SPBIS database. Integration of the new system will be done beginning with districts that have the most severe outbreaks. This system will completely replace the current data collection process.

The utility of this system will become apparent when field personnel are able to place the mobile device into its cradle and upload field data on the unit in a matter of seconds. The need for manual data entry will be eliminated. This single advance in the data collection process will make real-time data available for operational management.

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APPENDIX A

SURVEY FORM CODE IN VB SCRIPT

The following is the VBScript code for the SPBIS data collection form to be used in ArcPad®.

```
Option Explicit

Dim objEF
Dim objPgOneCtrls
Dim objPgThreeCtrls
Dim objPgFiveCtrls
Dim objPgSixCtrls
Dim objPgSevenCtrls
Dim strDistCode
Dim strForestCode
Dim strNorthLat
Dim strWestLong
Dim strSpot
Dim strHbo
Dim strBreakout
Dim strSurvey
Dim strSpotFlagTemp
Dim strHboFlagTemp
Dim strFlag


'Initialization Routines
'-----------------------

Sub InitializeForm

Set objEF = ThisEvent.Object
Set objPgOneCtrls = objEF.Pages("pg1").Controls
Set objPgThreeCtrls = objEF.Pages("pg3").Controls
Set objPgFiveCtrls = objEF.Pages("pg5").Controls
Set objPgSixCtrls = objEF.Pages("pg6").Controls
Set objPgSevenCtrls = objEF.Pages("pg7").Controls

objPgSixCtrls("txtInfTrees").Enabled = False

If objEF.Mode = 3 Then
        objPgOneCtrls("txtRegion").Value = "08"
        objPgOneCtrls("txtRegion").Enabled = False
        objPgOneCtrls("cboForest").ListIndex = -1
        objPgOneCtrls("cboSpecies").ListIndex = -1
        objPgOneCtrls("txtDistCode").Enabled = False
        objPgOneCtrls("cboHboName").Enabled = False
        objPgThreeCtrls("cboWild").ListIndex = -1
        objPgThreeCtrls("cboWildCode").ListIndex = -1
        objPgFiveCtrls("cboSurvType").ListIndex = -1
'       objPgFiveCtrls("dtpSurvDate").Value = Now
        objPgFiveCtrls("cboSuggTrtpln").ListIndex = -1
        objPgFiveCtrls("cboLogAccess").ListIndex = -1
        objPgSixCtrls("cboPulpSaw").ListIndex = -1
        objPgSixCtrls("cboGreenInf").ListIndex = -1

Else
```

```
        Dim test
        objPgOneCtrls("rdbAddNewSpot").Enabled = False
        objPgOneCtrls("txtRegion").Enabled = False
        objPgOneCtrls("cboForest").Enabled = False
        objPgOneCtrls("txtDistCode").Enabled = False
        objPgOneCtrls("cboDistrict").Enabled = False
        objPgOneCtrls("txtSpotNum").Enabled = False
        objPgOneCtrls("txtHboName").Enabled = False
        objPgOneCtrls("cboHboName").SetFocus
        Call LoadHboList("spb_survey_backup.dbf")

End If

End Sub


'|||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
'Application Functions
'---------------------

Sub LoadDependantList(strTableName)

Dim objRS
Dim strFilter
Dim cboFilter
Dim objControl

If "" & strTableName = "" Then
        Exit Sub
End If

Set cboFilter = ThisEvent.Object
strFilter = cboFilter.Value
Set objRS = Application.CreateAppObject("recordset")
Set objControl = objPgOneCtrls("cboDistrict")

If instr(strTableName, "\")=0 Then
        strTableName = LayerPath & strTableName
End If

On Error Resume Next
err.clear
objRS.open(strTableName)
If err.number<>0 Then
        msgbox "Cannot open Table " & strTableName
        Set objRS=Nothing
Exit Sub
End If

objControl.AddItem "",""
objControl.Clear
objRS.MoveFirst
While Not objRS.EOF
        If objRS.fields(1) = strFilter Then
                objControl.AddItem objRS.Fields(2), objRS.fields(3)
        End If
```

```
objRS.MoveNext
Wend
objRS.close

Set objRS = Nothing
Set cboFilter = Nothing
Set objControl = Nothing

End Sub
'-----------------------------------------------------------------------------------------


Sub LoadHboList(strTableName)

Dim objRS
Dim strFilter, strRegion, strForest, strDistrict
Dim objControl

If "" & strTableName = "" Then
	Exit Sub
End If


strFilter = CInt(objPgOneCtrls("txtSpotNum").Value)
strRegion = objPgOneCtrls("txtRegion").Value
strForest = objPgOneCtrls("cboForest").Value
strDistrict = objPgOneCtrls("txtDistCode").Value
Set objRS = Application.CreateAppObject("recordset")
Set objControl = objPgOneCtrls("cboHboName")

If instr(strTableName, "\")=0 Then
	strTableName = LayerPath & strTableName
End If

On Error Resume Next
err.clear
objRS.open(strTableName)
If err.number<>0 Then
	msgbox "Cannot open Table " & strTableName
	Set objRS=Nothing
Exit Sub
End If

objControl.AddItem "",""
objControl.Clear
objRS.MoveFirst
While Not (objRS.EOF)
	If (objRS.Fields(4).Value = strForest) And (objRS.Fields(5).Value = strDistrict) And (objRS.fields(2).Value =
strFilter) Then
		objControl.AddItem objRS.Fields("HBO_NAME").Value, objRS.fields("HBO_NAME").Value
	End If
objRS.MoveNext
Wend
objRS.close

Set objRS = Nothing
```

```
Set objControl = Nothing

End Sub
'----------------------------------------------------------------------
Sub StoreHboName

Dim strSearch, objControl
Set objControl = ThisEvent.Object
strSearch = objControl.Value

objPgOneCtrls("txtHboName").Value = strSearch

Set objControl = Nothing
End Sub
'--------------------------------------------------------------------


Function LayerPath

Dim objLyr
Dim strPath
Set objLyr = application.map.SelectionLayer
strPath = objLyr.FilePath
strPath = left(strPath,InstrRev(strPath,"\",-1,1))
LayerPath = strPath
Set objLyr = Nothing

End Function
'---------------------------------------------------------------------


Sub StoreDistrictCode(strTableName)

Dim strSearch, objControl
Set objControl = ThisEvent.Object
strSearch = objControl.Value

'strDistCode = ReturnDistCode(strTableName, strSearch)

objPgOneCtrls("txtDistCode").Value = strSearch

Set objControl = Nothing

End Sub
'----------------------------------------------------------------------


Function ReturnDistCode (strTableName, strSearch)

Dim objRS
Dim strForestCode

Set objRS = Application.CreateAppObject("recordset")
strForestCode = objPgOneCtrls("cboForest").Value

If instr(strTableName, "\") = 0 Then
```

```
		strTableName = LayerPath & strTableName
End If
objRS.Open(strTableName)
If err.number<>0 Then
		msgbox "Cannot open Table " & strTableName
		Set objRS = Nothing
		Exit Function
End If
objRS.MoveFirst
While Not objRS.EOF
		If (objRS.Fields(1) = strForestCode And objRS.fields(3) = strSearch) Then
			ReturnDistCode = objRS.Fields(2)
		Exit Function
		End If
objRS.MoveNext
Wend
objRS.Close

strForestCode = ""
Set objRS = Nothing

End Function
'-----------------------------------------------------------------------


Function ReturnDistrictName(strTableName, strSearch)

Dim objRS
Dim strForestCode

Set objRS = Application.CreateAppObject("recordset")
strForestCode = objPgOneCtrls("cboForest").Value

If instr(strTableName, "\") = 0 Then
		strTableName = LayerPath & strTableName
End If
objRS.Open(strTableName)
If err.number<>0 Then
		msgbox "Cannot open Table " & strTableName
		Set objRS = Nothing
		Exit Function
End If
objRS.MoveFirst
While Not objRS.EOF
		If (objRS.Fields(1) = strForestCode And objRS.fields(2) = strSearch) Then
		ReturnDistrictName = objRS.Fields(3)
		Exit Function
		End If
objRS.MoveNext
Wend
objRS.Close

strForestCode = ""
Set objRS = Nothing

End Function
```

```
'-----------------------------------------------------------------------


Sub StoreForestCode(strTableName)

Dim strSearch, objControl
Set objControl = ThisEvent.Object
strSearch = objControl.Value

objPgOneCtrls("txtForestCode").Value = strSearch

Set objControl = Nothing

End Sub
'-----------------------------------------------------------------------


'Sub UpdateHBO
'
'Dim strHbo
'Dim strBreakout
'Dim strHBO
'strHbo = objPgOneCtrls("txtHead").Value
'strBreakout = objPgOneCtrls("txtBrk").Value
'strHBO = strHbo & strBreakout

'objPgOneCtrls("txtHboName").Value = strHBO

'End Sub
'-----------------------------------------------------------------------


Sub UpdateFlags

Dim strResponse

strResponse =       MsgBox("Would you like to send this data into SPBIS?", vbYesNo)
If strResponse = vbYes Then
        Call CreateDbfCopy
End If

End Sub
'-----------------------------------------------------------------------


Sub CreateDbfCopy

Dim objRS
Dim strFileName
Dim strSurvEntered
Dim strTreatEntered
Dim strSmcEntered
strSurvEntered = "no"
strTreatEntered = "no"
strSmcEntered = "no"
strFileName = "spb_survey_backup.dbf"
```

```
Set objRS = Application.CreateAppObject("recordset")
If instr(strFileName, "\") = 0 Then
		strFileName = LayerPath & strFileName
End If
objRS.Open strFileName, 2
If err.number<>0 Then
		msgbox "Cannot open Table " & strFileName
		Set objRS = Nothing
		Exit Sub
End If

Dim intMax, intCurrVal
objRS.MoveFirst
If objRS.recordCount <> 0 Then
		intMax = CInt(objRS.Fields(1).Value)
		While Not objRS.EOF
				intCurrVal = CInt(objRS.Fields(1).Value)
				If (intCurrVal > intMax) Then
						intMax = intCurrVal
				End If
				objRS.MoveNext
		Wend
		intMax = intMax + 1
Else
		intMax = 1
End If


If ((objRS.recordcount = 0) And (strSpot = "N")) Then
		objRS.AddNew
		objRS.Fields(1).Value = 1
		objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
		objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
		objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
		objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
		objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
		objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value
		objRS.Fields(9).Value = objPgOneCtrls("txtParentHbo").Value
		objRS.Fields(10).Value = objPgThreeCtrls("txtComp").Value
		objRS.Fields(11).Value = objPgThreeCtrls("txtSt").Value
		objRS.Fields(13).Value = objPgThreeCtrls("txtEstimatedAcres").Value
		objRS.Fields(14).Value = objPgThreeCtrls("cboPriority").Value
		objRS.Fields(16).Value = objPgThreeCtrls("txtPBA").Value
		objRS.Fields(17).Value = objPgThreeCtrls("txtTBA").Value
		objRS.Fields(18).Value = objPgThreeCtrls("cboWild").Value
		'objRS.Fields(19).Value = objPgThreeCtrls("cboWildCode").Value
		'objRS.Fields(20).Value = objPgThreeCtrls("txtWildName").Value
		objRS.Fields(21).Value = objPgThreeCtrls("txtSpotFndBy").Value
		objRS.Fields("SPHEROID").Value = "WGS84"
		objRS.Fields(65).Value = "N"
		objRS.Fields(67).Value = "N"
		If strSurvey = "N" Then
				objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
				objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
				objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
				objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
```

```
                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                objRS.Fields(69).Value = "N"
                strSurvEntered = "yes"
        Else
                objRS.Fields(69).Value = "B"
        End If

End If

If ((objRS.recordcount <> 0) And (strSpot = "N")) Then
        objRS.MoveLast
        objRS.AddNew
        objRS.Fields(1).Value = intMax
        objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
        objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
        objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
        objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
        objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
        objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value
        objRS.Fields(9).Value = objPgOneCtrls("txtParentHbo").Value
        objRS.Fields(10).Value = objPgThreeCtrls("txtComp").Value
        objRS.Fields(11).Value = objPgThreeCtrls("txtSt").Value
        objRS.Fields(13).Value = objPgThreeCtrls("txtEstimatedAcres").Value
        objRS.Fields(14).Value = objPgThreeCtrls("cboPriority").Value
        objRS.Fields(16).Value = objPgThreeCtrls("txtPBA").Value
        objRS.Fields(17).Value = objPgThreeCtrls("txtTBA").Value
        objRS.Fields(18).Value = objPgThreeCtrls("cboWild").Value
        objRS.Fields(19).Value = objPgThreeCtrls("cboWildCode").Value
        'objRS.Fields(20).Value = objPgThreeCtrls("txtWildName").Value
        objRS.Fields(21).Value = objPgThreeCtrls("txtSpotFndBy").Value
        objRS.Fields("SPHEROID").Value = "WGS84"
        objRS.Fields(65).Value = "N"
        objRS.Fields(67).Value = "N"
        If strSurvey = "N" Then
                objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
                objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                objRS.Fields(69).Value = "N"
```

```
                strSurvEntered = "yes"
        Else
                objRS.Fields(69).Value = "B"
        End If

End If

If ((strSpot <> "N") And (strHbo = "N")) Then
        objRS.MoveFirst
        While Not objRS.EOF
                If ((objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value) And (objRS.Fields(4).Value =
objPgOneCtrls("cboForest").Value) And (objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value)) Then
                        strSpotFlagTemp = objRS.Fields(65).Value
                        strNorthLat = objRS.Fields("N_LAT_DD").Value
                        strWestLong = objRS.Fields("W_LON_DD").Value
                End If
        objRS.MoveNext
        Wend
        objRS.MoveLast
        objRS.AddNew
        objRS.Fields(1).Value = intMax
        objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
        objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
        objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
        objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
        objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
        objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value
        objRS.Fields(9).Value = objPgOneCtrls("txtParentHbo").Value
        objRS.Fields(10).Value = objPgThreeCtrls("txtComp").Value
        objRS.Fields(11).Value = objPgThreeCtrls("txtSt").Value
        objRS.Fields(13).Value = objPgThreeCtrls("txtEstimatedAcres").Value
        objRS.Fields(14).Value = objPgThreeCtrls("cboPriority").Value
        objRS.Fields(16).Value = objPgThreeCtrls("txtPBA").Value
        objRS.Fields(17).Value = objPgThreeCtrls("txtTBA").Value
        objRS.Fields(18).Value = objPgThreeCtrls("cboWild").Value
        objRS.Fields(19).Value = objPgThreeCtrls("cboWildCode").Value
        'objRS.Fields(20).Value = objPgThreeCtrls("txtWildName").Value
        objRS.Fields(21).Value = objPgThreeCtrls("txtSpotFndBy").Value
        'objRS.Fields("N_LAT_DD").Value = strNorthLat
        'objRS.Fields("W_LON_DD").Value = strWestLong
        objRS.Fields("SPHEROID").Value = "WGS84"
        objRS.Fields(65).Value = strSpotFlagTemp
        objRS.Fields(67).Value = "N"
        If strSurvey = "N" Then
                objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
                objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
```

```
                'objRS.Fields(35).Value = strNorthLat
                'objRS.Fields(36).Value = strWestLong
                'objRS.Fields(37).Value = "WGS84"
                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                objRS.Fields(69).Value = "N"
                strSurvEntered = "yes"
        Else
                objRS.Fields(69).Value = "B"
        End If

End If

If ((strSpot <> "N") And (strBreakout = "N")) Then
        objRS.MoveFirst
        While Not objRS.EOF
                If ((objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value) And (objRS.Fields(4).Value =
objPgOneCtrls("cboForest").Value) And (objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value)) Then
                        strSpotFlagTemp = objRS.Fields(65).Value
                        strNorthLat = objRS.Fields("N_LAT_DD").Value
                        strWestLong = objRS.Fields("W_LON_DD").Value
                End If
        objRS.MoveNext
        Wend
        objRS.MoveLast
        objRS.AddNew
        objRS.Fields(1).Value = intMax
        objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
        objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
        objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
        objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
        objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
        objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value
        objRS.Fields(9).Value = objPgOneCtrls("txtParentHbo").Value
        objRS.Fields(10).Value = objPgThreeCtrls("txtComp").Value
        objRS.Fields(11).Value = objPgThreeCtrls("txtSt").Value
        objRS.Fields(13).Value = objPgThreeCtrls("txtEstimatedAcres").Value
        objRS.Fields(14).Value = objPgThreeCtrls("cboPriority").Value
        objRS.Fields(16).Value = objPgThreeCtrls("txtPBA").Value
        objRS.Fields(17).Value = objPgThreeCtrls("txtTBA").Value
        objRS.Fields(18).Value = objPgThreeCtrls("cboWild").Value
        objRS.Fields(19).Value = objPgThreeCtrls("cboWildCode").Value
        'objRS.Fields(20).Value = objPgThreeCtrls("txtWildName").Value
        objRS.Fields(21).Value = objPgThreeCtrls("txtSpotFndBy").Value
        'objRS.Fields("N_LAT_DD").Value = strNorthLat
        'objRS.Fields("W_LON_DD").Value = strWestLong
        objRS.Fields("SPHEROID").Value = "WGS84"
        objRS.Fields(65).Value = strSpotFlagTemp
        objRS.Fields(67).Value = "N"
        If strSurvey = "N" Then
                objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
                objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtP ln").Value
                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
```

```
                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                'objRS.Fields(35).Value = strNorthLat
                'objRS.Fields(36).Value = strWestLong
                'objRS.Fields(37).Value = "WGS84"
                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                objRS.Fields(69).Value = "N"
                strSurvEntered = "yes"
        Else
                objRS.Fields(69).Value = "B"
        End If

End If


If ((strSpot <> "N") And ((strHbo <> "N") Or (strBreakout <> "N")) And (strSurvey = "N")) Then
        objRS.MoveFirst
        While Not objRS.EOF
                If ((objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value) And (objRS.Fields(4).Value =
objPgOneCtrls("cboForest").Value) And (objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value) And
(objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value)) Then
                        strSpotFlagTemp = objRS.Fields(65).Value
                        strHboFlagTemp = objRS.Fields(67).Value
                        strNorthLat = objRS.Fields("N_LAT_DD").Value
                        strWestLong = objRS.Fields("W_LON_DD").Value
                        'MsgBox "Blah"
                        'MsgBox strSpotFlagTemp
                        If objRS.Fields(69).Value = "B" Then
                                objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                                objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
                                objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                                objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
                                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                                'objRS.Fields("N_LAT_DD").Value = strNorthLat
                                'objRS.Fields("W_LON_DD").Value = strWestLong
                                'objRS.Fields("SPHEROID").Value = "WGS84"
                                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                                objRS.Fields(69).Value = "N"
                                strSurvEntered = "yes"

                        End If
                End If
        objRS.MoveNext
        Wend
        If strSurvEntered = "no" Then
                objRS.MoveLast
```

```
                objRS.AddNew
                objRS.Fields(1).Value = intMax
                objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
                objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
                objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
                objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
                objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value
                objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                objRS.Fields(24).Value = objPgFiveCtrls("dtpSurvDate").Value
                objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
                objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                objRS.Fields("N_LAT_DD").Value = strNorthLat
                objRS.Fields("W_LON_DD").Value = strWestLong
                objRS.Fields("SPHEROID").Value = "WGS84"
                objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                objRS.Fields(65).Value = strSpotFlagTemp
                objRS.Fields(67).Value = strHboFlagTemp
                objRS.Fields(69).Value = "N"
                strSurvEntered = "yes"

        End If
End If

If ((objRS.recordcount = 0) And (strSpot = "M")) Then
        objRS.AddNew
                objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value
                objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
                objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
                objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
                objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
                objRS.Fields(65).Value = "M"
End If

If ((objRS.recordcount <> 0) And (strSpot = "M")) Then
        objRS.MoveFirst
        While Not objRS.EOF
                If objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value Then
                        objRS.Fields(3).Value = objPgOneCtrls("txtRegion").Value
                        objRS.Fields(4).Value = objPgOneCtrls("cboForest").Value
                        objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value
                        objRS.Fields(7).Value = objPgOneCtrls("cboSpecies").Value
                        objRS.Fields(65).Value = "M"
                End If
        objRS.MoveNext
        Wend
End If

If strHbo = "M" Then
```

```
        objRS.MoveFirst
        While Not objRS.EOF
                If ((objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value) And (objRS.Fields(4).Value =
objPgOneCtrls("cboForest").Value) And (objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value) And
(objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value)) Then
                        objRS.Fields(9).Value = objPgOneCtrls("txtParentHbo").Value
                        objRS.Fields(10).Value = objPgThreeCtrls("txtComp").Value
                        objRS.Fields(11).Value = objPgThreeCtrls("txtSt").Value
                        objRS.Fields(13).Value = objPgThreeCtrls("txtEstimatedAcres").Value
                        objRS.Fields(14).Value = objPgThreeCtrls("cboPriority").Value
                        objRS.Fields(16).Value = objPgThreeCtrls("txtPBA").Value
                        objRS.Fields(17).Value = objPgThreeCtrls("txtTBA").Value
                        objRS.Fields(18).Value = objPgThreeCtrls("cboWild").Value
                        objRS.Fields(19).Value = objPgThreeCtrls("cboWildCode").Value
                        'objRS.Fields(20).Value = objPgThreeCtrls("txtWildName").Value
                        objRS.Fields(21).Value = objPgThreeCtrls("txtSpotFndBy").Value
                        objRS.Fields(67).Value = "M"
                End If
        objRS.MoveNext
        Wend
End If

If strSurvey = "M" Then
        objRS.MoveFirst
        While Not objRS.EOF
                If ((objRS.Fields(2).Value = objPgOneCtrls("txtSpotNum").Value) And (objRS.Fields(4).Value =
objPgOneCtrls("cboForest").Value) And (objRS.Fields(5).Value = objPgOneCtrls("txtDistCode").Value) And
(objRS.Fields(8).Value = objPgOneCtrls("txtHboName").Value) And (objRS.Fields(24).Value =
objPgFiveCtrls("dtpSurvDate").Value)) Then
                        objRS.Fields(23).Value = objPgFiveCtrls("cboSurvType").Value
                        objRS.Fields(25).Value = objPgFiveCtrls("dtpGrdChkDate").Value
                        objRS.Fields(26).Value = objPgFiveCtrls("cboSuggTrtPln").Value
                        objRS.Fields(27).Value = objPgFiveCtrls("cboFlgClr").Value
                        objRS.Fields(28).Value = objPgFiveCtrls("cboLogAccess").Value
                        objRS.Fields(29).Value = objPgSixCtrls("cboPulpSaw").Value
                        objRS.Fields(30).Value = objPgSixCtrls("cboGreenInf").Value
                        objRS.Fields(31).Value = objPgSixCtrls("txtInfTrees").Value
                        objRS.Fields(32).Value = objPgSixCtrls("txtNumFading").Value
                        objRS.Fields(33).Value = objPgSixCtrls("txtNumGreen").Value
                        objRS.Fields(34).Value = objPgSixCtrls("txtNumVac").Value
                        'objRS.Fields("N_LAT_DD").Value = strNorthLat
                        'objRS.Fields("W_LONG_DD").Value = strWestLong
                        'objRS.Fields(37).Value = "WGS84"
                        objRS.Fields(38).Value = objPgSevenCtrls("txtComments3").Value
                        objRS.Fields(69).Value = "M"
                End If
        objRS.MoveNext
        Wend
End If

objRS.Update
objRS.Close
Set objRS = Nothing
strSpotFlagTemp = ""
strHboFlagTemp = ""
```

```
End Sub
'--------------------------------------------------------------------------------------------------


'||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
'Validation Routines
'-------------------


Sub ValidateWild

If ThisEvent.Object.Value = "Y" Then
	objPgThreeCtrls("cboWildCode").Enabled = True
	objPgThreeCtrls("cboWildCode").ListIndex = -1
Else
	objPgThreeCtrls("cboWildCode").Enabled = False
End If

End Sub
'------------------------------------------------------------------------------


Sub ValidateBATotal

Dim dblPBA, dblTBA
dblPBA = CDbl(objPgThreeCtrls("txtPBA").Value)
dblTBA = CDbl(objPgThreeCtrls("txtTBA").Value)
If dblPBA > dblTBA Then
	ThisEvent.Result = False
	ThisEvent.MessageText = "The basal area for Pine should be less than or equal to the total basal area.
Please re-enter the values"
	ThisEvent.messageType = vbExclamation
End If

End Sub
'--------------------------------------------------------------------------------


Sub ValidateNumeric

Dim strValue
strValue = ThisEvent.Object.Value
	If strValue <> "" Then
		If Not IsNumeric(strValue) Then
			ThisEvent.Result = False
			ThisEvent.MessageText = "Please enter a numeric value"
			ThisEvent.messageType = vbExclamation
		End If
	End If

End Sub
'-----------------------------------------------------------------------------


Sub ValidateComma
```

```
Dim objControl
Set objControl = ThisEvent.Object
Dim intComma
Dim intLength
Dim strSearchString
strSearchString = objControl.Value
intComma = InStr(strSearchString, ",")
If intComma > 0 Then
        ThisEvent.Result = False
        ThisEvent.MessageText = "Commas are not acceptable entries!!!!  Please delete the commas."
        ThisEvent.messageType = vbExclamation
        End If

End Sub

'-------------------------------------------------------------------------------


Sub ValidateInitialDetection

Dim strResponse
Dim strDate
strDate = objPgFiveCtrls("dtpSurvDate").Value


MsgBox "Please verify Initial Detection date of" & strDate
strResponse =     MsgBox("Is this value correct?", vbYesNo)
If strResponse = vbNo Then
        ThisEvent.Result = False
        ThisEvent.MessageType = vbExclamation
        objPgFiveCtrls("dtpSurvDate").SetFocus
End If

End Sub
'----------------------------------------------------------------------

Sub ValidateRadioButtons

If strSurvey = "" Then
 ThisEvent.Result = False
        ThisEvent.MessageText = "Please choose from one of the radio button options at the top of the page."
        ThisEvent.messageType = vbExclamation
 End If

End Sub

'|||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
'Data-entry Control Functions
'----------------------------


Sub IncrementNum (strNum)

Dim intNum
If strNum = "2" Then
        intNum = CInt(objPgSixCtrls("txtNumFading").Value)
```

```
            objPgSixCtrls("txtNumFading").Value = intNum + 1
ElseIf strNum = "3" Then
            intNum = CInt(objPgSixCtrls("txtNumGreen").Value)
            objPgSixCtrls("txtNumGreen").Value = intNum + 1
ElseIf strNum = "4" Then
            intNum = CInt(objPgSixCtrls("txtNumVac").Value)
            objPgSixCtrls("txtNumVac").Value = intNum + 1
End If

End Sub
'-----------------------------------------------------------------------------------


Sub DecrementNum (strNum)

Dim intNum
If strNum = "2" Then
            intNum = CInt(objPgSixCtrls("txtNumFading").Value)
            objPgSixCtrls("txtNumFading").Value = intNum - 1
ElseIf strNum = "3" Then
            intNum = CInt(objPgSixCtrls("txtNumGreen").Value)
            objPgSixCtrls("txtNumGreen").Value = intNum - 1
ElseIf strNum = "4" Then
            intNum = CInt(objPgSixCtrls("txtNumVac").Value)
            objPgSixCtrls("txtNumVac").Value = intNum - 1
End If

End Sub

'-----------------------------------------------------------------------------------


Sub SumTreeCounts

  Dim intNum1, intNum2, intTotal
  intNum1 = CInt(objPgSixCtrls("txtNumFading").Value)
  intNum2 = CInt(objPgSixCtrls("txtNumGreen").Value)
  intTotal = intNum1 + intNum2
  objPgSixCtrls("txtInfTrees").Value = intTotal

End Sub

'||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
'Exit Routines
'-------------


Sub GPS_Update

Dim objLayer, objRS, strInput, strFileName
Set objLayer = Application.Map.SelectionLayer
Set objRS = objLayer.Records
objRS.Bookmark = Map.SelectionBookmark
If (GPS.IsOpen) Then
            objRS.Fields("N_LAT_DD").Value = GPS.Latitude
            strNorthLat = GPS.Latitude
```

```
        objRS.Fields("W_LON_DD").Value = GPS.Longitude
        strWestLong = GPS.Longitude
End If
objRS.Update

Set objRS = Nothing
Set objLayer = Nothing

If strSpot = "N" or strHbo = "N" or strBreakout = "N" Then
        strFileName = "spb_survey_backup.dbf"
        Set objRS = Application.CreateAppObject("recordset")
        If instr(strFileName, "\") = 0 Then
                strFileName = LayerPath & strFileName
        End If
        objRS.Open strFileName, 2
        If err.number<>0 Then
                msgbox "Cannot open Table " & strFileName
                Set objRS = Nothing
                Exit Sub
        End If

        objRS.MoveLast
        objRS.Fields("N_LAT_DD").Value = strNorthLat
        objRS.Fields("W_LON_DD").Value = strWestLong
objRS.Update
objRS.Close
End If


Set objRS = Nothing
End Sub
'-------------------------------------------------------------------------------

Sub GPS_Activate

Dim strInput
If Not((GPS.IsOpen)) Then
        strInput = MsgBox ("Would you like to activate the GPS?", 4)
        If (strInput = vbYes) Then
                Application.GPS.Open
        End If
End If

End Sub
'-------------------------------------------------------------------------------


Sub FreeMemory

'objPgOneCtrls("cboForest").Clear
'objPgOneCtrls("cboDistrict").Clear

Set objPgSevenCtrls = Nothing
Set objPgSixCtrls = Nothing
Set objPgFiveCtrls = Nothing
Set objPgThreeCtrls = Nothing
```

```
Set objPgOneCtrls = Nothing


strForestCode = ""
strNorthLat = 0
strWestLong = 0
strSpot = ""
strHbo = ""
strBreakout = ""
strSurvey = ""
strSpotFlagTemp = ""
strHboFlagTemp = ""
strFlag = ""


End Sub



'||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
'Flag Update Routines

Sub UpdateSpotFlag(strFlag)
        strSpot = strFlag
        objPgOneCtrls("txtHboName").Value = 1
        objPgOneCtrls("txtParentHbo").Value = "Master"
End Sub


Sub UpdateHeadFlag(strFlag)
        strHbo = strFlag
        objPgOneCtrls("cboHboName").ListIndex = -1
        objPgOneCtrls("cboHboName").Enabled = False
        objPgOneCtrls("txtHboName").Enabled = True
End Sub


Sub UpdateBreakoutFlag(strFlag)
        strBreakout = strFlag
        objPgOneCtrls("cboHboName").ListIndex = -1
        objPgOneCtrls("cboHboName").Enabled = False
        objPgOneCtrls("txtHboName").Enabled = True
End Sub


Sub UpdateSurveyFlag(strFlag)
        strSurvey = strFlag
End Sub
```

APPENDIX B

SPBIS DATA UPLOAD APPLICATION CODE

The following is the code for the upload interface between SPBIS and the mobile device.

```
SQL = "INSERT INTO spb_main_spots_table " + _
            "(SPOT_NUMBER, REGION,
FOREST,DISTRICT,SPECIES,COMMENTS,INPUT_TYPE)" + _
            "VALUES (" + spotNum + "," + _
                        region + "," + _
                        Forest + "," + _
                        District + ", '" + _
                        Species + "', '" + _
                        commMain + "', " + _
                        "'P')"
ADOC.Execute SQL
   SQL = "INSERT INTO spb_heads_breakouts " + _
            "(SPOT_CN, HBO_NAME, PARENT_HBO, COMPARTMENT," + _
            "STAND, USTAND, EST_ACRES, PRIORITY, HAZARD_RATING, " +
_
            "BA_PINE, BA_TOTAL, WILDERNESS, WILD_CODE,
WILDERNESS_NAME,
FOUND_BY, COMMENTS) " + _
            "VALUES ('" + spotCN + "', '" + _
             hboName + "', '" + _
             Parent_HBO + "', " + _
             comp + ", " + _
             stand + ", '" + _
             ustand + "', " + _
             est_Acres + ", '" + _
             priority + "',' " + _
             Haz_rate + "', " + _
             BA_pine + ", " + _
             BA_total + ", '" + _
             wild + "', '" + _
             wild_code + "', '" + _
             wildName + "', '" + _
             found_by + "', '" + _
             comm_HBO + "')"

 ADOC.Execute SQL

       SQL = "INSERT INTO SPB_SURVEYS " + _
               "(HBO_CN, SURVEY_TYPE_CODE, DATE_SURVEYED,
DATE_GROUND_CHECKED," + _
               "FLAGGING_COLOR, LOGGING_ACCESS_CODE, PULP_OR_SAW,
TREATMENT_CODE, " + _
               "FRESH_ATTACK, NUM_GREEN_TREES, NUM_INFESTED_TREES,
NUM_RED_FADED_TREES, " + _
               "NUM_VACATED_TREES, N_LAT_DD, W_LON_DD, SPHEROID,
Comments) " + _
               "VALUES ('" + hboCN + "', '" + _
                SURV_TYPE + "', '" + _
                SURV_DATE + "', '" + _
                GR_CH_DATE + "', '" + _
                FLG_COLOR + "', '" + _
                LOG_CODE + "', '" + _
                PULP_SAW + "', '" + _
                TRT_CODE + "', '" + _
```

```
                FRESH_ATT + "', " + _
                NUM_GR_TR + ", " + _
                NUM_INF_TR + ", " + _
                NUM_RF_TR + ", " + _
                NUM_VAC_TR + ", " + _
                N_LAT_DD + ", " + _
                W_LON_DD + ", '" + _
                SPHEROID + "', '" + _
                COMM_SURV + "')"

    ADOC.Execute SQL
       SQL = "INSERT INTO SPB_TREATMENTS " + _
              "(HBO_CN, SALE_ID, CUTTING_UNIT_ID, PERMIT_NUM,
TREATMENT_CODE, DATE_MARKED, DATE_SOLD, DATE_TREATED, DATE_SUPPRESSED,
" +
_
              "CONTRACTOR_ID, CALCULATED_ACRES, NUM_TREES_TREATED,
PAINT_COLOR, SALVAGE_VOLUME_PULP, SALVAGE_VOLUME_SAW, " + _
              "SUPP_VOLUME_DATE, SUPP_VOLUME_PULP,
SUPP_VOLUME_SAW,
MARKERS, comments) VALUES ('" + hboCN + "', " + _
                SALE_ID + ", " + _
                CUT_ID + ", '" + _
                PERMIT_NUM + "', '" + _
                PRIM_TRT + "', '" + _
                DATE_MARK + "', '" + _
                DATE_SOLD + "', '" + _
                DATE_TRT + "', '" + _
                DATE_SUPP + "', '" + _
                CONTR_ID + "', " + _
                CALC_ACRES + ", " + _
                NUM_TR_TRT + ", '" + _
                PNT_COLOR + "', " + _
                SAL_V_PULP + ", " + _
                SAL_V_SAW + ", '" + _
                SUP_V_DATE + "', " + _
                SUP_V_PULP + ", " + _
                SUP_V_SAW + ", '" + _
                MARKERS + "', '" + _
                COMM_TRT + "')"

    ADOC.Execute SQL

       SQL = "INSERT INTO spb_special_mgt_considerations " + _
              "(HBO_CN , SMC_CODE, DATE_INITIATED, DATE_CLEARED,
REVIEWER, Approved, Comments ) " + _
              "VALUES ('" + hboCN + "', '" + _
                SMC_CODE + "', '" + _
                DATE_INIT + "', '" + _
                DATE_CLEAR + "', '" + _
                REVIEWER + "', '" + _
                Approved + "', '" + _
                COMM_SMC + "')"

    ADOC.Execute SQL
```

APPENDIX C

SPBIS DATA COLLECTION USERS MANUAL

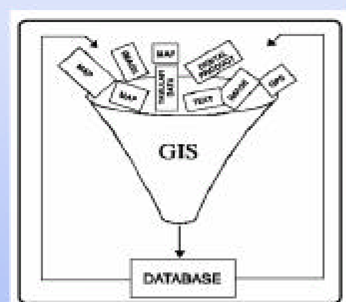
TABLE OF CONTENTS

Page

What is GIS?

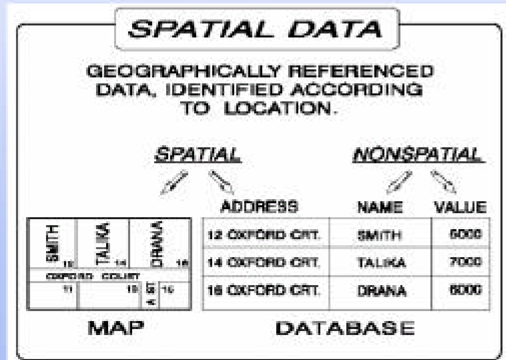
Geographic Information System

- A spatially-referenced database system
  - Spatial attributes:
    - Characterized by location (x, y, and z coordinates)
    - Graphic component: expressed in the form of maps, images
  - Non-spatial attributes
    - Information associated with the spatial feature
- Computer-based link between the two



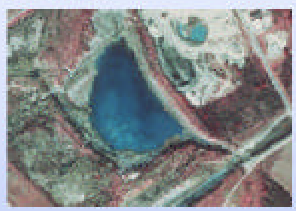
Spatially referenced data

- Any data that has a spatial/location component

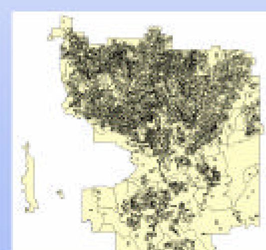


- A location on a map
- Street addresses
- X, Y coordinates
- A region –a forest

GIS data model

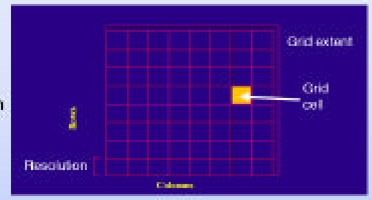


- Raster data model
  - Grid (cell) based
  - Simple data structure
  - Continuous surface/features
    - Aerial photo, digital elevation model, digital photographs
- Vector data model
  - Node/arc based
  - Discrete entities/features
  - Precise and accurate
  - Variety of advanced analysis
    - Digital maps, shape files, GIS coverages

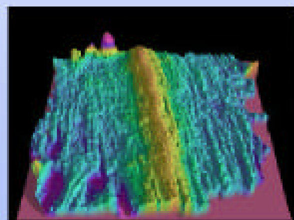


Raster data model

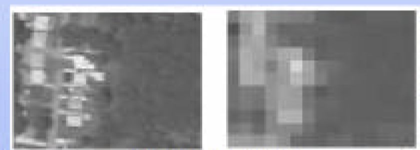
- Grid (cell) based
- Simple data structure
- Continuous surface/feature
  - aerial photo, digital elevation model, digital photographs



Cell based



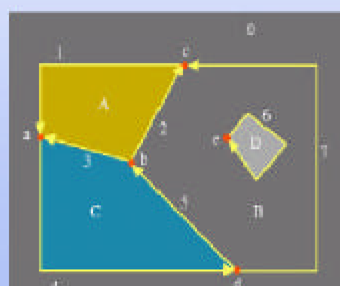
Continuous surface



Spatial resolution

Vector data model

- Directional linear connection between two points
- Basic elements: points ? Lines ? Polygon
- X, Y coordinates of points, lines, and polygons: unlimited precision



Points: a, b, c, d

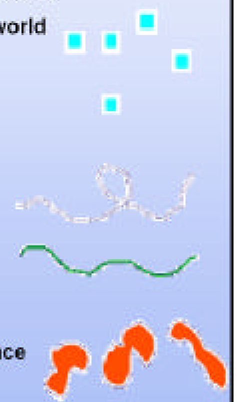
Lines: 0, 1, 2, 3, 4, 5, 6, 7

Polygons: A, B, C, D

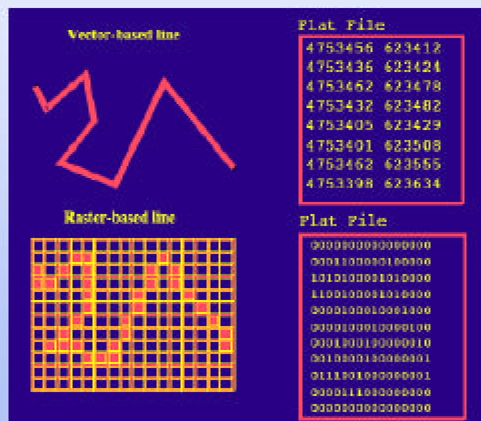
Vector feature type

Objects/phenomena represented as three types

- Points/Nodes: a tree, location of cities on the world map
  - Single set of x,y coordinates
  - No dimensions or direction
- Lines/Arcs: streams, roads, utility lines
  - Linear feature between two points
  - Length and direction (from-node, to-node)
- Polygons: compartments, stands, lakes
  - Closed region made of lines/arcs in sequence
  - Perimeter, area, centroid

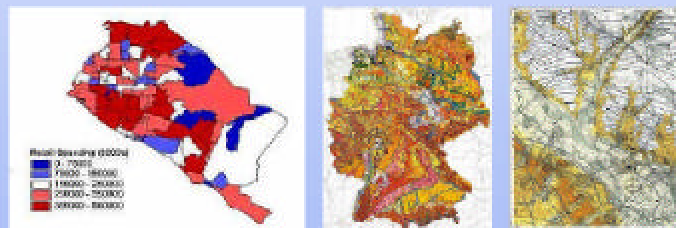


Raster vs. Vector



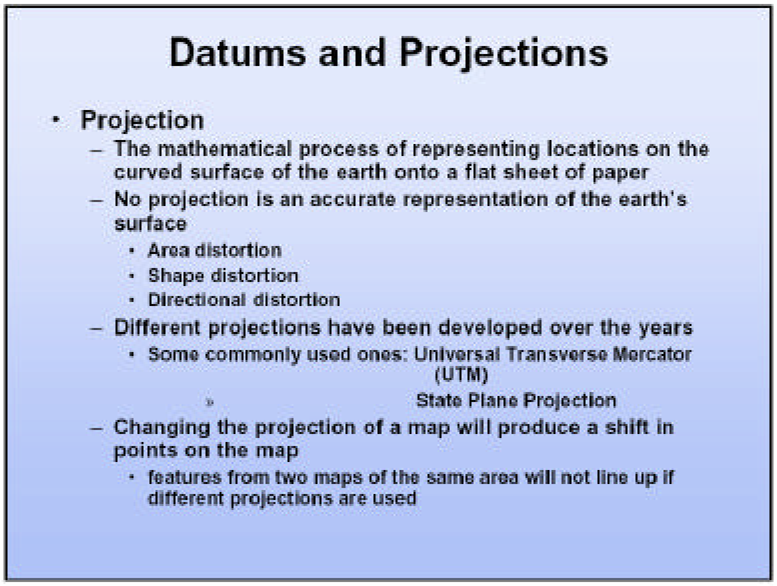
What is a Map…?

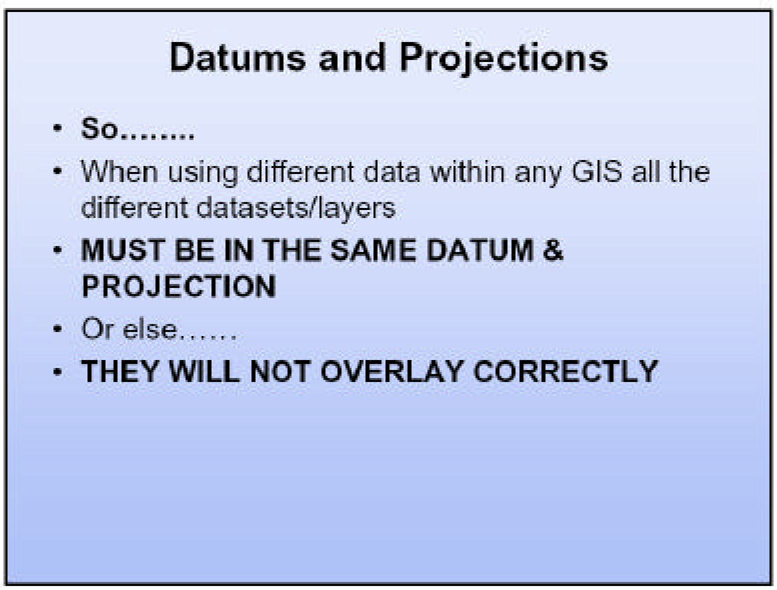
- In the simplest of terms, it is an abstract representation of the 3-dimensional world (features and phenomena) onto a 2-dimensional surface/plane
  - Not a miniature version of reality, but an abstracted version of reality
  - Mathematical translations convert actual locations on the earth to locations on these abstract models, using lat-long coordinates obtained from GPS



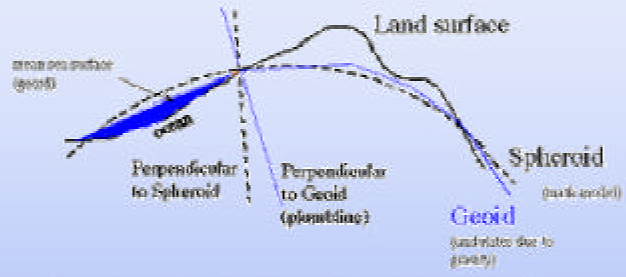
Datums and Projections

- Necessary for mapping spatial features and phenomena, constitute established standards and procedures for representing the earth
- Datum
  - Define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth.
  - A mathematical abstraction of the mean sea-level of the earth, with a reference point of origin
  - Different datums have been developed over the years
    - Some commonly used ones: NAD27
      - » NAD83
  - Changing the datum associated with a map will produce a shift in points on the map
    - features from two maps of the same area will not line up if different datums are used


Datums and Projections
• Projection
– The mathematical process of representing locations on the curved surface of the earth onto a flat sheet of paper
– No projection is an accurate representation of the earth's surface
• Area distortion
• Shape distortion
• Directional distortion
– Different projections have been developed over the years
• Some commonly used ones: Universal Transverse Mercator (UTM)
» State Plane Projection
– Changing the projection of a map will produce a shift in points on the map
• features from two maps of the same area will not line up if different projections are used

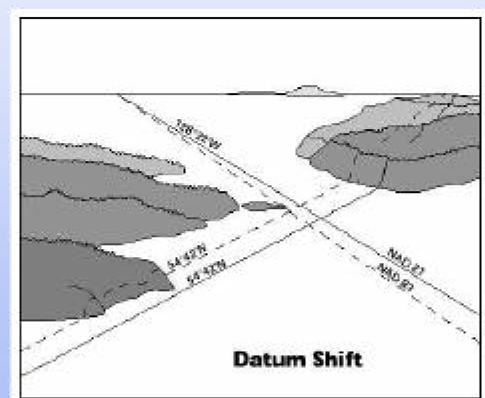

Datums and Projections
• So........
• When using different data within any GIS all the different datasets/layers
• MUST BE IN THE SAME DATUM & PROJECTION
• Or else……
• THEY WILL NOT OVERLAY CORRECTLY

Datum


Land surface
Perpendicular to Spheroid
Perpendicular to Geoid (plumbline)
Spheroid
Geoid

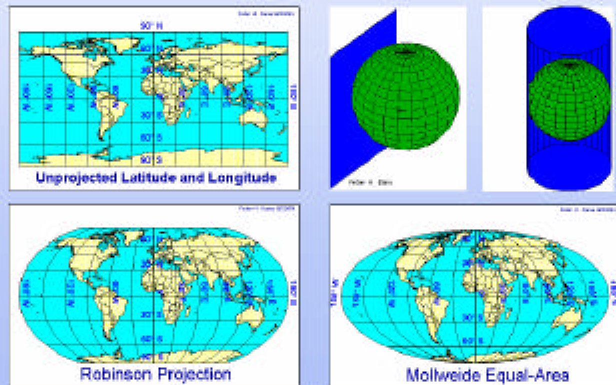

Datum plane
(mean sea level)
400 feet
300
200
100
0

Datum


Datum Shift

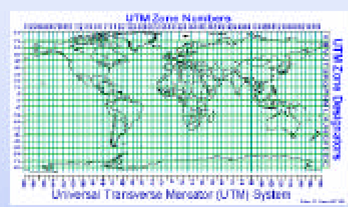
Projection

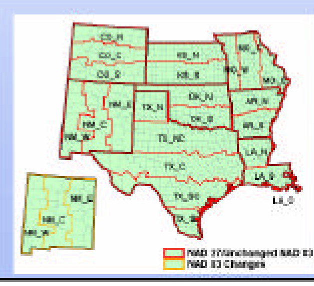
Depends on how you project the Earth, the shape and locations are changing!!



Important projections

- **Universal Transverse Mercator (UTM)**
  - used to define horizontal positions world-wide
  - divides the surface of the Earth into 6 degree zones
- **State Plane Coordinate System**
  - divides all US states and territories into over 120 numbered sections, referred to as zones
  - Each zone has specific projection parameters adjusted for the region

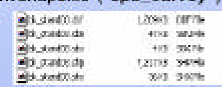




ESRI's GIS System

- Software: ArcGIS, ArcPad and more
- File type (Digital vector layers): for the SPBIS data collection

- Shapefile (.shp file): used with ArcGIS, ArcPad
- A single dataset is a collection of files with extensions .shp, .shx, .sbx, .dbf, .prj
    - The .dbf file stores the spatial and non-spatial attributes of the data
    - Three types of shapefiles – Point, Line and Polygon
    - In this exercise we will use a point shapefile ("spb_survey") to collect the SPB data points on the field.



- The attribute information will be stored in the "spb_survey.dbf" file linked to the point shapefile

Working with ArcPad

Presenter: Brian Parr
ESRI Redlands, California

ESRI

Workshop Overview

- **Topics**
  - Introduction to ArcPad
  - Working with layers
  - Querying and measuring tools
  - Editing tools
- **Format**
  - Slide shows followed by software demonstrations
  - Each topic followed by a Topic Review

What is ArcPad?

- **ESRI mapping software designed for mobile devices**
- **Runs on**
  - Windows CE (mobile devices)
  - Windows 95 and 98
  - Me
  - NT
  - 2000
  - XP
- **GIS/GPS solution**

2 of 18

What is ArcPad?

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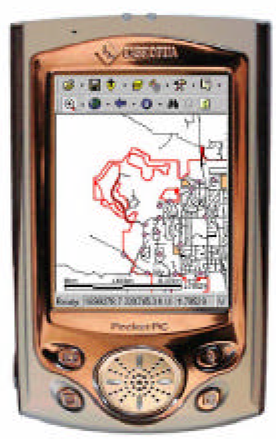
- **GIS/GPS solution**



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What is ArcPad?

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  - Windows CE (mobile devices)
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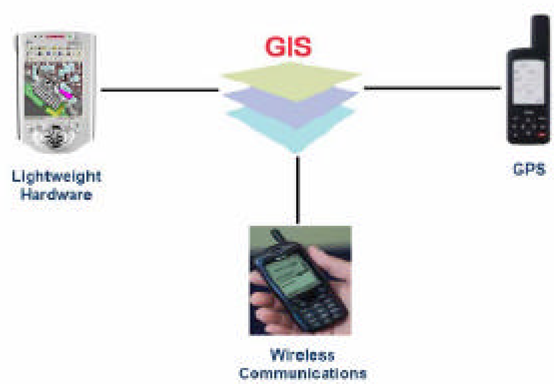
  - Me
  - NT
  - 2000
  - XP
- **GIS/GPS solution**

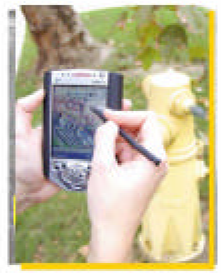
ArcPad integrates technologies



What can you do with ArcPad?

- ArcPad enables you to get you out of the office

- Take inventory
- Update data
- Monitor change



- Track events
- Navigate to a location

What can you do with ArcPad?

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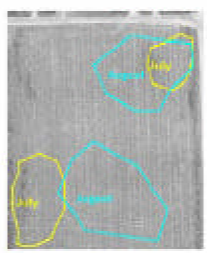

- Track events
- Navigate to a location

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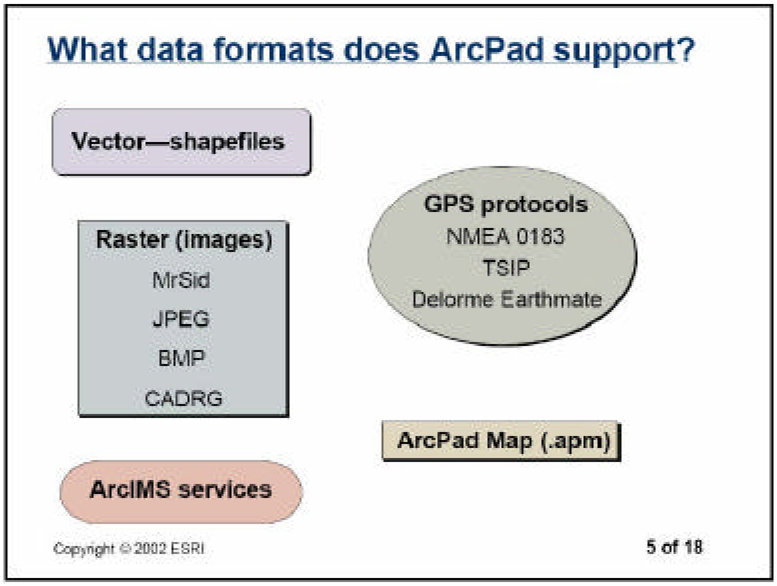
What data formats does ArcPad support?
Vector—shapefiles
Raster (images)
MrSid
JPEG
BMP
CADRG
GPS protocols
NMEA 0183
TSIP
Delorme Earthmate
ArcPad Map (.apm)
ArcIMS services
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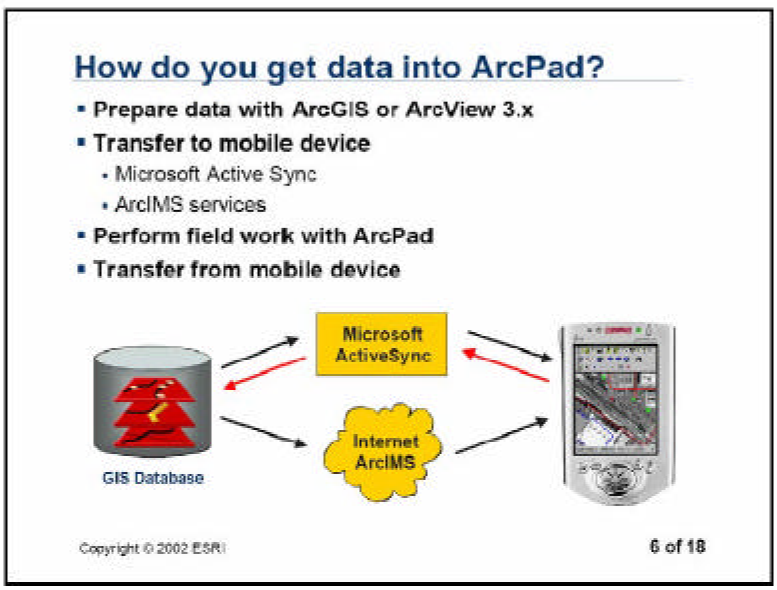
How do you get data into ArcPad?
Prepare data with ArcGIS or ArcView 3.x
Transfer to mobile device
Microsoft Active Sync
ArcIMS services
Perform field work with ArcPad
Transfer from mobile device
Microsoft ActiveSync
Internet ArcIMS
GIS Database
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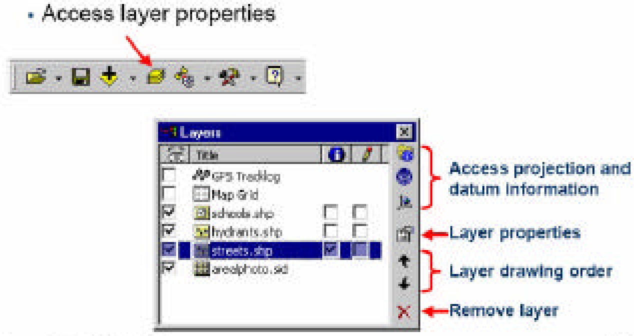
Topic Review

- What is ArcPad?
- ArcPad integrates technologies
- What can you do with ArcPad?
- What data formats does ArcPad support?
- How do you get data into ArcPad?

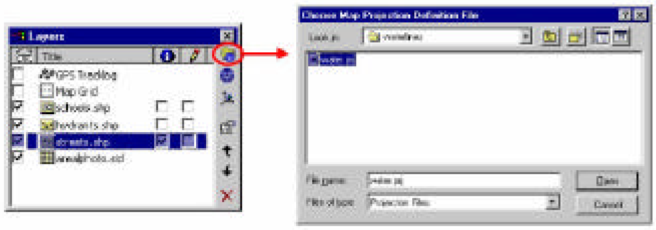
Working with layers

- **Layers dialog**
  - Toggle visibility, identification, editing
  - Arrange drawing order
  - Manage and access projection information
  - Access layer properties



Map and layer projections

- Default is latitude-longitude WGS84
- Reads .prj files
- Map adopts layer's projection
- Access projection and datum information
- On-the-fly projection of GPS input



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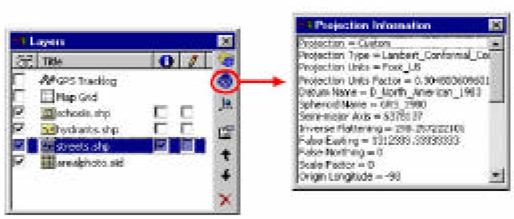
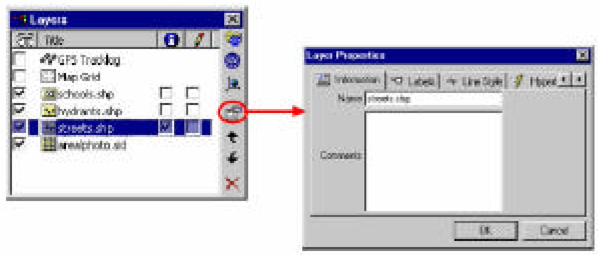


Setting layer properties

- **Layer Properties dialog**
  - Control label options
  - Set drawing style and symbology
  - Manage hyperlinks
  - Access field properties
  - Define scale dependencies

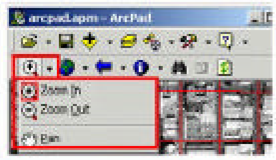


Topic Review

- **Working with layers**
- **Map projections**
- **Setting layer properties**

Browsing your data

- User-defined
- Fixed extents
- Previous/Next
- Bookmarks
- Define Extent/Scale



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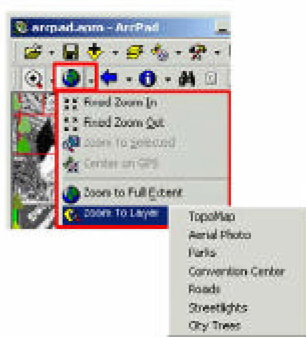

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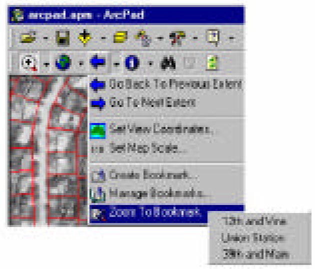
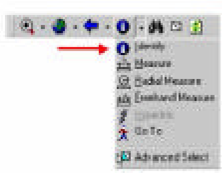
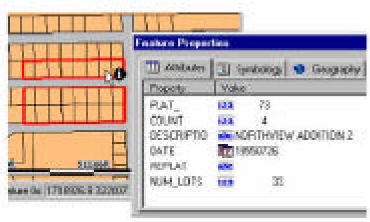


Query tools

- Identify
- Advanced Select
- Find





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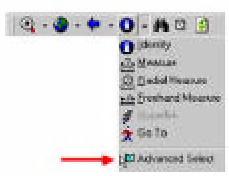

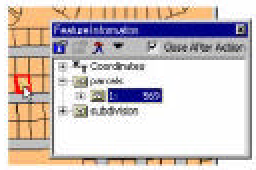

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Query tools

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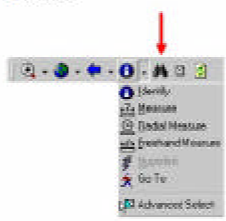

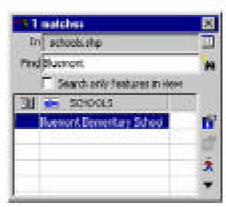

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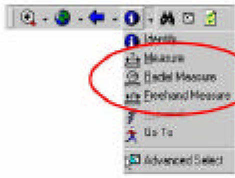
Measuring features

Measure and Radial Measure

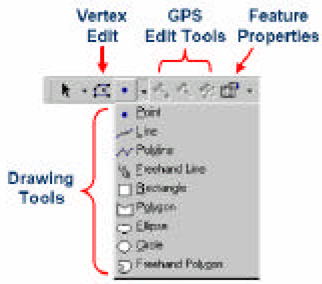


Measuring features

Freehand Measure

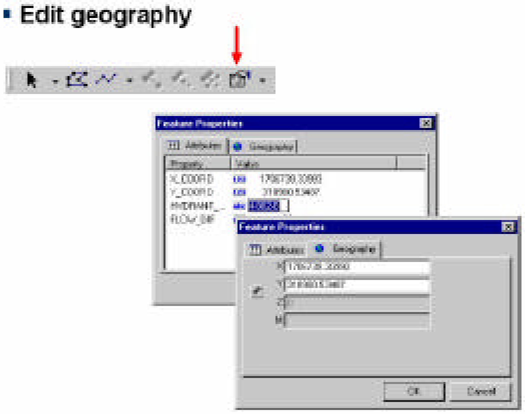
Capturing data

- Manual or GPS input
- Edit existing or new shapefiles
- Predefined shapes, user-defined
- Update/Add attributes



Editing feature properties

- Edit attributes
- Edit geography



ArcPad tools

- ArcGIS and ArcView 3.x
- Create ArcPad Maps (.apm)
- Export symbology
- Package shapefiles

Topic Review

- Map browsing
- Query tools
- Measuring features
- Capturing data
- Editing feature properties
- ArcPad tools

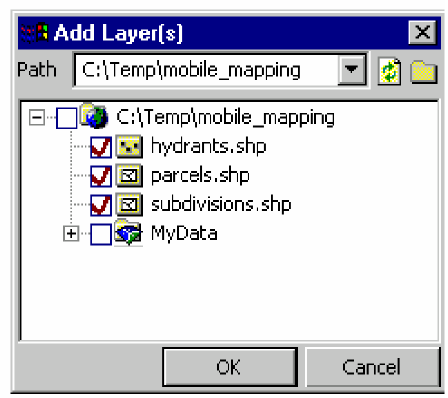
Working with layers and editing features in ArcPad®

For this exercise, assume you work for the County where it's your job to update the GIS data. Recently, you've been asked to add a hydrant and three streets to the GIS database. You will use ArcPad to collect the features. You would normally use GPS in combination with ArcPad to create new data, but in this exercise you will add features using ArcPad's drawing tools.

Note on "tapping" versus "clicking" buttons, tools, icons etc. in this exercise. This exercise has been designed to run on a mobile device. With a mobile device, you tap your pen or stylus on the buttons and menus in your software instead of clicking them. If you're running ArcPad on a desktop computer, "clicking" your mouse will have the same affect as "tapping" the display on a mobile device.

Estimated time to complete: 25 minutes

Step 1. Open ArcPad and add layers Open ArcPad, if necessary.



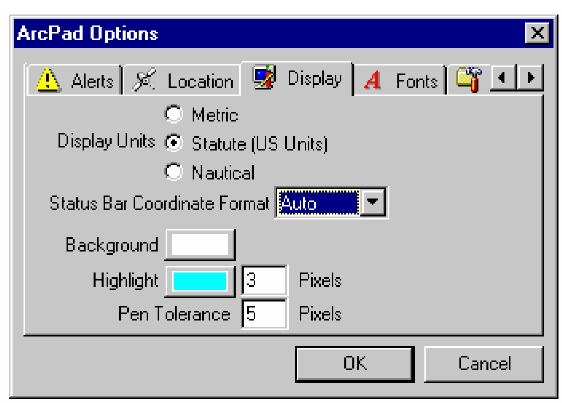
Tap the Add Layer button .

In the Add Layer(s) dialog, tap the Directory Browser button .

In the Directory Browser dialog, tap your mobile_mapping folder (e.g., **C:\Temp\mobile_mapping**), then tap OK.

Tap the boxes next to hydrants, parcels, and subdivisions.

Step 2. Change the map units



The scale bar in your map is using metric units, but the map units of your data use feet. You will use the Properties dialog in ArcPad to make your scale bar and map units match.

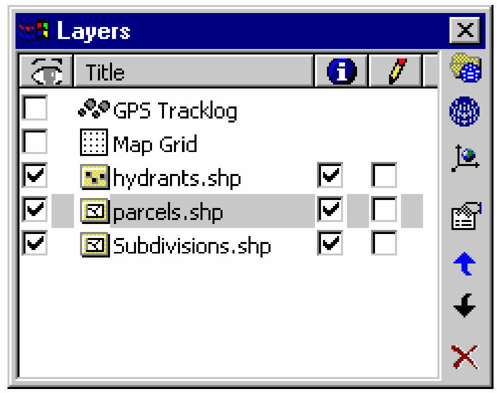
From the Main toolbar, tap the Tools button .

In the top-right corner of the ArcPad Options dialog, use the right facing arrow to scroll through the options until you see the Display tab.

Tap the Display tab.

For Display Units, tap the Statute (US Units) option.

Step 3. Change the layers drawing order



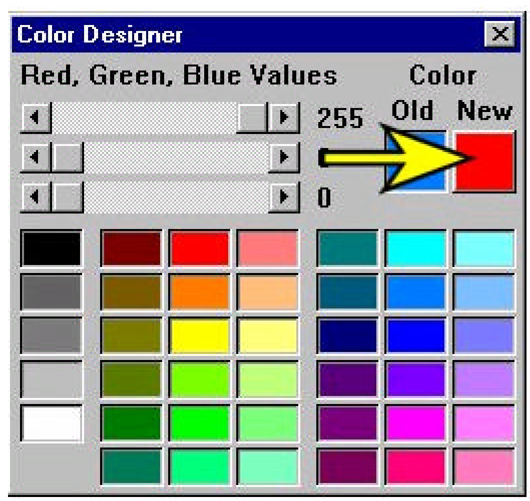
To make the data easier to work with, you will change its drawing order so the hydrant layer draws on top of the parcels layer, and the parcels layer draws on top of the subdivisions layer.

Tap the Layers button .

In the Layers dialog, highlight the hydrants layer.

On the right side of the layers dialog, tap the up arrow to move the hydrants layer above both the subdivisions and parcels layers. Use the same method to place parcels above Subdivisions.

Step 4. Change the hydrant symbols



The drawing order is appropriate for your needs, but the symbology of your data does not let you see all three layers at once. To clear things up, you will change the symbology of the layers.

Tap the Layers button.

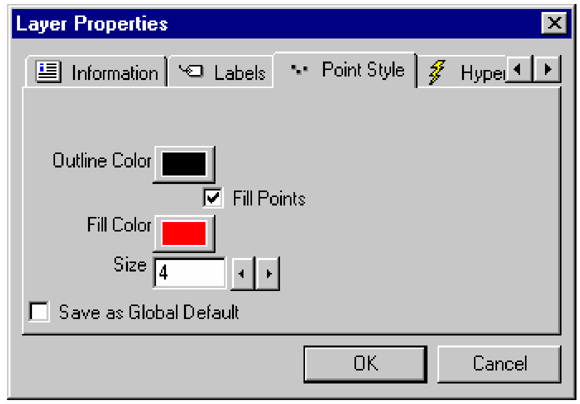
Highlight the hydrants layer, then tap the Layer Properties button .

In the Layer Properties dialog, tap the Point Style tab.

Make sure the Fill Points box is checked, then tap the Fill Color symbol.

In the Color Designer, tap a dark red color from the color palette.

In ArcPad Version 6.0, the color you chose is copied to the new color chip that is located in the upper-right corner of the Color Designer. In Version 6.0.1, the new color is displayed as the background color in the OK button; the old color is displayed as background color in the Cancel button.



Tap the New color chip to confirm your choice (Version 6.0) or tap the OK button (Version 6.0.1).

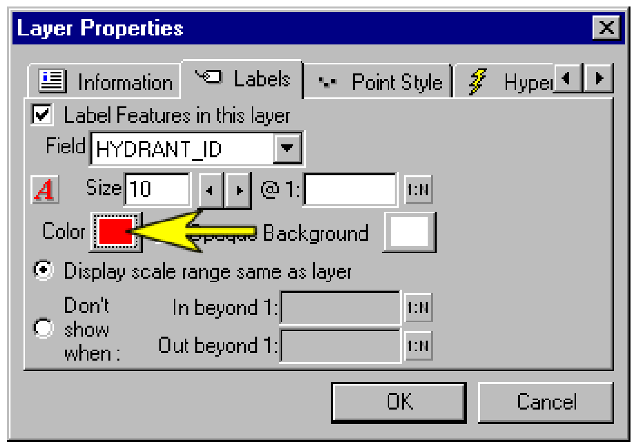
If necessary, change the Outline Color to black.

Change the size of the hydrants to **4**.

The color and size of the hydrants is set.

Step 5. Turn on the hydrant labels In the Layer

Properties dialog, tap the Labels tab.



Check the "Label Features in this layer" box.

If necessary, from the Field dropdown list, choose HYDRANT_ID.

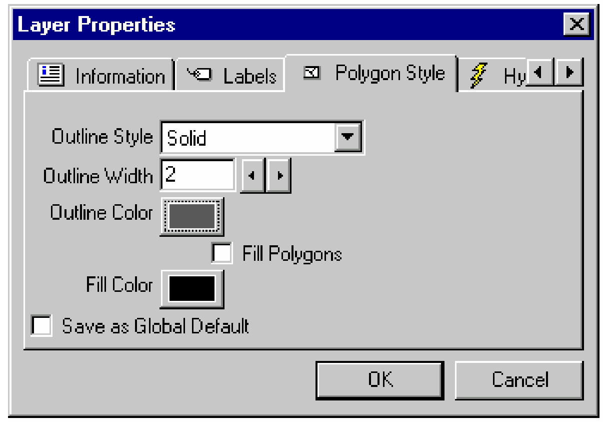
For Size type **10**.

Tap the Color symbol.

In the Color Designer, choose a red color from the color palette, then tap the new color chip (Version 6.0) or tap the OK button (Version 6.0.1).

Check the Opaque Background option. This will put a background behind each label.

Step 6. Change the parcel symbology



Double-tap the parcels layer in the Layers dialog.

This is a shortcut for opening the Layer Properties dialog.

Tap the Polygon Style tab.

Set the Outline Width to **2**.

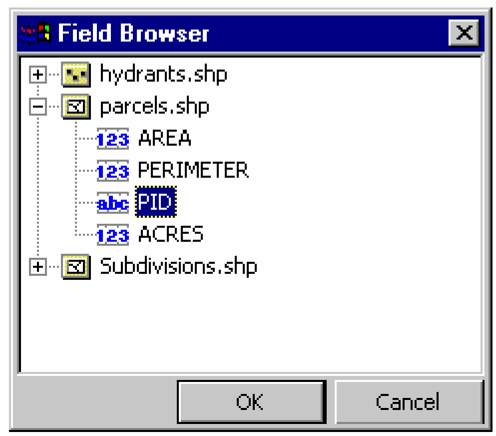
Change the outline color to dark gray.

Make sure the Fill Polygons option is unchecked.

Tap OK to close the Layer Properties dialog.

Close the Layers dialog.

Step 7. Locate a parcel



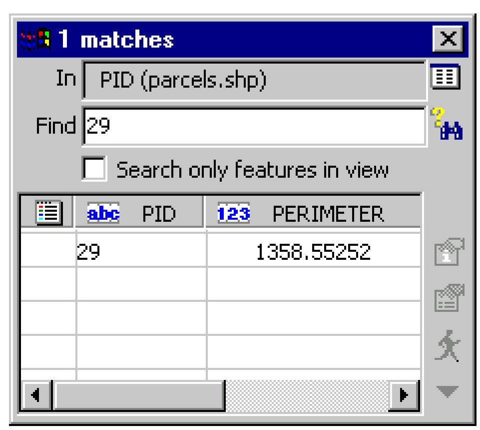
The hydrant you are going to add is located in the southwest corner of Parcel 29. Before you can add the new hydrant, you must locate parcel 29.

On the Browse toolbar, tap the Find button .

In the Find dialog, tap the Select Layers button .

In the Field Browser dialog, tap the plus sign next to parcels.shp.

In the list of fields, tap the PID field to highlight it.



Tap OK.

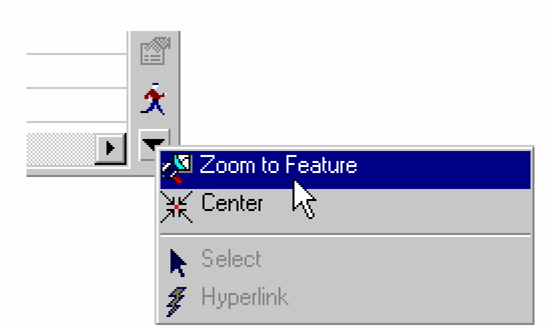
In the Find text box, enter **29**, and then tap the Search button .

One match is found and posted in the results list.

In the results table, tap the record to highlight it.

Notice the associated feature is also highlighted in the ArcPad display.

In the lower-right corner of the Find dialog, tap the dropdown arrow and choose Zoom to Feature.



Close the Find Dialog.

Tap the Clear Selected Features button .

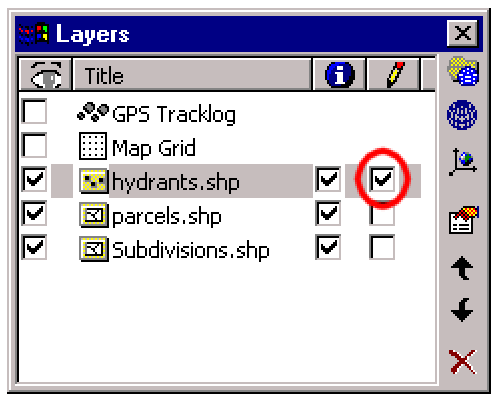
You have located the parcel, now you can record the location of the hydrant that is on it.

Step 8. Activate hydrant editing

Before you can add the hydrant, you must make the hydrant layer available for editing.

Tap the Layers button.

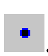
In the Layers dialog, check the editing box for the hydrants layer.



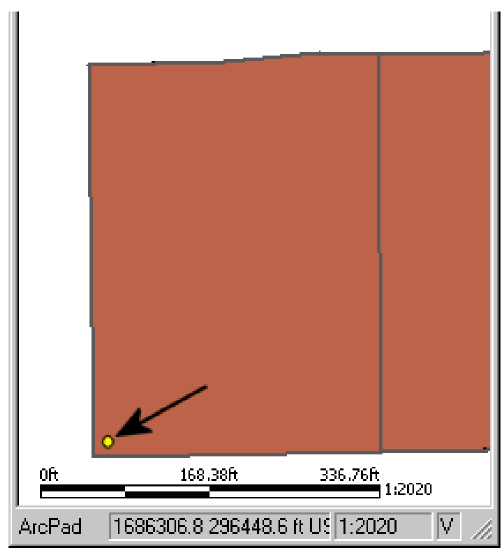
Close the Layers dialog.

Step 9. Add the hydrant

In most cases, capturing a hydrant with ArcPad would occur in the field with GPS. In this exercise, you will add the hydrant by tapping its approximate location in the display.

On the Edit/Drawing toolbar, tap the Point button .

Tap the southwest corner of the parcel at the location shown below.

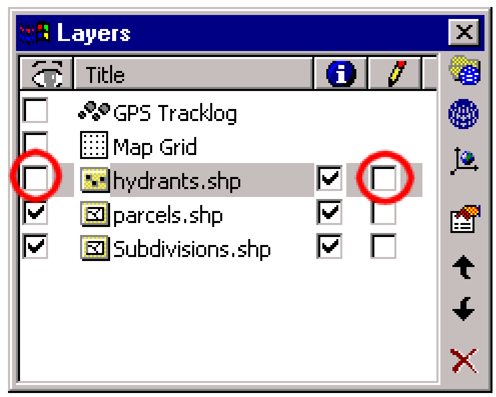


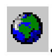
The Feature Properties dialog appears once you've added the hydrant. This dialog is used to assign attributes to a feature. It can also be used to edit the geometry of a feature by allowing you to explicitly define the coordinate values of a feature's vertexes or a point. Within the Feature Properties dialog, tap to the immediate right of the field type icon  to bring up the text cursor. If it does not activate on the first try, try again.

Enter **14** for the Hydrant_ID, and then tap OK.

Step 10. Reset the display

Before you begin adding the streets, you'll turn off the hydrants layer and change some of the display properties.



Tap the Zoom to Full Extent button .

Tap the Layers button.

Turn off the visibility and the editing status of the hydrant layer.

Close the Layers dialog.

To save room in your display, you will turn off the scale bar.

Tap the Tools dropdown arrow , then tap the Scale Bar option to turn it off.

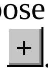
Tap the Tools dropdown arrow again, and then turn on the Panning Frame.

The display is cleaned up and ready for adding streets, but before you can do this you will need to create a streets layer.

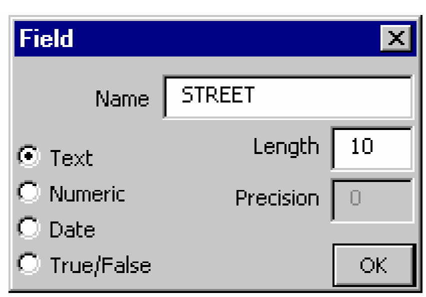
Step 11. Create a new streets layer

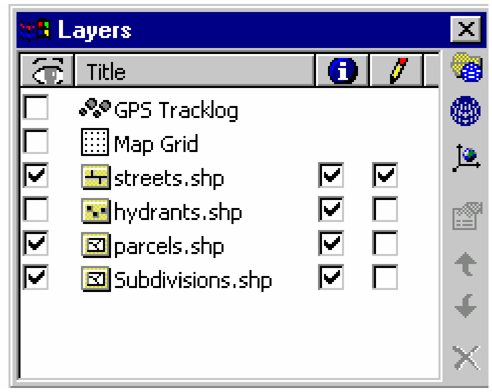
Tap the dropdown arrow next to the Open Map button . Choose New Layer.

In the New Shapefile dialog, tap the Type dropdown arrow, and choose Polyline.

Tap the Add Field button .

In the Field dialog, name the field **STREET**.





Tap OK.

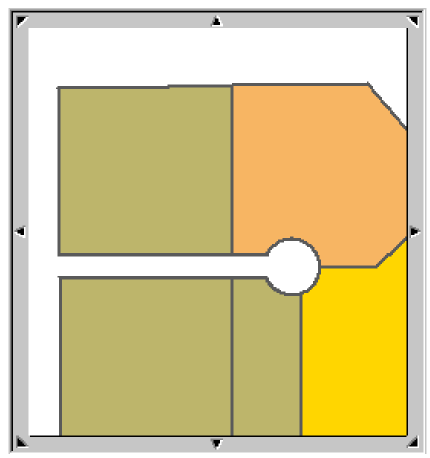
In the Create New ShapeFile Layer dialog, name the new shapefile **Streets**, and save it in your MyData folder (e.g., **C:\Temp\mobile_mapping\MyData**).

Tap the Layers button.

After you create a new shapefile in ArcPad, it is automatically added to the current map with its visibility and editing status activated.

Close the Layers dialog.

Step 12. Use the Zoom-In Tool



You will add the first street to the cul-de-sac located at the north end of the study area. Before you can draw the street you need to zoom in closer to its location.

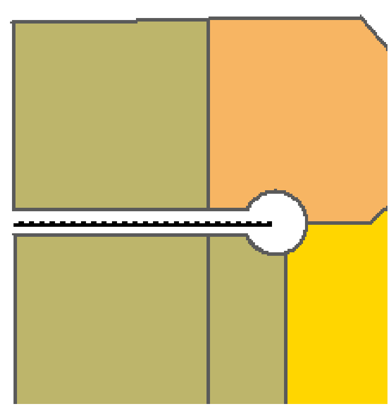
Tap the Zoom In button .

Zoom in to the area shown below.

Step 13. Digitize Kansas Street

Tap the Line button .

To draw a line with this tool, tap where you want the line to start, then, while holding the pen down, drag to the location you want the line to end. The location where you lift the pen off the display defines where the line ends. Using the tap-and-drag technique described above, draw the cul-de-sac's street centerline at the location shown below.



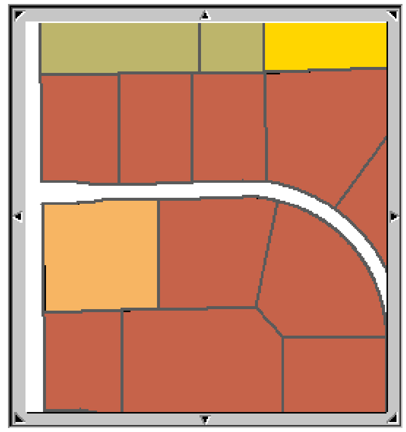
After you draw the street, enter **Kansas St** for the street name, and then tap OK.

Click the Full Extent button.

Step 14. Digitize State Street

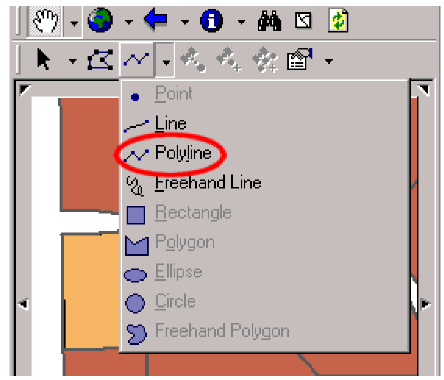
The next street you will add is south of the one you just added.

Zoom in to the area shown in the graphic below.

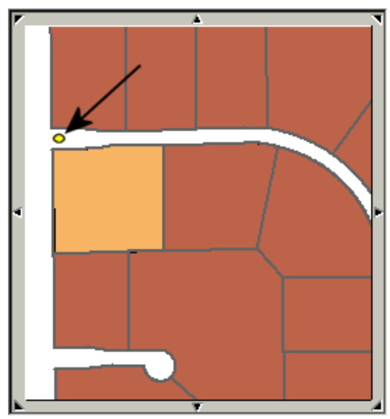


To add this street, you will use the Polyline tool. To use this tool, tap the location where you want the line to start, then tap and drag to define each successive vertex. After adding the final vertex, tap the Polyline button to finish the sketch.

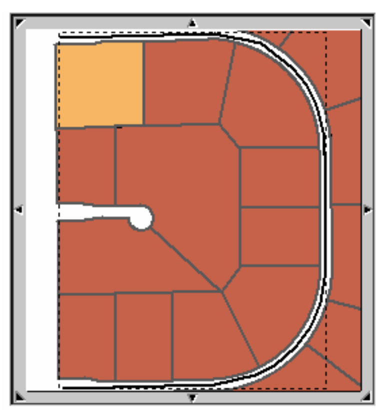
From the Editing tools dropdown list, choose Polyline.



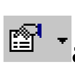
Tap the location shown below to begin drawing the street.



Tap just to the right of the first vertex and drag to the next location where you want to place a vertex, when you remove the styles from display (or release the mouse button) the vertex is added. Digitize the rest of the street by using the tap and drag process to add the polyline's vertices. When you get to the edge of the display, use the panning frame to bring the rest of the street into view, or click the Full Extent button and continue adding vertexes. When you're finished drawing the street, tap the Polyline button.



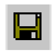
Name the street **State St**, then tap OK to close the Feature Properties dialog.

Tap the dropdown arrow next to the Feature Properties button  and choose Zoom to Selected Feature.

Step 15. Save your map and close ArcPad

Your work is done for now, but you should save the current map just in case you need to return to this study area again.

Tap the Zoom to Full Extent button.

Tap the Save Map button .

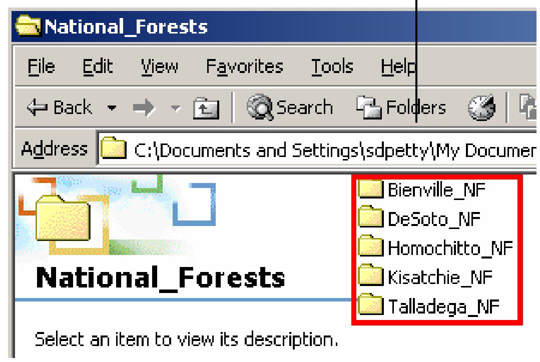
Name the map **Streets.apm** and save it in your MyData folder.

Loading Data onto the Trimble© GeoXT®

Step 1. Data Preparation

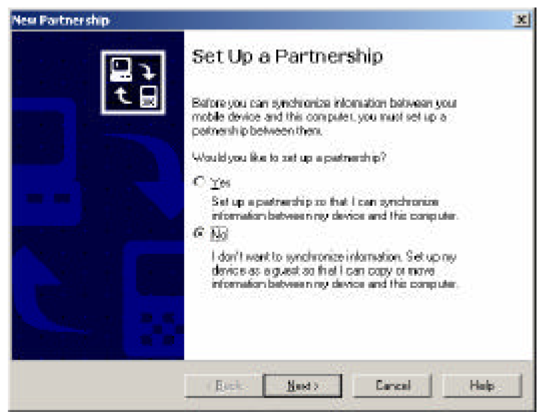
Collect all desired base map files (compartments, stands, water features, roads etc.) on your desktop PC and place them in a folder that will be easy to locate. It is important to make sure all files are projected alike, including the SPBIS survey shapefile. Failure to project the files alike will result in layers that will not line-up properly. Projections can easily be changed using desktop GIS software such as ArcGIS® or ArcView®.

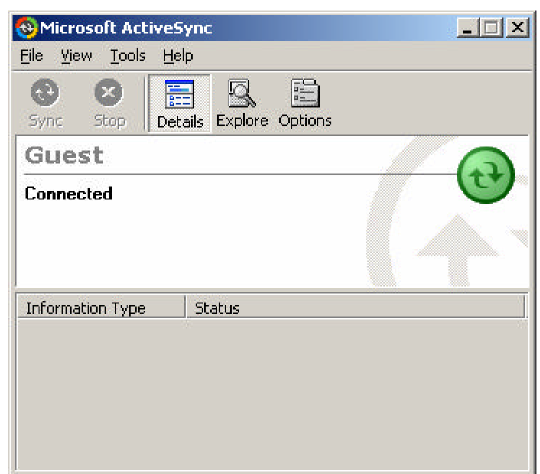
Possible base map folder names



Step 2. Transfer of data to the mobile unit

In order for your mobile unit to communicate with your desktop PC, Microsoft ActiveSync® is required. This program can be downloaded at no cost from the Microsoft website. To begin, connect the Trimble© GeoXT® support module, or cradle to the desktop PC via the USB data cable. Press the unit into the cradle to form a connection. When a proper connection has been made the unit will flash a message across the screen, and a screen prompt will appear on the desktop PC. This prompt will ask if you would like to synchronize your unit with the PC. For most applications choose **<u>NO</u>**, and click next. A window will appear stating that a connection has been established. You are now ready to transfer data. The following are the steps in the transfer process:





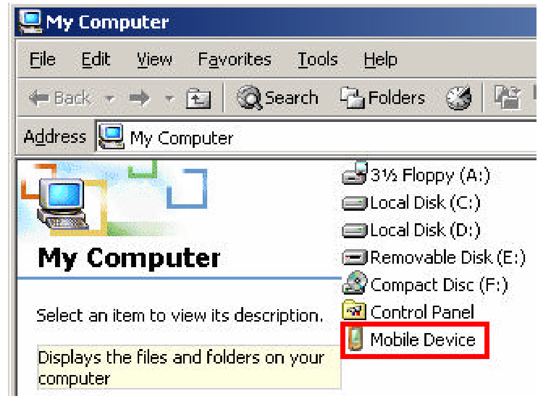
1. Double-click the **My Computer** icon on your desktop PC.

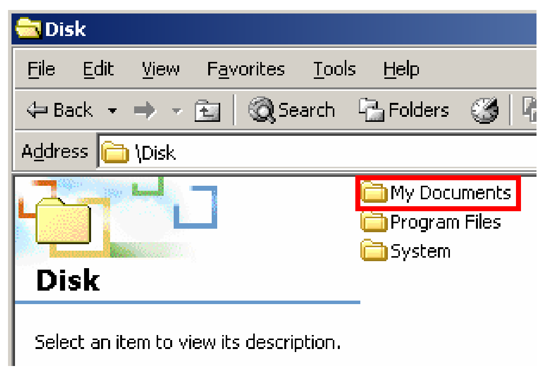
2. Double-click the **Mobile Device** icon

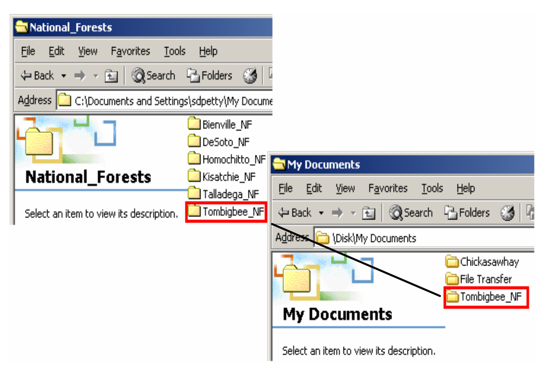
3. Double-click the **Disk** icon

4. Double-click the **My Documents** icon

5. Minimize the **My Documents** folder. Navigate to your base map folder on your desktop PC. Minimize the window. Drag the desired folder into the **My Documents** window. You may also right-click on the folder, chose copy, and paste the data into the **My Documents** folder. Your data is now on the mobile unit.







List of necessary files in addition to secondary GIS data files:

ArcPad.apm	:The ArcPad Map Document for displaying data and forms in ArcPad
Spb_survey files (.apl, .dbf, ..prj, .shp, .xml, .shx, .shx) :	Point shapefile to store and display data collected on field, and to display active dada collection forms in ArcPad.
District_codes.dbf	: Dbase file containing District Code information for use in ArcPad
Flg_color.dbf	: Dbase file containing Flagging Color Code information for use in ArcPad
Forest_codes.bdf	: Dbase file containing Forest Code information for use in ArcPad
Log_access.dbf	: Dbase file containing Logging Access Code information for use in ArcPad
Prim_trt.dbf	: Dbase file containing Primary Treatment Code information for use in ArcPad
Priority.dbf	: Dbase file containing Priority Code information for use in ArcPad
Pulp_saw.dbf	: Dbase file containing Pulp/Saw Code information for use in ArcPad
Smc_code.dbf	: Dbase file containing Special Management Consideration Code information for use in ArcPad
Species.dbf	: Dbase file containing Species Code information for use in ArcPad
Surv_type.dbf	: Dbase file containing Survey Type Code information for use in ArcPad
Trt_plan.dbf	: Dbase file containing Treatment Plan Code information for use in ArcPad
Wilderness_codes.dbf	: Dbase file containing Wilderness Code information for use in ArcPad
Yes_no.dbf	: Dbase file containing “yes” and “no” values for use in ArcPad

Note:

All GIS files, including “spb_survey.shp” files should be in the same geographic projection before files are checked out into ArcPad. Also make sure that “spb_survey.shp” has been added to the map document and is part of the check-out bundle before packaging the files.

SPBIS Data Collection Forms

This exercise is an introduction to using the Trimble GeoXT with custom ArcPad forms for data collection. After this exercise you should be able to

- Open and load an existing ArcPad Application
- Activate the in-built GPS unit from ArcPad
- Load and populate an ArcPad data collection form; Capture corresponding GPS points for the data
- Save and close the application

Step 1. Open and load and existing ArcPad application

- Turn on the Trimble GeoXT by pressing once on the large gray power button at the bottom.

- Double-tap the ArcPad icon on the display screen to launch ArcPad. This may also be done from the "Start" menu at the bottom left corner of the screen as follows:

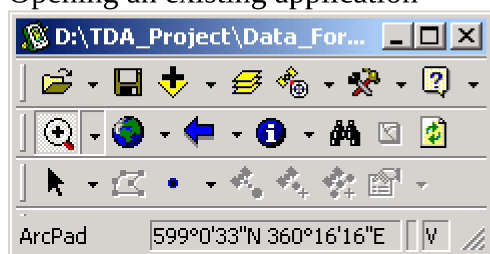
Start Programs ArcPad

- When the program has loaded, open the particular application by tapping on the "File" menu at the top right corner of the main menu bar, using the following steps:

File – Open Map – Disk – My Documents – Training – ArcPad.apm – Open

This will load the particular application called "ArcPad" located in the "Disk" portion of the main memory. All data and applications are loaded into the "Disk" portion of the memory, which is the non-volatile and permanent portion of the Trimble unit's memory.

Opening an existing application



Tap on the black arrow next to the "File" icon

Activate the in-built GPS unit from ArcPad

- Tap once on the black arrow next to the (insert image) icon on the main menu, to view the drop-down options.
- Tap once on the "GPS Active" option. A red rectangle appears around the corresponding icon to the left.

This will activate the in-built GPS unit of the GeoXT from within ArcPad. ArcPad will use the GPS configurations of the in-built GPS Controller. If the configuration is changed within ArcPad, it will over-write the settings of the GPS Controller.

Activating the in-built GPS unit

Tap on the black arrow next to the "GPS" icon to view the drop-down menu and GPS options.

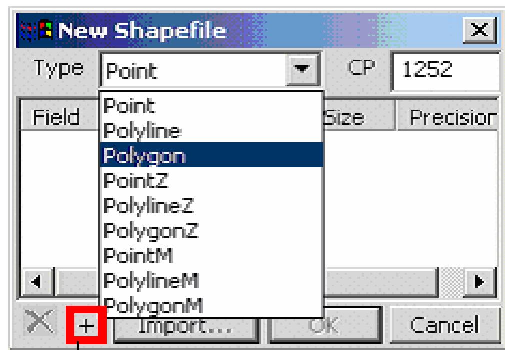
Step 2. Traversing a Spot to Determine Area

A new polygon shapefile is created for each spot to determine the area

- Tap the black arrow next to the "File" icon; choose the "New Layer" option.

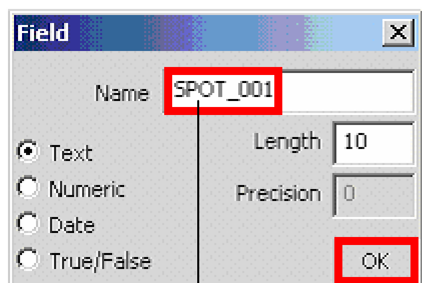
"File" icon

- From the "Type" dropdown menu choose "Polygon", and tap the plus sign in the lower left-hand corner.



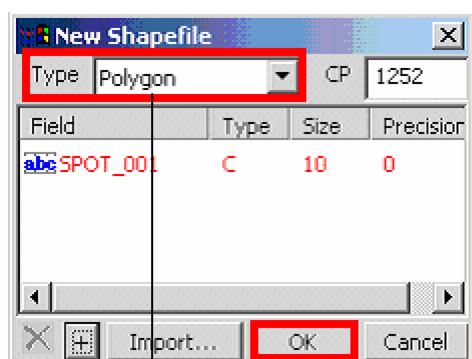
Add a polygon

- When a polygon has been added, a "Field" window will appear. Give the spot a unique identification in the "Name" field, and click "OK"



Give the polygon a unique name

- The "New Shapefile" window will appear. Check to make sure the type is correct and tap "OK".
- You will be prompted to save the new shapefile. Save the file in the same folder as your base map for easy access.



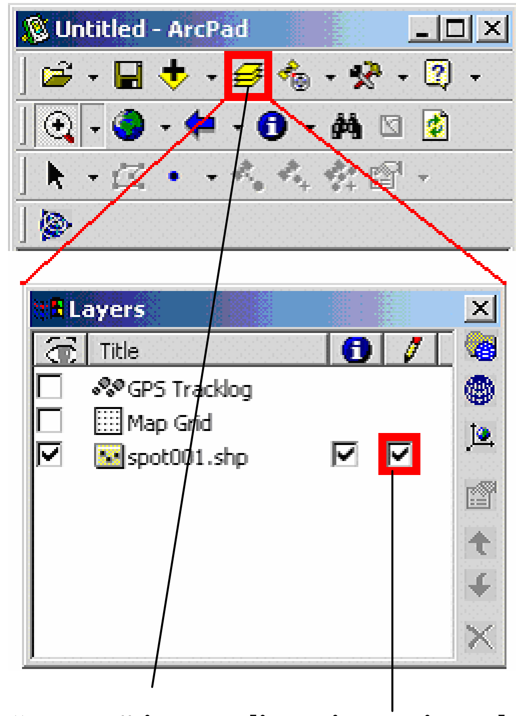
Make sure the correct type is chose

- After your shapefile has been saved, tap the “Layers” icon to activate the layer control window. The system will default to the most recently created shapefile, but if several are created at one time check to make sure the spot being traversed is open for editing.

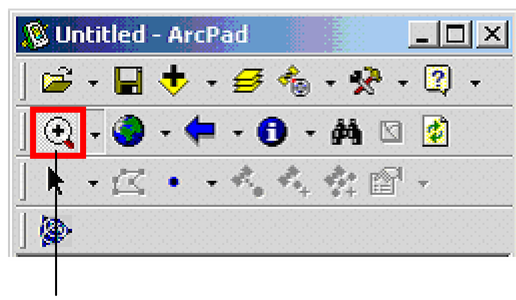
- Mark a location, in the field, on the perimeter of the spot to begin traversing. Use flagging tape to make sure you can return to your starting point. It is best to walk the spot before creating the shapefile to ensure that all infested trees are included in the area. When a starting point has been determined, activate the GPS, if it is not already. Use the “zoom in” tool to reduce the map scale to a level at which the spot polygon can be seen.

- Tap the black arrow next to the “Feature Type” icon. Choose polygon. When the GPS is activated the “Add GPS Vertices Continuously” icon will also be activated. When you are ready to being traversing, tap the icon once. The icon will remain depressed until tapped again.

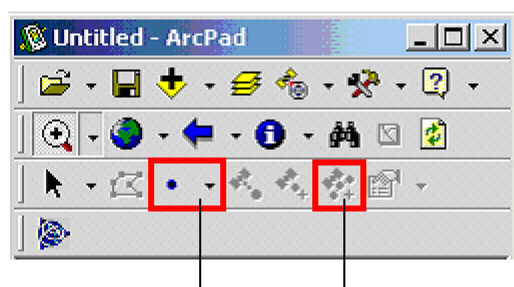
- Begin walking the perimeter of the spot. It is important to keep moving as a new vertex is added whether you are moving or not. Stopping can skew the polygon. If you need to stop, tap the “Add GPS Vertices Continuously” icon again to pause. When you are ready to continue tap the icon again.



“Layers” icon; Edit option activated



“Zoom-In” Tool

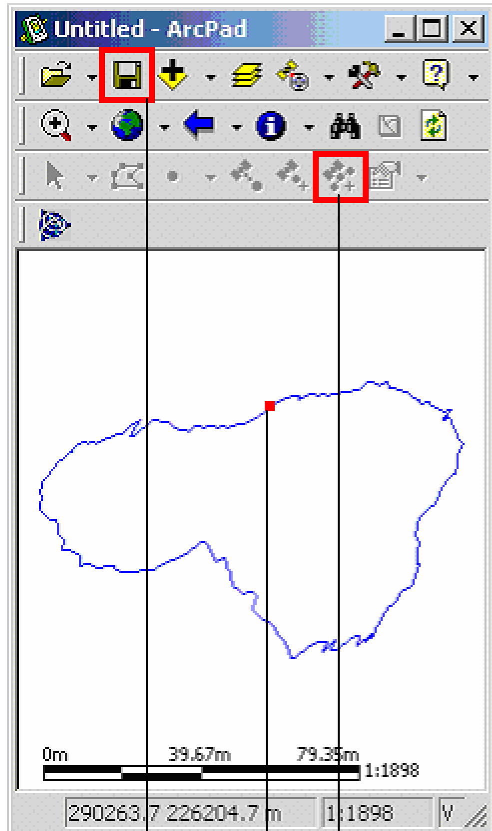


Choose “Polygon” from the “Feature Type” drop-down menu. Tap “Add GPS Vertices Continuously” icon to start

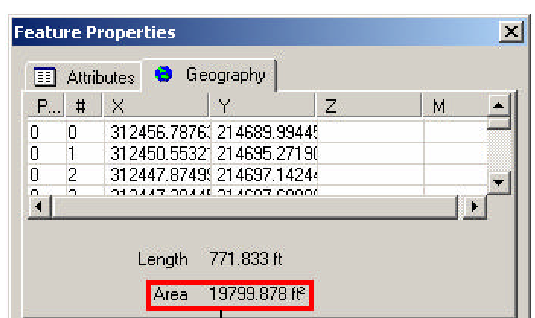
- When the entire spot has been traversed, and you have returned to the starting point, tap the "Add GPS Vertices Continuously" icon once again to stop additional vertices from being added. Tap the last vertex and hold the stylus down. A menu will appear. Chose the "Finish Sketch" option. The polygon is now complete. Tap the "Save" icon to ensure no data is lost.

- Once the sketch has been finished, an attribute table will appear. Click the Geography tab to view the coordinates for each point taken by the GPS and the area in square feet or acres, depending on spot size. Make sure the display units are Statue or US units. This can be set under ArcPad Options, Display.

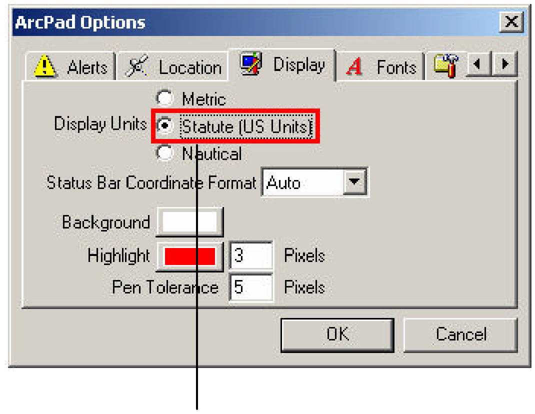
- SPBIS requires the area estimates in acreage. The unit will not output acreage if the spot is less than 1 acre. This is a slight inconvenience, but the square footage value can be converted to acreage using the unit calculator. It is accessed by clicking the **Start Menu, Programs, Accessories, and Calculator**. The conversion equation is:
  Sq ft value / 43,560 = Acreage



Tap the "Add GPS Vertices Continuously" icon to stop adding vertices. Place stylus on last vertex, hold down until menu appears, chose "Finish Sketch" to complete the polygon. Tap the "Save" icon.



Attribute table containing the area



Setting display units to Statute, US Units

Step 4. Load and populate an ArcPad® data collection form; Capture corresponding GPS points for the data

Before loading the forms and creating new point features the correct layer needs to be set to the "Edit" mode. For this exercise we will be adding data and records for the Southern Pine Beetle, hence the corresponding layer should be set in the Edit mode.

- Tap on the "Layers" icon (indicated by the red box) to activate the layer control box.

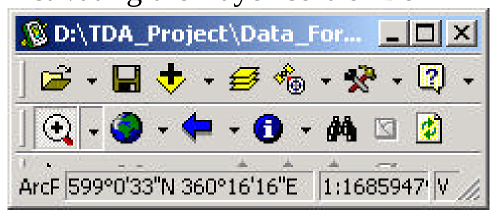
- Place a check mark on the last box against the layer named "spb_survey". This will make that layer editable.

- Tap on "GPS Point" icon to create a point and activate the forms. As a new point is being created the data form associated with the form will be displayed.

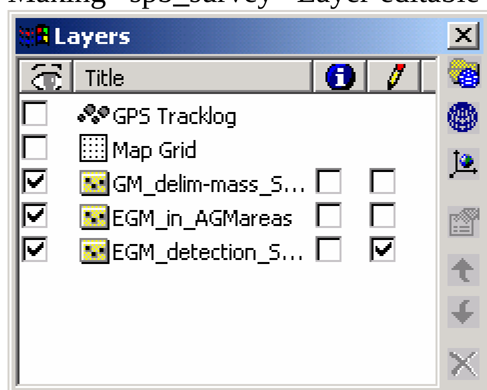
- Enter the required values in the fields and tap "OK" to close the form and save the information. Clicking "OK" will close the form and save the information entered into the .dbf table, which can be opened in Excel if required.

- Click on "Yes" when prompted about entering data into SPBIS.

Activating the Layer control Box



Making "spb_survey" Layer editable

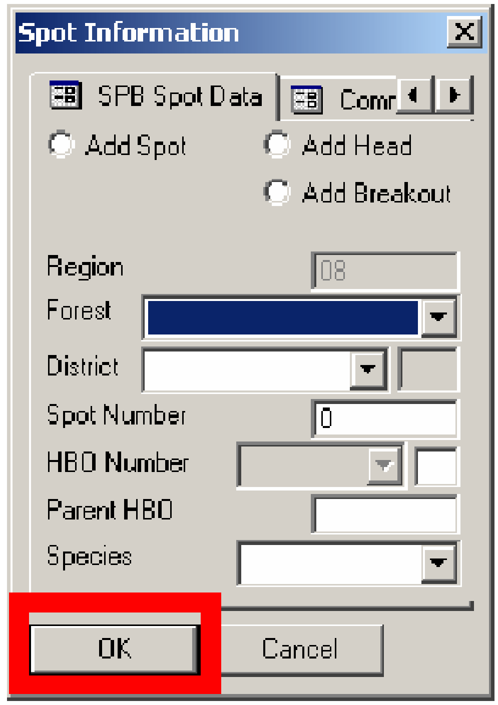


Adding a new point

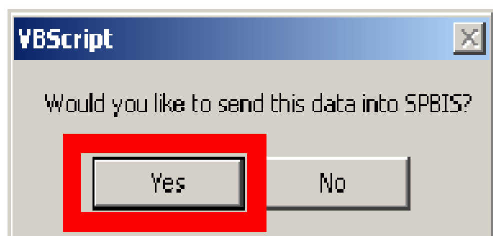
All the information entered into the form will be stored as one record linked to the new point that is created. The information is stored in the .dbf file associated with the point.

In the application, at this a backup .dbf file is also created which will contain all the fields required by SPBIS, in a format different from the .dbf file associated with the shapefile. In addition it also contains some flag fields required for accurate entry into SPBIS.

Again, this is an important step in for this application,, since data will be prepared for entry into the SPBIS database only if "Yes" is selected. In the event that the data is incomplete the option “No” may be selected and the missing data entered at a later date. However, only the most current information will be stored, hence if a value had been changed without having entered the previous one into SPBIS that particular entry for that control will be lost, since the old value will be overwritten in the default .dbf table.



- Repeat previous steps if necessary to add a second point and record.



Step 5. Saving and Exiting ArcPad

- Save the file by tapping on “File” from the main menu using the following steps: File – Save Map

Saving and exiting the application

- Close ArcPad either by tapping on the close icon at the top right corner of the screen as you would any windows application or by tapping on “Exit” from the main “File” menu.

Tap on the black arrow next to the “File” icon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Microsoft® Windows® CE Operating System FAQ

December 4, 2003 | Mapping & GIS

Introduction

This document lists the frequently asked questions about Microsoft® Windows® CE operating systems, and some of the Trimble Windows CE devices.

It also discusses the operating systems that are used by the GeoExplorer® CE series, Trimble® Recon handheld, and GIS TSCe™, and the applications that can run on them.

What is an operating system?

An operating system includes the core components required to manage hardware and software resources. The operating system also provides a consistent application interface. Applications specific to the hardware platform are also included with the operating system.

What is Windows CE?

Windows CE is the Microsoft architecture that is used to build the various versions of the Windows CE operating system. The Windows CE operating system is not restricted to handheld computers; it is also appropriate for cash registers, cellular telephones, medical instruments, and any other appliance that requires a small, embedded operating system. There have been two major releases of Windows CE; Windows CE 3.0 and Windows CE .NET.

What is the difference between Windows CE 3.0 and Windows CE .NET based operating systems?

Windows CE .NET is the successor to Windows CE 3.0. Windows CE .NET includes several improvements to performance, multimedia and browsing capabilities, and a more comprehensive driver support. Windows CE .NET has had several releases, including 4.0, 4.1, and 4.2. Windows CE 3.0 is no longer widely available, as most Windows CE operating systems being released are based on CE .NET.

What is Pocket PC?

Pocket PC, Pocket PC 2002, and Windows Mobile™ 2003 software for Pocket PC are operating systems developed by Microsoft for personal digital assistants (PDAs). Handheld computers that run these Pocket PC operating systems are referred to and branded as Pocket PCs.

Pocket PC operating systems are custom versions of Windows CE 3.0 or Windows CE .NET 4.2. The current Pocket PC operating system is Windows Mobile 2003 software for Pocket PC and is based on Windows CE .NET 4.2, whereas the original Pocket PC and Pocket PC 2002 operating systems were based on Windows CE 3.0. Microsoft has developed Pocket PC operating systems to include a set of system components from the Windows CE operating system and application components designed for PDAs, such as Microsoft Pocket Internet Explorer, Microsoft Pocket Word, Microsoft Pocket Excel, and Microsoft Pocket Outlook®. Pocket PC supports synchronization of files, and Pocket Outlook applications (Inbox, Calendar, Contacts, and Tasks).

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Pocket PC devices do not all use the same Pocket PC operating system. OEMs (Original Equipment Manufacturers) who build these devices make custom versions of the Pocket PC operating system to add features specific to their devices, while still meeting the Microsoft specifications for the platform, and maintaining a standard user interface. Thus, a Pocket PC device from one OEM might include different applications or device drivers than a Pocket PC device from another OEM.

What is HPC 2000?

HPC 2000 software is a custom version of Windows CE 3.0 bundled by Microsoft for manufacturers that do not meet the hardware specifications required for Pocket PC. HPC 2000 has components that are not available on Pocket PC, and some components in Pocket PC are not available in the HPC 2000 software.

OEMs who use HPC 2000 software make custom versions of the operating system to add features specific to their devices.

There is no concept of the HPC 2000 platform with CE .NET devices, though applications that have been compiled for HPC 2000 may run on CE .NET operating systems, subject to a compatible installation. Trimble is no longer developing HPC 2000 operating systems for the GIS TSCe or GeoExplorer CE series.

Which operating system does the GeoExplorer CE use?

The operating system that the GeoExplorer CE series uses is either Windows CE 3.0 or CE .NET 4.20. There have been several releases of different operating systems and the revision numbers reflect which release is installed. Windows CE 3.0 versions of the GeoExplorer CE had revision numbers ranging from 1.04 to 1.10. From October 2003, the GeoExplorer CE series began shipping with the CE .NET operating system to utilize support for Bluetooth® wireless technology and other improvements available with CE .NET. The initial CE .NET version revision number is 2.00.

Which operating system does the Trimble Recon handheld use?

The operating system that the Trimble Recon handheld uses is either CE .NET 4.10 or Windows Mobile 2003 (Pocket PC). There have been several revisions of the CE .NET operating system and the revision numbers reflect which release is installed. The Trimble Recon handheld with CE .NET had revision numbers 4.1.4 and 4.1.6. From November 2003, the Trimble Recon handheld began shipping with Windows Mobile 2003 software for Pocket PC to utilize the synchronization capabilities and other improvements available with Pocket PC.

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Which operating system does the GIS TSCe use?

The operating system that the GIS TSCe uses is either Windows CE 3.0 or CE .NET 4.0. There have been several operating system revisions and the revision numbers reflect which release is installed. Windows CE 3.0 versions of the GIS TSCe had revision numbers ranging from 2.3.4 to 2.3.7. From August 2003, the GIS TSCe began shipping with CE .NET 4.0 to utilize the improvements available with CE .NET.

What applications will run on the GeoExplorer CE?

Applications for the GeoExplorer CE Windows CE 3.0 handheld need to be compiled for HPC 2000 with an Intel StrongARM processor. Applications for the current GeoExplorer CE need to be designed for CE .NET version 4.20 devices with Intel StrongARM processors. The applications must also be able to detect and use the GeoExplorer CE Portrait screen.

What applications will run on the Trimble Recon handheld?

Applications for the Trimble Recon CE .NET handheld need to be designed for CE .NET version 4.10 devices with Intel ARM-XScale processors. Applications for the current Trimble Recon handheld need to be built for Windows Mobile 2003 software for Pocket PC.

What applications will run on the GIS TSCe?

Applications for the GIS TSCe Windows CE 3.0 handheld need to be compiled for HPC 2000 with an Intel StrongARM processor. Applications for the current GIS TSCe need to be designed for CE .NET 4.0 devices with Intel StrongARM processors. The applications must also be able to detect and use the GIS TSCe Landscape screen.

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GeoExplorer® CE Series

August 1, 2002 **Mapping & GIS**

System

What is Microsoft Windows CE?

Microsoft Windows CE is the Microsoft operating system for mobile devices. It supports a wide range of communication options, so you can be mobile and still have access to your enterprise data, e-mail, and the Internet. The handhelds in the GeoExplorer® CE series use Windows CE version 3.0 Embedded, so you can choose the software that meets your field requirements.

What operating system is on the GeoExplorer CE handheld?

The GeoExplorer CE handheld uses Windows CE version 3.0 Embedded. You can only install and run applications on the GeoExplorer CE handheld that are compiled for a Handheld PC 2000 (H/PC 2000) with an Intel StrongARM processor.

Can the operating system be upgraded?

Revisions of the Windows CE 3.0 Embedded operating system will be included with receiver firmware upgrades.

You cannot upgrade a GeoExplorer CE handheld to later versions of Win CE. The operating system is hardware-dependent. A new operating system may require faster processors and other hardware changes such as memory capacity and communication options.

What software is standard on the GeoExplorer CE handheld?

- Microsoft Pocket Internet Explorer and Inbox for Web browsing and e-mail.
- Windows Explorer, Remote Networking, Terminal, Calculator, and Text Editor for day-to-day tasks.
- GPS Controller and GPS Connector for full GPS control, comprehensive status information, and in-field mission planning.

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What software is available for my field requirements?

A range of software is available for the GeoExplorer CE series, including:

- Trimble's TerraSync™ version 2.20 software, for powerful data collection and data maintenance. Use the TerraSync software to populate and update your GIS with quality data and ensure accurate and up-to-date information for decision-making. For more information, visit www.trimble.com/terrasync.html.
- ESRI's ArcPad version 6.0 with the Trimble GPScorrect™ version 1.00 extension, to ensure high quality position data for ESRI mobile GIS applications. GPScorrect provides full GPS data control within ArcPad, and also collects data for postprocessing. For more information, visit www.trimble.com/gpscorrect.html.
- Custom software developed with the GPS Pathfinder® Tools version 1.60 Software Development Kit (SDK), to meet your organization's unique requirements. For information about how the GPS Pathfinder Tools SDK makes it easy to add GPS capabilities to your field software, visit www.trimble.com/pathfindertools.html.
- GPS datalogging applications using the industry-standard NMEA protocol that are compiled for Windows CE 3.0 (H/PC 2000) devices with StrongARM processors. Software applications are available for a wide variety of industry-specific needs. For more information on the NMEA standard, visit www.nmea.org/pub/index.html.
- Applications for Windows CE 3.0 (H/PC 2000) StrongARM devices that support your field data requirements, such as timber cruising applications, imagery software, or character recognition utilities.

Which Trimble software versions are required for the GeoExplorer CE series?

- TerraSync 2.20 or later
- GPS Pathfinder Office 2.90 or later
- GPScorrect 1.00 or later for use with ESRI ArcPad 6.0 or later
- GPS Pathfinder Tools SDK 1.60 or later

Can I buy a standalone GeoExplorer CE handheld?

Yes. The handhelds in the GeoExplorer CE series are available standalone or with a range of software. For details, please see your local Trimble representative.

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Can I write my own applications?

Yes. You can use Trimble's GPS Pathfinder Tools SDK to develop applications for the GeoExplorer CE series handheld. Version 1.60 of the SDK supports the GeoExplorer CE series. For more information, visit the Trimble website at www.trimble.com/pathfindertools.html, or contact your local Trimble sales representative.

Applications that support the NMEA protocol can also use the integrated GPS receiver. Applications must be compiled for an H/PC 2000 with a StrongARM processor.

What are the major differences between the GeoXT™ and GeoXM™ GPS CE handhelds?

The GeoXM GPS CE handheld provides 2–5 meter accuracy required for mobile GIS applications, and 512 MB of internal disk memory for secure storage of large GIS datasets and background images.

The GeoXT GPS CE handheld provides submeter accuracy required for professional GPS/GIS data collection and data maintenance, and EVEREST™ multipath rejection technology for tough GPS environments. The GeoXT is available in 128 MB and 512 MB options.

What are the accuracy specifications of the GeoExplorer CE series?

The GeoXM GPS CE handheld provides 2–5 meter accuracy.

The GeoXT GPS CE handheld provides submeter accuracy. It uses EVEREST multipath rejection technology to eliminate multipath signals in difficult GPS environments. The GeoXT can also collect carrier phase data that can provide 30 cm accuracy when processed with the GPS Pathfinder Office software.

How rugged is the GeoExplorer CE handheld?

The GeoExplorer CE handheld operates in temperatures ranging from –10°C to 50°C (14°F to 122°F). It is dustproof, shock and vibration resistant, and will endure wind-driven rain. The rating is IP 55, the same as the GeoExplorer 3 handheld and the GPS Pathfinder Pocket receiver.

What display does the GeoExplorer CE handheld have?

The GeoExplorer CE handheld has a ¼ VGA, full-color, outdoor display for visibility in direct sunlight and overcast conditions. The screen's high resolution allows background GIS data and imagery to be clearly displayed. The display is backlit so you can use it at night. Although a stylus is provided with the handheld, the touch screen does not require a special stylus to operate.

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How does temperature affect the GeoExplorer CE handheld?

Temperature specifications are as follows:

- Operating temperature: –10°C to 50°C (14°F to 122°F)
- Storage temperature: –20°C to 70°C (–4°F to 158°F)

These temperature ranges reflect the operating limits of the touch screen. However, operating at the temperature extremes may also shorten battery operating times.

Does the GeoExplorer CE series support Bluetooth?

Not at this time.

Where can I store the stylus?

The pouch supplied with the GeoExplorer CE handheld has a pocket for storing the stylus. There is also a loop for the stylus on the handstrap.

Can the embedded receiver firmware be upgraded?

Yes. Any upgrades for the GeoExplorer CE receiver firmware will be included with revisions of the Windows CE 3.0 Embedded operating system. Upgrades and revisions can be downloaded from the Trimble website at www.trimble.com.

Can a GeoXM be upgraded to a GeoXT?

Yes. An upgrade program will be introduced in the 4th quarter of 2002. To upgrade, you must return the handheld to a Trimble Service Provider.

Are my GeoExplorer 3 accessories compatible with the GeoExplorer CE handheld?

The GeoExplorer 3 external power kit and external antenna can be used with the GeoExplorer CE handheld.

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What can the optional serial clip be used for?

The optional serial clip attaches to the communication swipes on the back of the GeoExplorer CE handheld. When the serial clip is attached, it adds a serial port (COM1) to the GeoExplorer CE handheld.

You can use the serial clip to:

- supply external power from a camcorder battery or a vehicle's battery
- recharge the internal battery from an external power source
- connect to a desktop computer to transfer data, back up the Disk, or install software
- receive differential corrections from an external real-time correction source such as a Beacon-on-a-Belt (BoB™) receiver or DGPS radio
- connect to an external modem or cellphone for wireless Internet access
- connect to other external devices (for example, a digital camera or laser rangefinder)

What are the optional accessories?

- Serial/power clip
- Portable external power kit
- Vehicle power adapter
- External antenna (1.5 m and 5 m cable options) with magnetic base
- Pole mountable groundplane
- Antenna backpack kit
- Baseball cap with antenna sleeve
- Hard carry case
- Null modem data cable
- Beacon-on-a-Belt (BoB) differential correction receiver

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Configuration

How do I configure ESRI ArcPad™ to work on the GeoExplorer® CE handheld?

Detailed installation instructions for ESRI ArcPad are provided in the ArcPad documentation. You can also download installation instructions from the ESRI website at www.esri.com/arcpad.

To configure ArcPad on the GeoExplorer CE handheld:

1. In ArcPad, tap the Tools button.
2. In the *Protocol* field select NMEA 0183.
3. Select the *GPS* tab and from the *Port* field select COM2.
4. Tap **OK**.
5. Tap the GPS button. The software activates the integrated GPS receiver.

Tip*: ArcPad can also connect using the TSIP protocol. However, if you use NMEA, you can run GPS Controller at the same time for advanced GPS and real-time configuration and status information. You do not need to set the baud rate or other communication protocols.*

How do I configure ArcPad with the GPScorrect™ extension to work on the GeoExplorer CE handheld?

GPScorrect is preconfigured to connect to the GeoExplorer CE handheld's integrated GPS receiver. To use ArcPad with the GPScorrect extension on the GeoExplorer CE handheld:

1. In ArcPad, tap the GPS button. The software activates the integrated GPS receiver on COM3.
2. If you want to configure GPS and real-time, or view status information, run GPScorrect. In the Trimble toolbar, tap the GPScorrect button.

How do I configure TerraSync™ to work on the GeoExplorer CE handheld?

TerraSync is preconfigured to connect to the GeoExplorer CE handheld's integrated GPS receiver. To run TerraSync, tap the F1 GPS touch button. The software automatically activates the integrated GPS receiver on COM3.

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Can I lock the touch screen?

Yes. To lock the touch screen and hardware buttons, tap Start / *Programs* / *Utilities* / *Device Lock*.

To unlock the touch screen, drag the key icon in the top left corner of the screen over the padlock icon in the bottom right corner of the screen.

***Tip**: You can configure a touch button to run the Device Lock utility.*

Can I reconfigure the touch buttons, and what are the options?

Yes. To change the program or control that is assigned to each touch button, tap Start / *Settings* / *Control Panel* / *Touch Buttons*. The options include all installed programs and many of the Control Panel options.

Can I calibrate the screen responses to stylus taps?

Use the Stylus control to customize the way the screen responds to stylus taps. To access this control, tap Start / *Settings* / *Control Panel* / *Stylus*.

To adjust the double-tap rate, select the *Double-Tap* tab and follow the instructions on the screen.

If the touch screen does not respond properly to your stylus taps (for example, if you have to tap an area next to an icon, not directly over it, to select it), recalibrate the touch screen. To start the recalibration sequence, select the *Calibration* tab, or press the Display button and the Power button at the same time. Follow the instructions on the screen to recalibrate the touch screen.

Can I do GPS prediction (mission planning) on the GeoExplorer CE handheld?

The GPS Controller software includes a Plan section that displays an animated skyplot and DOP (satellite geometry) graph for your current position for the next 12 hours. For more information, refer to the *GeoExplorer CE Series Getting Started Guide* or the GPS Controller Help.

***Note**: If TerraSync or the GPScorrect extension for ArcPad is installed, use the Plan section in that application instead of GPS Controller.*

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What happens to GPS Controller when data collection software is installed on the GeoExplorer CE handheld?

GPS Controller offers a subset of the functionality in TerraSync and the GPScorrect extension for ArcPad, so it is not required if either of these applications is installed. If TerraSync or GPScorrect is installed on your GeoExplorer CE handheld, all shortcuts to GPS Controller are removed, and the F1 GPS touch button is reassigned to the TerraSync or GPScorrect Status section. If you uninstall the software, the GPS Controller shortcuts are restored.

To restore the GPS Controller shortcuts at any time without uninstalling the software:

1. On the GeoExplorer CE handheld, open Windows Explorer.
2. Browse to My Computer\Windows.
3. Tap Restore GPS Controller Shortcuts.exe.

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GeoExplorer® CE Series

February, 2003 Mapping & GIS

Memory

How much memory does the GeoExplorer® CE handheld have?

The GeoXM™ has 512 MB of internal disk memory for secure storage of large GIS datasets and background images. The GeoXT™ is available in 128 MB and 512 MB options.

The internal disk memory is not expandable or removable.

All handhelds in the GeoExplorer CE series have 32 MB RAM.

Can the memory in a GeoXT be upgraded from 128 MB to 512 MB?

Yes. An upgrade program will be introduced in the 2nd quarter of 2003. The handheld must be returned to a Trimble Service Provider for the upgrade.

How is memory configured in the GeoExplorer CE handheld?

The GeoExplorer CE handheld has two types of memory, which are similar to the RAM and hard disk in a desktop PC. The GeoExplorer CE handheld's main memory (RAM) is used mainly for running programs, but it also stores essential files for the Windows CE operating system including the registry. As with other CE devices (which usually only have RAM), you can adjust how much of the 32 MB of main memory is allocated to running programs and storing data. For more information, refer to the *GeoExplorer CE Series Getting Started Guide*.

How do I protect my data and installed programs?

The Disk is like a PC's hard disk. It is used for storing programs and data. The Disk is a non-volatile storage location, so files stored on the Disk are much safer than files stored in the main memory.

To protect your data, Trimble recommends that you:

- regularly back up the main memory (RAM)
- back up the main memory after installing software
- install software to the Disk
- store data on the Disk
- use ActiveSync to regularly back up the Disk to a desktop computer.

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Is there a size limit for the main memory backup on the GeoExplorer CE handheld?

Provided there is sufficient space on the Disk, you can back up the main memory even when it is full. A warning message appears if you try to back up the main memory when there is not enough space on the Disk.

How do I back up the main memory?

To back up the main memory:

1. On the Windows CE taskbar, tap Start.
2. Select *Settings / Control Panel / Back Up Main Memory*.

How do I restore the main memory?

There is no software control for restoring the main memory. To restore the last backup of the main memory, hard reset the GeoExplorer CE handheld. Hold down the Power button for 15 seconds to turn the GeoExplorer CE handheld off, then press the Power button to turn it on again.

The main memory is cleared and then restored from the backup on the Disk. You will lose any unsaved data (for example, any unsaved changes to documents) and any data in the main memory that has changed since the last main memory backup.

How do I back up the main memory to a desktop computer?

To back up the main memory to a desktop computer:

1. Connect the GeoExplorer CE handheld to the desktop computer using ActiveSync.
2. In ActiveSync, select *Tools / Backup/Restore*.
3. Select the *Full backup* option.
4. Click **Back Up Now**.
5. Wait while the contents of the main memory are backed up to the desktop computer. Do not use or disconnect the GeoExplorer CE handheld during the backup.

***Note**: After performing an initial full backup, you can save time by selecting the Incremental backup option.. This option only backs up information that has changed since the last backup.*

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SupportFAQ

GeoExplorer® CE Series

February, 2003 **Mapping & GIS**

How do I restore the main memory from a backup on a desktop computer?

To restore the main memory from a backup on a desktop computer:

1. Connect the GeoExplorer CE handheld to the desktop computer using ActiveSync.
2. In ActiveSync, select *Tools / Backup/Restore*.
3. Select the *Restore* tab.
4. Click **Restore Now**.
5. Wait while the contents of the main memory are restored from the backup on the desktop computer. Do not use or disconnect the GeoExplorer CE handheld during the restore process.
6. Perform a hard reset of the GeoExplorer CE handheld. Hold down the Power button for 15 seconds to turn the GeoExplorer CE handheld off, then press the Power button to turn it on again.

How do I back up the Disk to a desktop computer?

To back up files from the GeoExplorer CE handheld's Disk:

1. Connect the GeoExplorer CE handheld to the desktop computer using ActiveSync.
2. In ActiveSync, click **Explore**.
3. Windows Explorer opens, showing the contents of the GeoExplorer CE handheld. Browse to the location of the files that you want to back up.
4. Select the files that you want to back up and copy them to the desktop computer.

How do I restore the contents of the Disk from a backup on a desktop computer?

To restore files to the Disk from a backup on your desktop computer, simply connect the GeoExplorer CE handheld to the desktop computer using ActiveSync and copy the files from the backup on the desktop computer to the GeoExplorer CE handheld, overwriting the existing files.

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SupportFAQ

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February, 2003 — Mapping & GIS

What is the folder structure in the GeoExplorer CE handheld?

Some applications require program and data files to be stored in main memory (RAM). To allow such software to operate correctly, some folders (for example, My Documents and Program Files) on the Disk are duplicated in main memory.

You can store files and install software in either location. However, unless using the Disk causes problems in the applications you want to run, Trimble recommends that you store programs and data on the Disk.

For more information, refer to the *GeoExplorer CE Series Getting Started Guide*.

How can I check the available memory on the GeoExplorer CE handheld?

To check the available space on the Disk:

1. On the Windows CE taskbar, tap Start.
2. Select *Programs* / *Windows Explorer* / *Disk*.
3. Select *File* / *Properties*. A dialog appears, showing used and free space on the Disk.

To check the available main memory:

4. On the Windows CE taskbar, tap Start.
5. Select *Settings* / *Control Panel* / *System*.
6. Select the *Memory* tab to see how much of the main memory is in use, and how the used memory is allocated.

What happens when the GeoExplorer CE handheld loses power or is reset?

When the GeoExplorer CE handheld loses power or is reset, it turns off and the main memory is cleared. When power is restored, the main memory is restored from the backup on the Disk. You will lose any unsaved data (for example, any unsaved changes to documents) and any data in the main memory that has changed since the last main memory backup.

***Note**: Programs and files stored on the Disk are not affected by power loss. However, data and settings stored in main memory may be affected. If these settings are lost, some programs may not run correctly. To avoid problems, back up the main memory regularly, and always back up the main memory after installing software.*

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How can I maximize application performance?

Trimble recommends that you install all programs to Disk, and store your documents on the Disk. This also improves performance because more main memory can be allocated to running programs.

***Tip**: If possible, split large data files into smaller files for faster operation.*

If your programs are running slowly, or messages warning you that program memory is low appear, you can increase the proportion of main memory that is allocated to running programs.

To adjust memory allocation:

1. On the Windows CE taskbar, tap Start.
2. Select *Settings / Control Panel / System.*
3. Select the *Memory* tab.
4. Drag the slider to the left to increase program memory, or to the right to increase storage memory.
5. Tap **OK** to close the *System Properties* dialog.

***Note**: You can only change the allocation of memory that is not in use.*

Can you use a removable storage card with the GeoExplorer CE handheld?

No. The GeoExplorer CE handheld can only be opened by an authorized Trimble Service Provider.

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SupportFAQ

GeoExplorer® CE Series

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GPS

What are the accuracy specifications of the GeoExplorer® CE series?

- The **GeoXM**™ GPS CE handheld provides 2–5 meter accuracy.
- The **GeoXT**™ GPS CE handheld provides submeter accuracy. It uses built-in EVEREST™ multipath rejection technology to eliminate multipath signals in difficult GPS environments. The GeoXT GPS CE handheld can also collect carrier phase data that can provide 30 cm accuracy when processed with the GPS Pathfinder® Office software.

Does the external antenna improve accuracy?

No, but using it with a groundplane can increase the number of positions (yield) that can be obtained in difficult conditions.

Does the GeoExplorer CE handheld work better under canopy than the GeoExplorer 3 handheld?

Yes. The GeoXT uses EVEREST multipath rejection technology. It also has a larger internal groundplane with a higher specified antenna than the GeoExplorer 3 handheld. It's ideal for working under canopy, in urban canyons, or anywhere you need high-accuracy data collection and maintenance. For more information, refer to the white paper called *About EVEREST Multipath Rejection Technology*, which is available from the Trimble website at www.trimble.com/geoxt.html.

What is EVEREST multipath rejection technology?

Trimble's EVEREST multipath rejection technology provides a high-accuracy solution for codebased mapping. EVEREST rejects random errors in GPS measurements caused by multipath before they are stored. This results in more accurate, better quality data. Multipath occurs when a GPS signal is reflected off another surface (such as a tree or building) before being measured by the GPS receiver. For more information, refer to the white paper called *About EVEREST Multipath Rejection Technology*, which is available from the Trimble website at www.trimble.com/geoxt.html.

What GPS communication protocols are supported?

The GeoExplorer CE handheld supports the NMEA and TSIP GPS data communication protocols.

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What is NMEA?

NMEA is an open industry standard established by the National Marine Electronics Association (NMEA). The NMEA standard defines a format for communicating data collected or computed by a GPS receiver to an external device. The standard NMEA message types output by GeoExplorer CE series handhelds are GGA, VTG, GLL, GSA, ZDA, GSV, and RMC. For more information on the NMEA standard, visit www.nmea.org/pub/index.html.

What is TSIP?

The Trimble Standard Interface Protocol (TSIP) allows you to control a GPS receiver and set GPS configuration parameters. For receivers with appropriate capabilities, TSIP can be used to control beacon and satellite DGPS parameters and external sensor configurations.

How can I use the integrated GPS receiver?

The integrated GPS receiver has three internal GPS communication ports:

- COM2 – NMEA
- COM3 – TSIP
- COM4 – Real-time

Connecting to GPS is as simple as activating the port that supports the protocol you require. For example:

- **TerraSync** automatically connects to the integrated GPS receiver on COM3 (TSIP).
- **GPScorrect** automatically configures ArcPad so that when you use the Activate GPS command it connects on COM3 (TSIP).
- **Third-party field software** can use NMEA on COM2 or TSIP on COM3. NMEA applications cannot control the GPS receiver, so you can use the GPS Controller software to configure the integrated GPS receiver and view status information.

Can the GeoExplorer CE handheld be used as a receiver only?

Yes. You can use the GPS Connector software to configure the integrated GPS receiver to output NMEA or TSIP messages on COM1.

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What is differential correction?

Differential correction removes many of the errors in GPS data to improve accuracy. This is done by comparing GPS data collected on a field computer (the rover) with data collected simultaneously at a known location (the base). Because the base data is collected at a known location, any errors can be measured, and the necessary corrections can then be applied to the rover data.

What differential correction techniques are offered by the GeoExplorer CE handheld?

The GeoExplorer CE handheld has two main correction techniques:

- **Real-time correction** – corrections are transmitted from a base GPS receiver to the roving GeoExplorer CE handheld, and are applied to the GPS positions as they are generated. This has the benefit of giving accurate positions while you are in the field, and is excellent for navigating and relocating GIS data features in the real world.

- **Postprocessing** – corrections are recorded at the base GPS receiver and applied to the positions recorded by the roving GeoExplorer CE handheld using office software. This is a good technique when you need the best possible accuracy for your GIS but you don't require real-time accuracy for navigation. Trimble's field and office software solutions make it easy for you to postprocess GPS data collected in real time, giving you the best of both worlds.

What office software is available for my GPS data postprocessing requirements?

There are two options for processing GPS data collected with a GeoExplorer CE handheld:

- **GPS Pathfinder Office** version 2.90. The GPS Pathfinder Office software adds value to your GIS data collection and data maintenance projects by enabling you to plan your data collection session before you go into the field, making field work more productive. In addition, you can differentially correct your data from a number of sources and review your data in map form before transferring it to your GIS. For more information, visit www.trimble.com/pathfinderoffice.html.

- **GPS Pathfinder Express** on-line data processing service. To submit your GIS data to this service, simply e-mail the data from the field, or upload it on the GPS Pathfinder Express website. The service processes your data using your preferred options, and returns it to you in your choice of common GIS format. For more information, visit www.trimble.com/pathfinderexpress.html.

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Why is postprocessing important?

Postprocessing improves the accuracy and yield of GPS positions, even if the data has already been corrected in real time. This is because:

- postprocessing corrections are matched exactly by time (with real-time corrections they are approximate)
- postprocessing corrections are continuous (real-time communications can be interrupted, resulting in uncorrected positions)
- postprocessing uses carrier phase data for additional accuracy

What real-time options are offered by the GeoExplorer CE handheld?

The GeoExplorer CE handheld offers the following real-time differential correction options:

- Free corrections from WAAS satellites within the USA, received with the integrated WAAS receiver (standard)
- Free RTCM corrections from differential GPS radiobeacons, received with the Beacon-on-a-Belt (BoB™) differential correction receiver (purchased separately)
- RTCM corrections from a differential GPS radio transmitter, received with a DGPS radio (purchased separately)

What is WAAS?

The Wide Area Augmentation System (WAAS) was created by the Federal Aviation Administration (FAA) as a free-to-air differential correction service for the aviation industry. The system augments GPS with additional signals that increase the reliability, integrity, precision, and availability of GPS signals. For more information, refer to the WAAS FAQ at www.trimble.com/pathfinderpower.html.

Does the GeoExplorer CE handheld support WAAS?

Yes. The GeoExplorer CE handheld has an integrated WAAS receiver for free real-time corrections in the USA. For more information on WAAS, refer to the WAAS FAQ at www.trimble.com/pathfinderpower.html.

Can the GeoExplorer CE handheld use satellite differential corrections?

No, not directly. However, you can use the GeoExplorer CE handheld as a data collector for an external GPS receiver that can use satellite differential corrections, or you can connect a satellite differential receiver to the GeoExplorer CE handheld.

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Battery and Power

How long can the GeoExplorer® CE handheld operate on internal battery power?

The GeoExplorer CE handheld has an internal lithium-ion battery that will last up to 10 hours with GPS operating continuously.

How can I conserve power?

Although the GeoExplorer CE handheld's battery can operate for a full day without recharging, you can conserve battery power to extend operation time. Follow these tips to reduce power consumption:

- Disconnect from the integrated GPS receiver whenever it is not in use. When you disconnect from GPS, the integrated GPS receiver switches off and stops drawing power. Whenever GPS data is not required, use the application's Disconnect or Deactivate GPS option. Exiting the application also disconnects from the integrated GPS receiver.

  ***Tip**: Do not disconnect from GPS if you will be reconnecting within about five minutes Your application can take up to 30 seconds to reactivate the integrated GPS receiver, so disconnecting to save power can cost time.*

- Do not use the backlight. To turn the backlight off, press the Display button. You can also configure the backlight to automatically turn off if the GeoExplorer CE handheld has been idle for a specified time. For more information, refer to the *GeoExplorer CE Series Getting Started Guide*.

- Set the GeoExplorer CE handheld to go into Suspend mode when idle. For more information, refer to the *GeoExplorer CE Series Getting Started Guide*.

How can I extend the life of the internal battery?

If you are not going to use your GeoExplorer CE handheld for three months or more, Trimble recommends that you turn the handheld off instead of leaving it in Suspend mode. For more information, refer to the *GeoExplorer CE Series Getting Started Guide*. Alternatively, you can keep the GeoExplorer CE handheld connected to mains power to continually charge it.

Fully charging and then fully discharging will extend the life of the battery.

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How do I recharge the GeoExplorer CE handheld?

To recharge the GeoExplorer CE handheld, use the support module or the optional serial clip to connect it to an external power source. Depending on the optional accessories that you have purchased, you can use mains power, a camcorder battery, or a vehicle's battery to recharge the GeoExplorer CE handheld.

Trimble recommends that you turn on the GeoExplorer CE handheld before recharging the battery. If you recharge the battery when the handheld is in Suspend mode, the battery level displayed in the system tray may not be correct. To display the correct battery level, turn on the handheld and fully charge the battery again.

Will the GeoExplorer CE handheld recharge when suspended?

Yes, but the battery level displayed in the system tray may not be correct. Trimble recommends that you turn on the GeoExplorer CE handheld before recharging the battery.

What types of external power can I use?

Depending on the optional accessories that you have purchased, you can use mains power, a camcorder battery, or a vehicle's battery to supply power to the GeoExplorer CE handheld.

How long can the GeoExplorer CE handheld operate using an external camcorder battery?

Using power from an external camcorder battery doubles the GeoExplorer CE handheld's operating time, to up to 20 hours with GPS operating continuously.

Can the GeoExplorer CE handheld use external power without recharging the internal battery?

By default, the GeoExplorer CE handheld uses any external power source to recharge its internal battery. This draws more power from the external source than only using it to power the GeoExplorer CE handheld. Recharging the internal battery from a power source that can itself be drained (such as a camcorder battery) can be inefficient if you are using external power to extend your working time.

To get the maximum life out of an expendable external power source, you can disable recharging from the power/serial clip. When recharging is disabled, any power source connected to the serial clip is used only to provide power to the handheld.

For more information, refer to the *GeoExplorer CE Series Getting Started Guide*.

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What happens when the GeoExplorer CE handheld loses power?

If the internal battery runs flat and no external power source is available, the GeoExplorer CE handheld turns off and the main memory is cleared. When power is restored, the main memory is restored from the backup on the Disk. You will lose any unsaved data (for example, any unsaved changes to documents) and any data in the main memory that has changed since the last main memory backup.

Note: *Programs and files stored on the Disk are not affected by power loss. However, data and settings stored in main memory may be affected. If these settings are lost, some programs may not run correctly. To avoid problems, back up the main memory regularly, and always back up the main memory after installing software.*

Can I take the battery out?

No. Removing the internal battery voids your warranty. If you have a battery problem, contact your local Trimble representative.

The battery is rechargeable in the handheld using the support module or the optional serial clip.

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Troubleshooting

How do I reset the GeoExplorer® CE handheld?

Soft reset: If an application has stopped responding, hold down the Power button until the screen goes blank (about 5 seconds). The GeoExplorer CE handheld restarts automatically.

Hard reset: If a soft reset does not work, hold down the Power button for 15 seconds to turn the GeoExplorer CE handheld off, then press the Power button to turn it on again. The main memory is cleared and then restored from the backup on the Disk. You will lose any unsaved data (for example, any unsaved changes to documents) and any data in the main memory that has changed since the last main memory backup.

Note*: Programs and files stored on the Disk are not affected by resetting. However, data and settings stored in main memory may be affected. If these settings are lost, some programs may not run correctly. To avoid problems, back up the main memory regularly, and always back up the main memory after installing software.*

What do I do if my GeoExplorer CE's screen stops responding?

- If the screen is blank, low contrast may be the cause. Press the Contrast Up touch button to increase the contrast.
- If your GeoExplorer CE handheld stops responding to the stylus, or the screen goes blank, you may need to reset it, as described above.
- If resetting does not solve your problem, you may need to clear the main memory. Clearing the main memory automatically backs up the main memory to the Disk, then hard resets the GeoExplorer CE handheld. To clear the main memory:

  1. Tap Start / *Settings / Control Panel / Clear Main Memory*.
  2. A message appears, asking you to confirm that you want to clear the main memory. Tap **Continue**.
  3. A second message appears, asking you to confirm that you want to continue. Hold down the Display button and press the Power button.

Can a broken touch screen be replaced?

Yes. The handheld must be returned to a Trimble Service Provider for the repair.

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References:

Introduction to GIS (Lecture)
GEOG 255 Lecture note from University of Waterloo
http://www.watleo.uwaterloo.ca/~piwowar/geog255/Geog255.html

Introduction to ArcPad (Lecture and Exercise)
ESRI Virtual Campus (http://campus.esri.com)

GeoXT® Fact Sheets
Trimble Navigation Ltd.©. Sunnyvale, CA. 2004.
GeoXT® Frequently Asked Questions.
http://www.trimble.com/geoxt_ts.asp?Nav=Collection-22389

Got a question?

Please do not hesitate to contact us.

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APPENDIX D

PAPER SPBIS DATA COLLECTION FORM

The following is the paper SPBIS data collection form. Each "X" represents an essential field for initial data collection. These fields are represented in the digital form.

Jul 01 02 01:45p USDA Forest Service 318-473-7289 p.2

Southern Pine Beetle Information Data Sheet

SPB SPOT CODE: X (Forest) - X (District) - X (Spot #) **HEAD:** X (number) **BREAKOUT:** X (letter)

HEADS & BREAKOUTS

Compartment: X	Wilderness (circle one): Y N	BA Pine: X	Spot found by: X
Stand Number: X	Wilderness Name: X	BA Total: X	Date entered in SPBIS: X

SURVEYS

Survey Type (A/G/V)	Date Surveyed (DD-MON-YYYY)	Date Ground Checked (DD-MON-YYYY)	Suggested Treatment Plan*	Flagging Color	Logging Access	Pulp or Saw (P/S)
X	X	X	X	X	X	X

Fresh Attack (Y/N)	Number Infested Trees	Number Red/Fader Trees	Number Green Trees	Number Vacated Trees	North Latitude (+) Decimal degrees ex. (+xxx.xxxx)	West Longitude (-) Decimal degrees ex. (-xxx.xxxx)
X	X	X	X	X	X	X

TREATMENTS

Treatment	Sale ID	Cutting Unit ID	Permit Number	Date Marked (DD-MON-YYYY)	Salvage Volume - ccf		Date Sold (DD-MON-YYYY)
					Saw	Pulp	

Date Suppressed (DD-MON-YYYY)	Number Trees Treated	Infested Acres	Contractor ID	Paint Color	Supplemental Volume – ccf		
					Date (DD-MON-YYYY)	Saw	Pulp

✍ Comments:

Sketch map:

* **TREATMENT PLAN**	R = CUT & REMOVE	S = CUT & HAND SPRAY	I – INACTIVE OR DEAD
M – MONITORED	L = CUT & LEAVE	B – PILE & BURN	X – SEMIO-CHECMICAL

VITA

Saul David Petty was born to Kirk H. and Sandra D. Petty on September 17, 1980 in Houston, Texas. Saul started elementary school in Needville, Texas in 1986. In 1991 the family moved to Gilmer, Texas where Saul attended school until December of 1996. In January 1997 the family moved to Joes, Colorado. Saul graduated from Idalia High School in Idalia, Colorado with honors in May 1999. Saul attended Hill College in Hillsboro, Texas for one year before transferring to Texas A&M University in College Station, Texas in August 2000. He received his B.S. in Horticulture from Texas A&M University in August 2003. He completed his M.S. in Forest Science at Texas A&M University in May 2005. In July 2003, he began a student internship with the USDA Forest Service, Forest Health Protection Unit in Pineville, Louisiana. As part of this internship, he began work on a M.S. degree in Forest Science at Texas A&M University. Following graduation he will start a permanent position with the Forest Health Protection Unit in Pineville, Louisiana.

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