

## From GPS Data Collection to GIS Data Display A Walk-Through Example

The **Global Positioning System (GPS)** is a satellite based navigation system consisting of 24 satellites, a worldwide network of tracking stations, and a master control station located in Colorado Springs Colorado. GPS receivers can be carried in your hand, attached to a car, or embedded in the computer systems of ships and airplanes. A GPS receiver determines its position by processing the data from at least 4 satellites and applying the concept of triangulation ([How??](#)). Horizontal accuracy can be as low as 1-3m on the Earth's surface depending on the quality of the receiver and whether or not any [post processing](#) was performed.

A GIS is a computer based system used to capture, manage, integrate, analyze, and display data referenced to the earth. Paper maps have historically been used for orientation and as sources for specific information. With the advent of GIS, a user can make any map at any time and generate very specific information that relates to any number of specializations. With the right type of data, a person has the opportunity to model any multitude of scenarios relating to a particular question. Where would the invasive weed False Brome likely grow? Where would it be wise to preserve habitat for the endangered Fenders Blue Butterfly? What municipalities would we work with to protect native salmon habitat?

We will walk through a real life scenario that may be very similar to a project you hope to perform. This example incorporates all the data collection capabilities of a simple, hand-held GPS receiver and will guide you through the methods for transferring the data into a suitable format for data display in a GIS.

### What You Will Need:

Personal PC (These programs **are not** Apple compatible) with an internet connection

GPS Receiver

- Garmin E-Trex "Legend" with a PC interface cable

GIS Data Viewer

- ESRI's ArcExplorer 9.1 Java Edition
- Download: <http://www.esri.com/software/arcexplorer/index.html>

PC to Garmin Interface Software

- DNRGarmin 5.1.1 ArcGIS 9.x compatible
- Download: <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html>

## **Project Example**

Synopsis:

My class is participating in a large restoration project in a partnership with Oregon State Parks. One aspect of the project involved planting a variety of native tree species over a sizeable area. We would like to map the locations of the trees using a simple, hand-held GPS receiver and record a variety of **attributes**, including species name, diameter at breast height (DBH), and height. Our plan is to make a presentable map of the restoration area. Therefore, we will record the locations of all the trees planted, any trails or roads that are near the study site, and the actual boundary of the restoration area. For clarity, we will incorporate a high resolution overhead photograph of the restoration area for our final map.

## **Overview of the Steps**

1. Download and install ArcExplorer and DNRGarmin
2. Download an overhead photograph
3. Create the attribute table and setup the GPS unit
4. Collect the field data
5. Transfer the field data to your PC
6. Create a map in GIS

## **Download and Install ArcExplorer and DNRGarmin**

GIS Data Viewer

- ESRI's ArcExplorer 9.1 Java Edition
- Download: <http://www.esri.com/software/arcexplorer/index.html>

PC to Garmin Interface Software

- DNRGarmin 5.1.1 ArcGIS 9.x compatible
- Download: <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html>

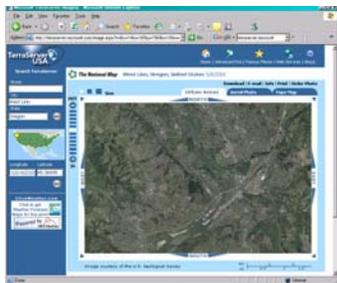
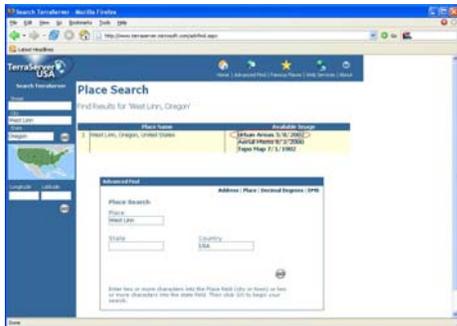
Click on the links and follow the download and installation instructions

## **Download an Overhead Photograph**

Overhead photos of varying resolution can be downloaded for free at <http://teraserver.microsoft.com/>. Once on the homepage, you can either type in a location or interactively pan and zoom in on the world map.

This project took place at Mary S. Young State Park in West Linn, Oregon.

1. Type in West Linn, Oregon on the home page and press “go”. You will be taken to a screen with a selection of available images. For our example, we will select the most recent image available. Click on “Urban Areas 5/8/2002”.



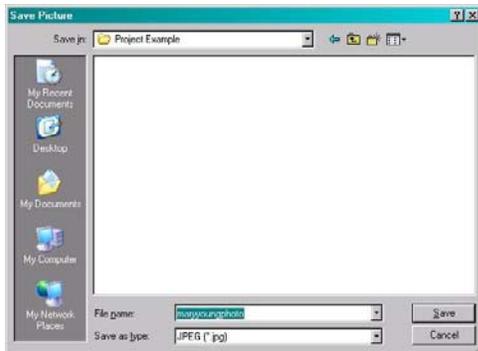
2. It is necessary to have a general idea of where you will be doing your project to get the proper overhead picture. To find our study area, look in the upper middle portion of the image. The study sight is the clearing just to the left of the river. There is a large forested area between the river and the study site. Zoom in and center on the restoration area. Make sure you zoom in as close as possible while still being able to see the entire restoration site. We will be conducting the tree planting in a portion of the clearing in the middle of the photo.



Once you have an acceptable overhead view, you will need to download the picture and its accompanying world file.

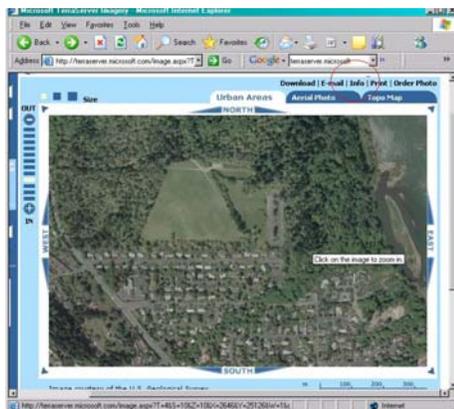
Download the picture:

1. Position your mouse pointer over the image.
2. Click the right mouse button.
3. Select the "**Save Picture As**" or the "**Save Image As**" menu item.
4. Enter the directory and name of the file to create (ex. maryyoungphoto) and save as a JPEG (.jpg extension).



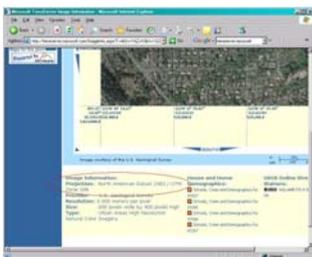
Download the [world file](#)

1. Directly above the image, click on “info”.

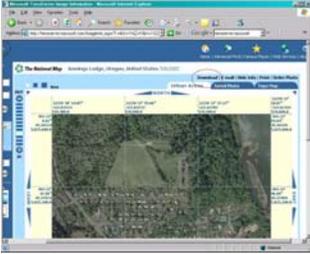


2. Scroll to the bottom of the page and make a note of the [datum and projection](#) information. Your GPS data must end up in the same datum and projection if you hope to display them together in a GIS.

- maryyoungphoto.jpg is in **North American Datum 1983 (NAD 83)/ UTM Zone10N**



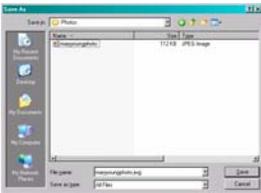
3. Scroll back to the photo. Click on the “download” link directly above the image.



4. Right click on the world file link and select “save target as” or “save link as”.



5. Go to the same folder you saved your image. In the “save target as” menu, you may need to change the “type” from “.txt” to “All Files”.



6. In the name field, you must use the same name that was used for the image but the extension must be .jwg (ex. maryyoungphoto.jwg).

The photo is now ready for use in a GIS.

### **Create attribute table and setup GPS unit**

Your GPS receiver is capable of recording **vector data** with associated names. The **attribute** information must be manually recorded by you. For our example, attribute data will only be recorded for trees.

Create the attribute table:

1. Create a chart with a column for tree id, and columns for all your attributes. This can be done with pencil & paper or on a spreadsheet program such as Microsoft Excel. This is small list attributes that can be added to depending on what you want to record

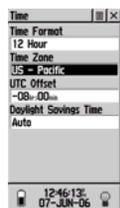
Tree ID	Species	DBH	Height	Status

Collect the Field Data:

Spend some time getting to know your GPS receiver before going into the field. There are a number of different menus and options that can be utilized to improve performance, and it helps to know how to easily navigate through the different menus. Following are the setup tasks that are necessary for our project. All of the setup options are accessed through the Main Menu.



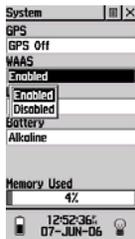
1. Make sure the time zone is set up correctly
  - From the main menu, go to setup, and select time
  - For our example, the time was changed to US Pacific



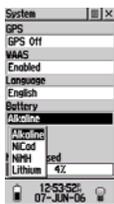
2. Make sure the GPS is collecting in the same datum as your overhead picture
  - From the main menu, go to setup, and select units
  - Our photograph uses the NAD83 datum. Under datum, change to NAD83



3. Make sure the GPS is using it's built in **differential correction** system. This unit uses a **“real time” differential correction** system called WAAS.
  - From the main menu, go to setup, and select system
  - Under WAAS, make sure it is enabled. This will give your data better accuracy



4. Make sure the GPS knows what types of batteries you are using. This allows it to accurately display how much power you have remaining.
  - From the main menu, go to setup and select system
  - Under batteries, choose your battery type

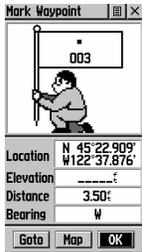


You GPS receiver should now be ready to take into the field

## **Collect the Field Data**

Go to the field site and turn on the GPS receiver. Initially, the receiver will start searching for satellites. Wait until enough satellites are located and the unit displays “ready to navigate”. This process can take some time. Ideally, try to stand in an open area, away from any structures, and away from dense canopy cover. Even under the best conditions, it can take a number of minutes to actually track the required number of satellites. We will be collecting three types of vector data- points (trees), lines (roads, trail, water), and a polygon (restoration boundary). In the GPS, point data is collected using the waypoint feature, and lines & polygons are collected using the track feature. We will collect the points first.

1. Go to the first tree. From the main menu, select “mark”. Once this is selected, the location is immediately recorded in the GPS as a waypoint. You will be taken to a screen with a picture of a man holding a flag.



2. Navigate to the default name in the flag and click on it. Change the name in the flag to a unique name (ex T1) and press OK.



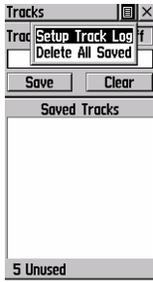
3. Record the name in your pre-made attribute table
4. Record all the attribute information in the attribute table

Tree ID	Genus	DBH	Height	Status
T1	<i>Acer Circinatum</i>	2.25"	7.5'	Live

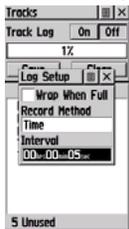
5. Repeat steps 1-4 for all remaining trees.

Next, we will collect line data. For the purpose of our project, we will collect four separate lines to achieve the proper clarity and orientation necessary for our final map. There are two paths that run by the study area, a drainage ditch that goes through the area, and a road that runs adjacent to the site. All four lines will be collected separately using the same technique. Starting with the path:

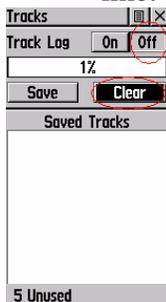
1. Stand at the beginning of the path.
2. From the main menu, go to tracks and open the “options” menu. You can access the options menu by pressing next to the “X” at the top right of the screen. From the options menu, select “Setup Track Log”.



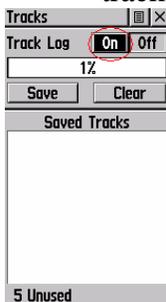
3. Change the record method to time and change the interval to five seconds. Now, the GPS will record a point every five seconds then connect the points to complete the line.



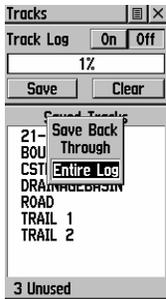
4. Go back to the tracks menu. Turn the track log off and select “clear” to clear the track log. You must clear the track log every time you want to start a new line.



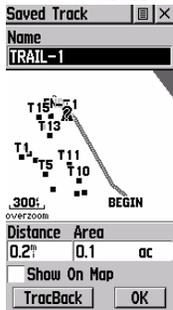
5. Once the track log is cleared and you are at the beginning of the path, turn the track log on and start walking.



6. Once you reach the end of the path, turn the track log off and select “save”.
7. A prompt will ask what you want to save. There may be many options or just one. Regardless of the number of options select “entire log”.



8. You will be taken to a menu where you can rename the line with a unique name (ex trail-1). Name it and press “OK”.



9. Complete steps 4-7 for the next path, the drainage ditch, and the road.

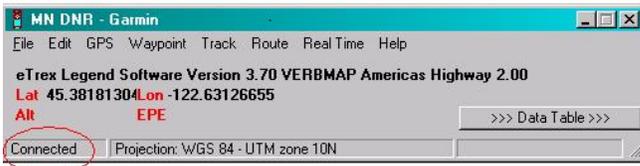
To map a polygon (the restoration boundary), you will use the same steps that were used to record lines by using the track menu. When the data is transferred onto the computer you can tell the interface program that this particular track is a polygon and it will automatically connect the first and last points recorded to close off the line and create a polygon.

Start anywhere on the boundary of the restoration area. Follow steps 1-7 from above and walk the perimeter of the restoration site. Save and rename the track.

### **Transfer the Field Data to your PC**

Your GPS data now needs to be downloaded onto a computer into a format suitable for GIS data display. We will convert our data into [ESRI shapefiles \(.shp\)](#). For this tutorial, we have supplied the data we collected. [Click here for instructions and access to sample data files to download and save onto your computer.](#) Once the sample data files are saved onto your computer, open DNRGarmin click on “file” > “Load From” > “File”. This is instead of downloading the data from the GPS. Download the waypoint data by selecting “waypoints.txt”. Each track can be downloaded separately by selecting either “trail 1.txt”, “trail 2.txt”, “drainage basin.txt”, “road.txt”, or “boundary.txt”. This is how you can load data from another source, however, we have included the steps necessary to actually download the data directly from the GPS unit.

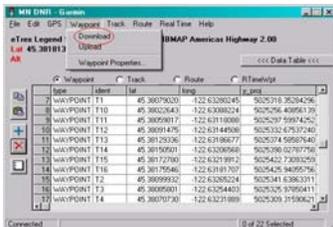
1. Connect the GPS receiver to your computer via the PC interface cable that came with the GPS unit. On the top back of the GPS unit, lift the rubber cover above the battery area to find the plug-in.
2. Open DNRGarmin. The program will automatically search for the connection to the GPS unit
3. Once DNRGarmin is opened, you can verify that the GPS is connected by looking at the bottom left hand corner of the screen.



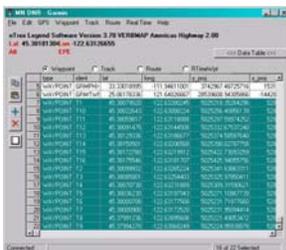
We collected 16 waypoints that will be placed into one shapefile and five tracks (4 lines and 1 polygon) that will be placed into 5 separate shapefiles.

### Downloading Waypoints:

1. Select “download” under the waypoints menu. You will then see all the waypoints that are currently saved on the GPS unit.

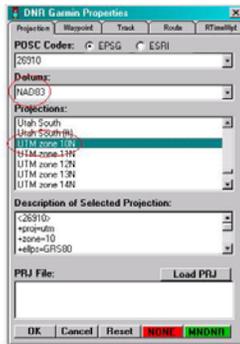


2. Select the waypoints that will be incorporated into the shapefile. Our waypoints were labeled T1-T16 for each tree in the restoration area.

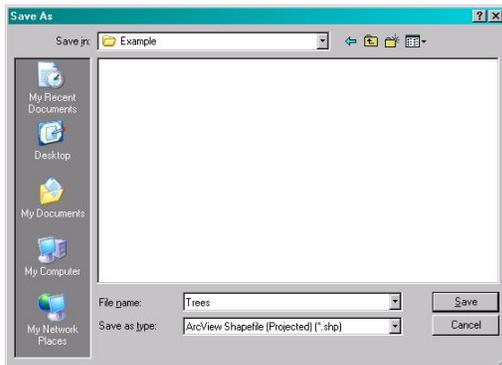


3. Under the file menu select “set projection”. This only needs to be done if you want your data projected into a **projected coordinate system**. Our GPS data was collected in the NAD83 datum. Our base map (the overhead picture) is in NAD83 and in the UTM zone 10N projection. We need to project the GPS data into this same projection.

4. In the “DNRGarmin Properties” dialog, go the projection tab and select “NAD\_1983” under Datums and “UTM\_Zone\_10N” under Projections and press “OK”.



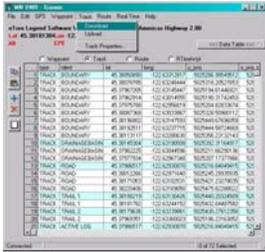
5. Under the file menu, select “Save To” then select “File”. In the following dialog, navigate to where you will be storing your shapefiles and type in a name (ex trees). Next to “save as type”, select ArcView Shapefile (projected) and press “Save”.



These steps can be repeated if you collected more than one type of point.

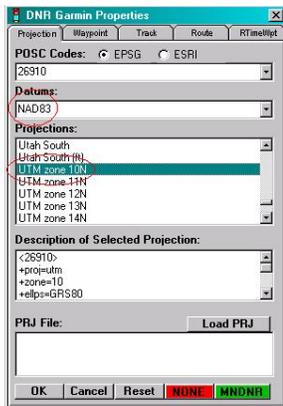
### Downloading the Line Tracks:

1. Select “download” under the “tracks” menu. You will see all the data points for the tracks you have collected. You can now turn off the GPS receiver.



2. Under the file menu select “set projection”. This only needs to be done if you want your data projected into a **projected coordinate system**. Our data was collected in the NAD83 datum. Our base map (overhead picture) is in NAD83 and in the UTM zone 10N projection. We want to project the GPS data into this same projection.

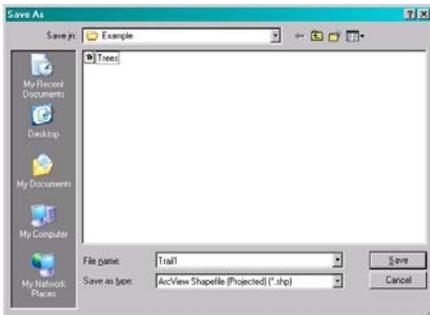
3. In the “DNRGarmin Properties” dialog, go the projection tab and select “NAD\_1983” under Datums and “UTM\_Zone\_10N” under Projections and press “OK”.



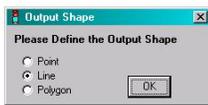
4. Select the track data that will be incorporated into the first shapefile. Our first track is “trail 1”.



5. Under the file menu, select “Save To” then select “File”. In the following dialog, navigate to where you will be storing your shapefiles and type in a name (ex trail1). Next to “save as type”, select ArcView Shapefile (projected) and press “Save”.



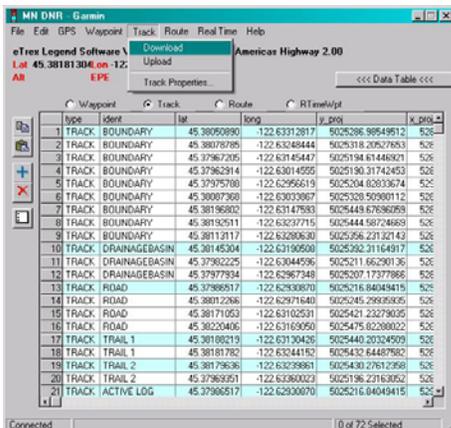
6. Choose the line option in the “Output Shape” dialog and press OK.



7. Repeat steps 4-6 for the three remaining lines.

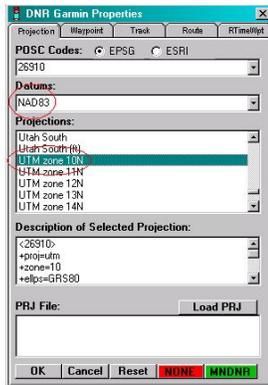
### Download Polygon Tracks:

1. Select “download” under the “tracks” menu. You will see all the data points for the tracks you have collected.

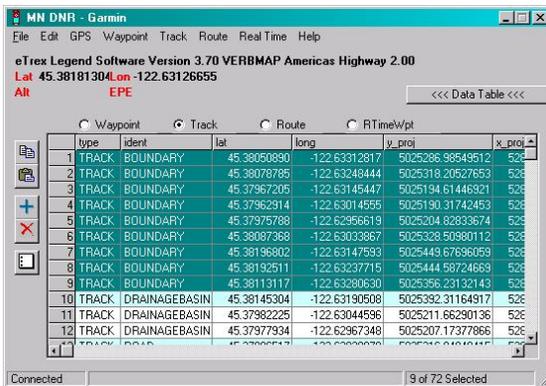


2. Under the file menu select “set projection”. This only needs to be done if you want your data projected into a **projected coordinate system**. Our GPS data was collected in the NAD83 datum. Our base map (overhead picture) is in NAD83 and in the UTM zone 10N projection. We want to project the GPS data into this same projection.

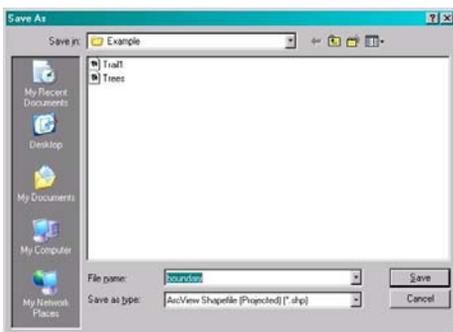
3. In the “DNRGarmin Properties” dialog, go the projection tab and select “NAD\_1983” under Datums and “UTM\_Zone\_10N” under Projections and press “OK”.



4. Select the track data that will be incorporated into the shapefile. Our polygon track is labeled “boundary”.



5. Under the file menu, select “Save To” then select “File”. In the following dialog, navigate to where you will be storing your shapefiles and type in a name (ex boundary). Next to “save as type”, select ArcView Shapefile (projected) and press “Save”.



6. Choose the polygon option in the “Output Shape” dialog and press OK.



Repeat these steps if you have any other polygons that were collected.

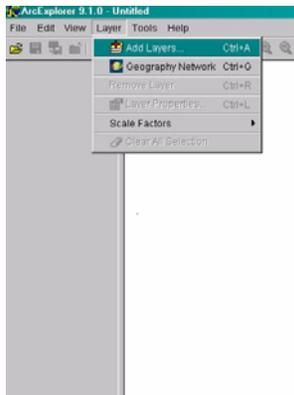
You are now ready to view your data in ArcExplorer.

### **Create a Map in a GIS**

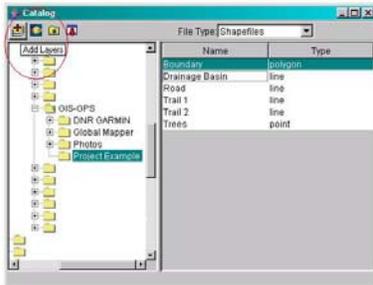
A GIS is a computer based system used to capture, manage, integrate, analyze, and display data referenced to the earth. With the right type of data, a person can visualize anything they want, whenever they want, and have the opportunity to model any multitude of scenarios relating to a particular question. A GIS is based on the concept of **layering**. Each layer is a thematic plane containing geographically and logically related data and each layer can be manipulated and analyzed separately. Our project incorporates 7 separate layers; 1 point shapefile (trees), 4 line shapefiles (trail 1, trail 2, road, drainage basin), 1 polygon shapefile (boundary) and one JPEG (maryyoungphoto).

To display your data:

1. Open ArcExplorer.
2. In the “Layer” menu, select “Add Layers”

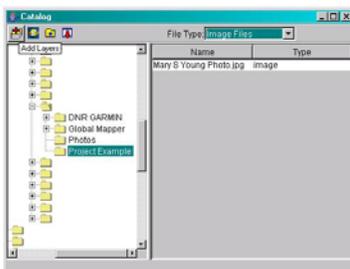


3. Navigate to where you saved your shapefiles. Highlight the shapefiles you would like to add and select “add layers” to add them to the table of contents on the left side of ArcExplorer

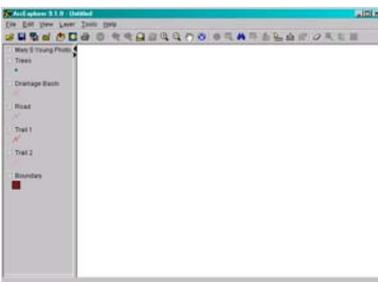


Add all 6 shapefiles.

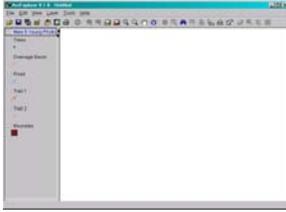
4. In the same menu, change the “file type” to “image file” and navigate to where you saved your overhead picture. (If you don’t see your picture file where you saved it, close out of the catalog and select “add layers” again to refresh the screen. Your image file should now appear.). Highlight the image file (ex Mary S Young Photo.jpg) and select “add layers” to add the image to the table of contents in ArcExplorer.



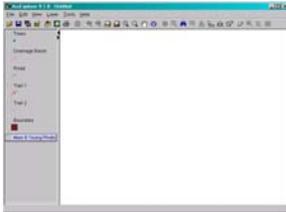
Once all the layers have been added, close out of the catalog screen. ArcExplorer should look similar to this.



5. Click on Mary Young Photo. It will be highlighted with a box around it.

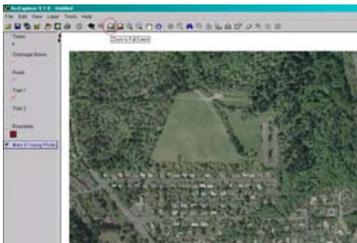


6. Hold the mouse pointer over this layer, click and hold the left mouse button and drag this layer to the bottom of the table of contents.



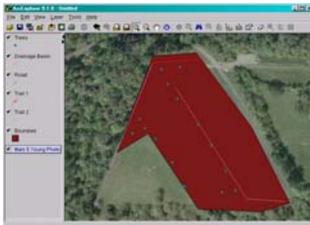
This will make the overhead picture the bottommost layer making it possible to view all the other layers.

7. Click in the box next to Mary Young Photo to turn it on, then, click on “zoom to full extent”.

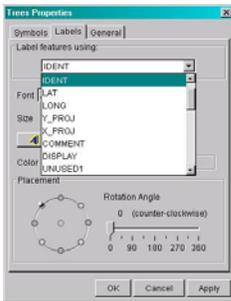


The entire image will be visible in the display.

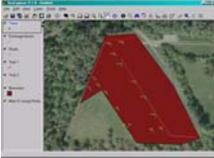
8. Click in the boxes next to the remaining layers to turn them on. To get a better view, click on the magnifying glass icon (zoom in) and draw a bounding box around the restoration area.



9. Highlight “trees” in the table of contents. Right click on trees and select “Layer Properties”. In the Trees Properties dialog click on the “Labels” tab. Under “Label Features Using” select “idnt”. In the “Trees Properties” dialog you can select many different display options for each layer including; font type and size, symbol types and colors, and a variety of different types of effects.



Your map should now display the names for the trees.



Spend some time playing with the layer properties for each layer until you come up with a suitable display. This is what our final map looks like. To save the map, click on “file” then “save as”. Type in a name and save the file with a .axl extension. To open the file in the future, open ArcExplorer first, then open your project.



Reading through the help menu will give you a good idea of the analytical capabilities in ArcExplorer. This is mainly a data viewer and has limited capabilities for data analysis. However, it is possible to measure distances, create buffers around selected objects, and do analysis using the query builder. The attribute table can be used to identify particular trees on the map by their specialized characteristics and can assist when doing follow up investigations at the site.

### **Tips and Advice**

Garmin’s E-Trex Legend is limited to storing no more than 10 tracks and 500 waypoints at a time. Plan accordingly.

Heavy downpours can block the GPS radio signals. Plan ahead.

Employ some type of differential correction to improve accuracy.

When downloading overhead pictures, you must save the world file in the same folder and with the same name as the image.

When viewing data in a GIS, all layers must be in the same datum and projection. If you are using any data that comes from another source, make a note of the projection information so you can convert your GPS data into the proper projection.

There are many free sources of data available over the internet in a shapefile format. Following is a partial list of free data sources;

*Oregon Geospatial Data Clearinghouse*  
(<http://www.oregon.gov/DAS/IRMD/GEO/alphalist.shtml>)

*US Census/TIGER Files* (<http://www.census.gov/geo/www/tiger/>)

*TerraServer* (<http://terraserver.microsoft.com/>)

*US Fish and Wildlife Service* (<http://www.fws.gov/data/gisfgov.html>)

*Columbia River Gorge* (<http://www.fs.fed.us/r6/data-library/gis/columbia-gorge/crgnsa-data-www.html>)

*USGS Seamless Data* (<http://seamless.usgs.gov/>)

*NRCS (Soil layers)* (<http://soildatamart.nrcs.usda.gov/>)

*Geography Network* (<http://www.geographynetwork.com/>)

*ESRI* (<http://www.esri.com/data/index.html>)