GPS/GIS Technologies
Lesson 1
Classroom

Overview of Global Positioning System (GPS) And Geographic Information System (GIS)

Learner Outcomes

The learner will

- Define the terms GPS, GIS, triangulate and geo-referencing.
- Identify two strengths of ArcView 3.1.
- Generate a list of GPS/GIS applications in everyday life.

Background

The use of computerized information is a growing part of our society. People are using geographic, social, economic, political and environmental information to answer practical questions. The Chihuahuan Desert Lab will use two modern technologies—Global Positioning System (GPS) and Geographic Information System (GIS) to collect and analyze a variety of resource management projects in national parks.

GPS

GPS is an array of twenty-four satellites that orbit around the Earth, launched and maintained by the US Department of Defense (DOD). These satellites send a continuous stream of signals to the surface enabling a receiver to determine its height and location above the Earth. Due to national security, exact positions are scrambled, unless authorization is granted to a user via a private satellite subscription. The Chihuahuan Desert Lab subscribes to the SATLOC satellite. The GPS unit sends a call for location information to the SATLOC satellite. The SATLOC satellite references as many of the DOD satellites as are available in the area to determine exact locations. The DOD satellites then send signals back to SATLOC. SATLOC uses geometry to correct the signals based upon the curvature of the Earth and other factors, and sends location data back to the GPS unit. The GPS unit sends this data to either the hand-held or the laptop computer for storage and further analysis.

The basis of GPS is triangulation involving accessed satellites. To triangulate, a GPS receiver sends out radio signals at a known speed, recording the time it takes for each signal to return. Using the relationship of speed equals the distance divided by the time, SATLOC then calculates the distance from the satellite to the GPS unit.

Mathematically, a minimum of four satellite distances are needed to determine an exact position. When SATLOC and the GPS computer have synchronized signals, a reading is recorded and stored on the hand-held or laptop computer. This process continues automatically. Positional accuracy is increased as a result of SATLOC accessing more than four satellites. The greater the number of satellites accessed, the greater the positional accuracy.

The advantages of GPS over its forerunners are obvious. GPS is easier to use than the traditional navigational tools of astrolabe and compass and less subject to interference from weather systems. Without GPS, it can be difficult to establish the exact location of data collected when in the field. GPS allows you to take a program like FieldWorker and tag data with latitude and longitude information. Field data can then be easily exported to a personal computer for analysis and mapping.

Most maps are inaccurate due to the fact that they were created before GPS. Quite often, the errors contained in a map will be greater than GPS errors. This makes using the right map, and geo-referencing it correctly, very important. To geo-reference a map, go to three locations and record their coordinates with the GPS receiver. This will help minimize inconsistencies between the original map and your newly collected GPS data.

GIS allows a user to load a pre-existing map, and use it to overlay collected GPS data, a process known as geo-referencing. The program then shrinks or expands the *X* and *Y* axes so that the map has the correct scale. Most maps have three points on them with location coordinates, allowing you to simply type those coordinates in and the map will be geo-referenced.

GIS

ArcView 3.1 is the industry standard for GIS computer programs. It provides a systematic way to understand aspects of the spatial organization of the Earth's surface. GPS data can be imported and displayed as layers of information stacked on top of each other in any order the user chooses. ArcView 3.1 uses the word *theme* for layers. Themes may contain buildings, human interactions with the land, land parcels, streets, soil classes, utilities, land uses, geology, ecology, topography and human characteristics. Anything that can be mapped can be included as a theme in a GIS project.

There are four major components of GIS -- geography, data, a computer and a thinking operator. Although GIS can provide the answers, only the operator can guide the questions and make choices. People in all industries -- socialists, politicians, economist, environmentalist, city planners, etc. -- use GIS to help answer questions and find solutions.

The two major strengths of ArcView 3.1 are its speed and dynamic flexibility. By combining data, computer hardware and software, the GIS operator can quickly develop a hypothesis and explore a range of possibilities. GIS allows the operator to change and update information and reanalyze geographic information at will.

GIS is much more than just a technical tool; it is about applying the tool and know-how to real questions. There is an abundance of unanswered questions in our national parks. Students participating in the Chihuahuan Desert Lab course will use GPS/GIS to investigate some resource management issues at Carlsbad Caverns and Guadalupe Mountains National Parks. Participating students do real research, real science on real

land! Students taking this course are preparing themselves for careers for which there is a great demand for technical expertise.

Materials
- Supplements 1.1, 1.2, 1.3

Assessments
- Pre/Post-test
- Work sheet
- Brainstorm

Activity #1
Pre-test
15 minutes

Procedure
The teacher will
- Administer the pre-test.

Activity #2
GPS/GIS Overview
60 minutes

Procedure
The teacher will
- Discuss with students the information contained in the Background section.
- Instruct the students to fill in the blanks on the GPS/GIS work sheet during the discussion.

Activity #3
GPS/GIS Brainstorm
10 minutes

Procedure
The teacher will
- Facilitate a brainstorming session to generate a list of GPS/GIS applications.

Note: GIS is a tool used for planning school bus routes based on student residences, viewing global vegetation cover from satellite images, studying water consumption patterns in deserts, documenting archaeological sites and findings, designing noise abatement buffer zones around airports, laying out newspaper delivery routes, mapping current sewer service areas and projected need, profiling present bank customers by branch offices, modeling hurricane evacuation scenarios, identifying telephone market territories, researching changing mountain lion populations within the boundaries of Carlsbad Caverns National Park and researching the population of Mexican-free-tailed bats roosting in Bat Cave. GIS users may create maps to show levels of crime, war zones, pollution, traffic flow, ancient forest, or television cable service in a particular area. Everyday, thousands of social, political, economic and environmental choices are made based on GIS. The question should be worded -- Who doesn't use GIS?

Activity #4
Post-test
15 minutes

Procedure
The teacher will

- Administer post-test to access knowledge gained.

GPS/GIS Technologies
Lesson 2
Classroom and School Grounds

GPS/GIS Instruction and Practice

Learner Outcomes
The learner will
- Use the Global Positioning System (GPS) to locate objects that have been previously hidden in the grass of a large field.
- Use the Newton/GPS units to collect points for project.
- Correctly import the GPS data collected from the Newton into ArcView Geographic Information System (GIS).

Background
Students, working in three teams, will follow step by step procedures to gain experience using GPS/GIS technologies. In the first activity, students will locate objects using a GPS unit. In the second activity, students will collect data using a GPS unit. In the third activity, students will transfer the data they collected into ArcView (GIS).

Materials
- Supplement numbers 1.4 through 1.8
- GPS Unit(s)/Hand-held Newton/FieldWorker Software
- Small paper labels (*Underground Fiber Optic Telephone Line*, *Underground Water Line*, *Underground Gas Line*, *Underground TV Cable*, *Underground Sewer Line, Administration Building, National Parks Highway and Pecan Street Intersection,* etc.)
- Computer(s) with ArcView installed

Assessments
- Teacher observation of student's performance in each of the three activities. (Did the student locate the items hidden in the field? Did the student successfully collect data in the parking lot? Was the student able to transfer the data into ArcView?)
- GIS maps

Activity #1
GPS Scavenger Hunt
1 class period

Purpose of Activity
The purpose of this activity is to assist students in learning features and uses of the GPS unit, the Newton and FieldWorker Pro through activities that offer hands-on experience with the unit and software.

Background
Students should not only understand how to locate objects, but why location is important. For example, we can get in serious trouble if we do not know what is beneath us. Have you noticed warnings featured in telephone yellow pages? Does *Call Before You Dig*! sound familiar? Any time you go to a rental business and rent a

ditcher, there is a decal on the ditcher that states, *Call before you dig to locate underground cable and lines, or you will be financially responsible for repair costs of cut or damaged lines*. There is also a danger of serious injury or even death if you accidentally cut into an underground electric power line.

Before digging begins, someone should come out and locate underground power cables, telephone cables, cable television lines, water lines and gas lines. Cities must always keep updated maps showing the locations of these various services. Thus there is a great demand for individuals with skills in GPS and GIS.

Procedure
The teacher will

- Select a volunteer to go into the field and make initial GPS readings at various locations, hiding the various labels. The field is to represent the Pecan/National Parks Highway Intersection. Suggestions for labels are: Underground *Fiber Optic Telephone Line, Underground Water Line, Underground Gas Line, Underground TV Cable, Underground Sewer Line, Administration Building, National Parks Highway and Pecan Street Intersection, etc.*
- Have students pretend that they are under contract by the City of Carlsbad to assist city workers putting a new sewer line from Carlsbad Caverns and Guadalupe Mountains National Parks' Administration Building to the main sewer line located in the center of National Parks Highway at the Pecan Street intersection.
- Have students use the GPS unit's Navigator capabilities to relocate the underground locations of power cables, telephone cables, cable television lines, water lines, gas lines, etc. before the workers begin digging. Remind students that accuracy is important. (If they do not locate the underground services correctly, they will be responsible for paying a qualified person to repair any damages caused by the diggers cutting lines. They will also be financially responsible for injuries or death, which might result.)
- Provide step by step instructions so students are able to use the Navigator view on the Newton. The navigator view will lead students to the coordinates recently established by a previous contractor who determined the exact locations of all underground lines using a GPS unit.

Activity #2
Collecting GPS Data
1 class period

Procedure
The teacher will

- Divide students into teams of 3.
- Provide each team with a set of step by step instructions, a Newton and the GPS unit.

Procedure for Team One

- Name your project *Parking Lot*.
- Name station #1 *The Boundary*.
- Collect the GPS data as **points** using an **Automatic Trail**.

- Check the **GPS Preferences** to ensure they are set correctly.
- Tap the **GPS** icon to start the data collection process.
- When you have finished walking around the parking lot boundary, tap the **GPS** icon to stop collecting data. (You have just collected a series of points that can be imported into ArcView and will show you the outline of the parking lot.)

Note: If the data you collected to outline *The Boundary* took 100 points of data to outline its shape, then station # 1 actually used 100 station numbers. (A station stores only one data point.)

Procedure for Team Two

- Name your project *Parking Lot.*
- Name your first station *Painted Lines.*
- Collect the GPS data as **points** using an **Automatic Trail**.
- Check the **GPS Preferences** to ensure they are set correctly.
- Tap the **GPS** icon to start the data collection process.
- When you have finished walking along the painted lines in the parking lot, tap the **GPS** icon to stop collecting data.

Procedure for Team Three

- Name your project *Parking Lot*.
- Name your first station *Vehicles.*
- Collect the GPS data as points using **Average from Display** for each car**.**
- Check the **GPS Preferences** to ensure they are set correctly.
- Tap the **GPS** icon to start the data collection.
- Collect the location of each vehicle. Give each vehicle a **New Station** name by using the license plate number.
- When you have finished collecting your data, tap the **GPS** icon to stop collecting the data.

Activity #3
Importing Data into GIS
1 class period

Procedure

The teacher will

- Provide each team with step by step instructions for importing data into ArcView.
- Remind students to import data as **Points** and choose a name for the **Theme** during the last steps of the import process.

GPS/GIS Technologies
Lesson 3
Classroom

Technological Applications

Learner Outcomes

The learner will

- Brainstorm to identify ways in which spreadsheets/data bases/GPS/GIS technologies can be applied to Chihuahuan Desert Lab projects.
- Interpret statistical species population data collected, inputted and stored as the revegetation and the prairie dogs projects progress.

Background

The Chihuahuan Desert Lab has four resource management projects. Some projects are not as appropriate for GPS/GIS applications as others. Although GIS can be used as a spreadsheet for data storage and analysis for each of the four projects, it may not be the software of choice in each case. Students will use GPS/GIS technologies in the revegetation and the prairie dog projects.

Materials

- Flip chart or butcher paper
- Markers
- Supplement number 1.8
- ArcView Reference Manual – comes with software
- Spreadsheet/data base manuals specific to software being used

Assessments

- Teacher observation of student participation in brainstorming process
- Interpretative reports

Activity #1
Applications
1 class period

Procedure

The teacher will

- Assign students to one of four teams — revegetation, prairie dogs, cave swallows and water quality. Each team selects a recorder, timekeeper and presenter.
- Give each team seven minutes to brainstorm ways technological software and equipment could be used to enhance their particular project.
- Each team is given three minutes to display and present their list.
- Have students rank each team's list – most creative, most practical, most technological, and longest.
- Present a list of pre-identified uses of these technologies to ensure completeness.
- Have each student submit to the teacher the application(s) he/she would like to study during the course.

Activity #2
Interpretations
on-going

Procedure

The teacher will

- Arrange field trips to monitor project progress.
- Instruct students on data collecting procedures.
- Have students create a spreadsheet/data base template, if there is not a pre-existing template, to record and store their data.
- If necessary, assist students with inputting data onto spreadsheets.
- Facilitate the transferring of spreadsheet data into ArcView.
- Assign students interpretative reports based upon accumulated data from each project.