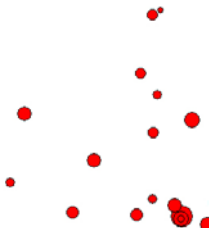
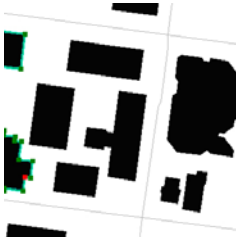
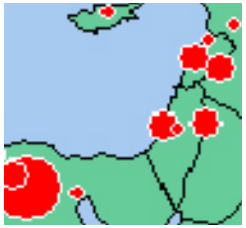
Working With

ArcView 9.2



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Introduction to this Manual

This manual is intended for undergraduate and graduate students learning to use ArcView 9 in a classroom setting. It is meant to be a complement, rather than substitute, for ArcView software manuals, ESRI training products, or the ArcView help options. It reflects the order and emphasis of topics that I have found most helpful while teaching introductory GIS classes. I expect that it will be particularly helpful to people new to GIS who may be intimidated by conventional software manuals. It may also be helpful as a resource to those who have completed a course in ArcView but don't always remember how to perform particular tasks. This manual does not try to be comprehensive, focusing instead on the basic tools and functions that users new to GIS should know how to use. Those who master these basic functions should have the skills to learn about additional tools, using the ArcView help menus, or just exploring additional menu options, toolbards, and buttons.

Each section in the manual introduces a general group of functions in ArcView, providing step by step instructions for using a set of tools with screen captures and a video showing those steps through screen captures.

One of the most difficult parts of learning how to use GIS is matching what you know you want to do in layman's or conceptual terms to the specific tool and technical language of ArcGIS. The table of contents provides an overview of the tools and functions covered, but you may find it just as helpful to use Adobe Acrobat's "find" function.

The other challenge is trouble-shooting. ArcGIS products include an enormous range of functionality which allows it to meet the needs of a wide range of users. But this wide range also results in what can be an overwhelming and sometimes temperamental product. Figuring out why things don't work is key to getting ArcGIS to do what you want it to do and minimizing your frustration. The section on trouble-shooting at the end of this manual is intended to help identify common problems and solutions.

This manual is intended to be shared. You do not need my permission to share this with a friend or even post it on a course website. Because I am continually updating it, I always appreciate feedback, whether you found a typo or spelling mistake or want to suggest a better way of explaining particular concepts and techniques. The best way to succeed with GIS is to make learning how to use it a collective process, so please join me in making GIS work for us.

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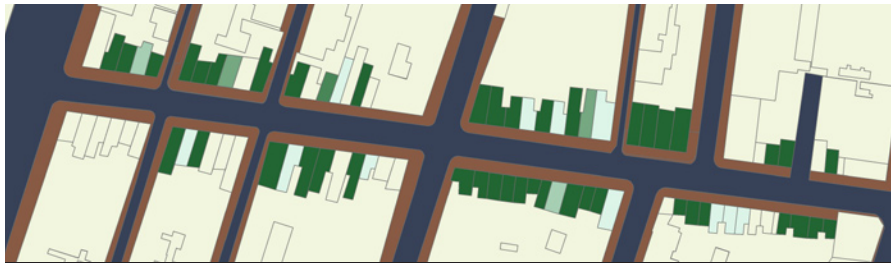
1 | Introduction to ArcGIS

ArcGIS is a collection of software products created by Environmental Systems Research Institute (ESRI) that includes desktop, server, mobile, hosted, and online GIS products. This introduction provides an overview of all of the products, but this manual focuses on the desktop applications, only.



Map made by Shimrit Keddem

Desktop GIS Products

The desktop GIS products allow users to integrate and edit data, create new map layers, and author maps. ArcGIS desktop includes a series of scaleable products. They are all based on the same architecture, but the more expensive products have more functionality. A matrix describing what functionality is available for each product is available at http://www.esri.com/library/brochures/pdfs/arcgis92-functionality-matrix.pdf.

ArcView

ArcView is the desktop version of ArcGIS meant for a general (non-professional) audience. It is the most popular desktop GIS software program, but it is not the only one. Even though it is the "baby" desktop GIS product within the ESRI family of products, it is still over-kill for many simple GIS projects. Some people will call this "ArcGIS" rather than "ArcView." They are one in the same; ArcView is part of the ArcGIS collection, so it is a more specific way to describe the software.

With the jump from ArcView 3.2 to ArcView 8, ESRI brought ArcView into its ArcGIS system so that it uses the same structure as its more sophisticated GIS products. ArcView 3.x has similar functionality to ArcView 8, but the products work in very different ways. That means that if you learned GIS using ArcView 3.x, you will probably need to do some work to be able to use ArcView 9. ArcView 9 adds some functionality to ArcView 8, but the two versions work in a very similar way, so if you learned how to use ArcView 8, you should have no trouble switching to ArcView 9.

ArcEditor

ArcEditor includes all the functionality of ArcView, adding the ability to edit features in a multiuser geodatabase so that multiuser editing and versioning are possible. ArcEditor also adds the ability to edit topologically integrated features in a geodatabase.

ArcInfo

ArcInfo is ESRI's professional GIS software. It includes all of the functionality in ArcView and ArcEditor, adding some advanced geoprocessing and data conversion capabilities.

ArcReader

ArcReader is a free product for viewing maps. You can explore and query map layers, but you cannot change symbology or create new data like you can in ArcView. ArcReader is a good way to share the maps you created in ArcView with people who don't have access to the software.

Extensions for ArcGIS Desktop

While the basic ArcGIS desktop products include an enormous amount of functionality, extensions can also be purchased (some are free) that extend this functionality. Many of these are specific to particular industries or data formats. The following are some of the more frequently used extensions.

Spatial Analyst

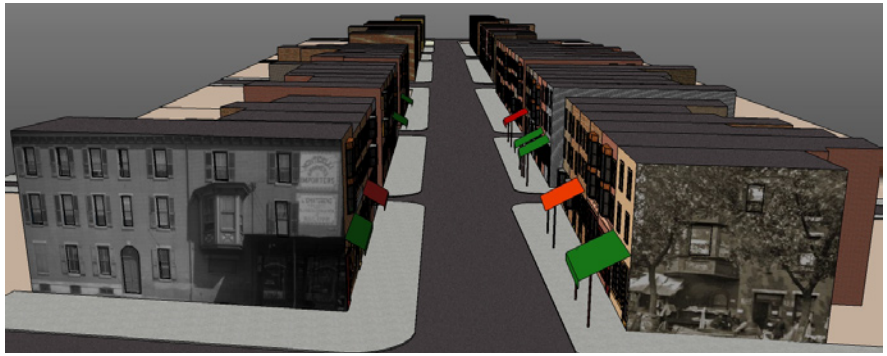
Allows for modeling and analysis with raster (cell-based) data. This includes creating density surfaces and conducting map algebra.

3D Analyst

Includes ArcGlobe. Allows users to view visualize and analyze spatial data in 3D. This includes extruding polygons (such as parcels and building footprints) and draping surfaces (such as orthophotos) on elevation models. You can also create video animations that simulate flying through your study area.

Geostatistical Analyst

This sophisticated tool allows users to analyze raster (cell-based) and point data using advanced statistical methods. Methods include Kriging and inverse distance-weighting.



Model made by Shimrit Keddem

Network Analyst

Allows for network-based analysis such as routing, determining closest facility, and service areas. Unlike simple representations of street networks that can be manipulated without this extension, networks can store information about traffic flow, one-way streets, and travel time.

Tracking Analyst

Makes it possible to animate point data representing events at discrete times and places. You can view events happing across time and space using the "playback" feature.

Streetmap

Makes possible geocoding of street addresses for the entire U.S. When using ArcGIS without Streetmap, street addresses generally need to be mapped one county at a time.

Business Analyst

Designed to support business decisions through a series of advanced tools and extensive collection of industry data.

CommunityViz

Designed for visualizing and analyzing land-use decisions. This product is distributed by Placeways rather than ESRI.

Scripts for ArcGIS Desktop

Extensions are simply bundles of scripts that are added together to ArcGIS. Individual scripts can also be added without purchasing whole extensions. These are generally written in Visual Basic, Python, or Avenue (the old programming language for ESRI) by users or ESRI staff members. A large collection are available for free at http://arcscripts.esri.com/.

Server GIS Products

Desktop GIS is ideal for individual use (appropriate for classroom learning and small-scale research projects), but distributing GIS data, maps, and tools requires server GIS products. This is critical in a work setting as well as when you wish to serve maps on the internet, which is increasingly common.

ArcGIS Server

Used for data management, visualization, and spatial analysis in an "enterprise" (large-scale user) setting.

ArcGIS Explorer

Lightweight product that comes with ArcGIS Server; provides access to GIS content; supports 2D and 3D maps and geoprocessing. This is ESRI's version of Google Earth.

ArcGIS Image Server

Needed for managing, processing, and distributing image data in a server environment.

ArcIMS

Used to create applications that deliver maps and data via the Internet.

Mobile GIS Products

These are useful for collecting data in the field. ArcPad includes many of the same functions as ArcGIS destop products and can be installed on a pocket-PC. The size of the hardware and the display screen limits how much functionality can be included. ArcPad must be customized through programming. ArcGIS products can also be used with global positioning systems (GPS), which allow users to identify the longitude and latitude coordinates of particular locations in the field.

Other GIS Products

ESRI is the leading GIS software maker, sort of the Microsoft of GIS. Many colleges and universities have site licenses for ESRI products, so GIS classes often use ESRI products. Other GIS products worth exploring include:

MapInfo

This family of products sold by CMC International can do much of what ESRI products can do. MapInfo is much simpler than ArcView for working with demographic data.

GRASS GIS

Geographic Resources Analysis Support System (GRASS) is free GIS software that is increasingly popular among proponents of open-source software.

Microstation

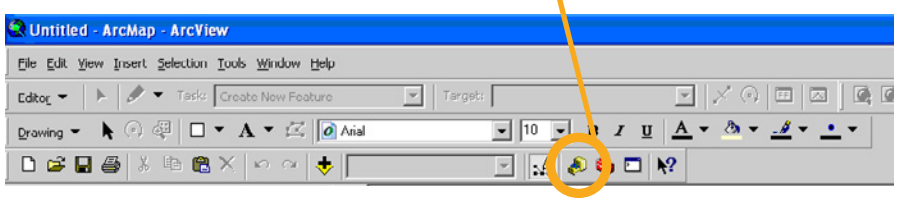
This is Bentley's engineering design platform that incorporates GIS functionality through a number of different products.

Introduction to ArcCatalog

ArcCatalog is designed to help you manage your spatial and non-spatial data. Using ArcCatalog may seem awkward, particularly to people who are familiar with ArcView 3.x., but using ArcCatalog will help you to develop good GIS habits, so it's worth the effort. ArcCatalog is an ideal place to first view your spatial data and supporting documentation.

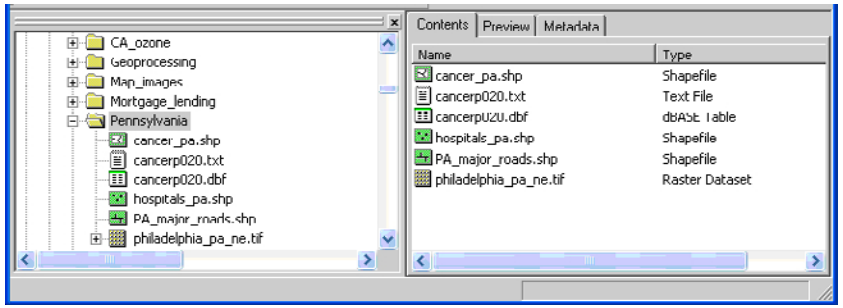
Launching ArcCatalog

ArcCatalog is a separate executable (.exe) file from ArcMap. You can launch ArcCatalog from the Start Menu (go to All Programs, ArcGIS, then ArcCatalog) or from ArcView. If ArcView is open, click on the ArcCatalog button (looks like a file cabinet) from the Standard toolbar.



Recognizing File Types

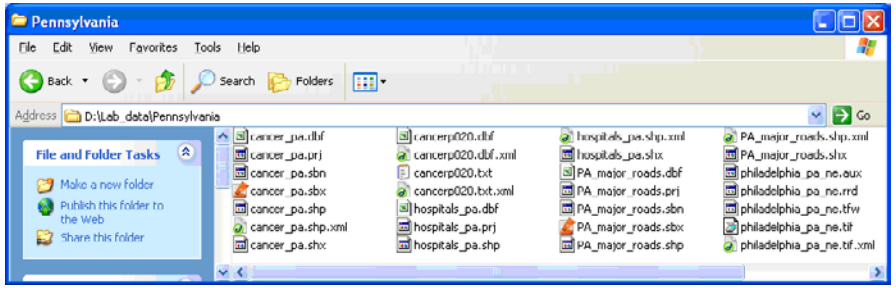
ArcCatalog will recognize files that are ready to be mapped using special icons. Vector data are represented with icons that show whether they are made up of points, lines, or polygons. In the screen capture to the right, the files in the "Pennsylvania" folder named "*cancer_pa.shp*," "*hospitals_pa.shp*" and "*PA_major_roads.shp*" are all shapefiles, a format of vector data specific to ESRI (but often use-able in other GIS software). The "*cancer_pa.shp*" layer icon indicates that it is made up of polygons, which happen to be all the counties in Pennsylvania. The icon for "*hospitals_pa.shp*" shows that it is made up of points, corresponding to the location of all the hospitals in Pennsylvania. The icon for "*PA_major_roads.shp*" shows that it is represented by lines, corresponding to each section of the state and federal highways in Pennsylvania.



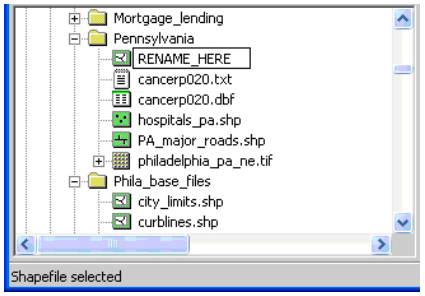
The file named "*philadelphia_pa_ne.tif*" has a different sort of icon that indicates that it is raster data, made up of a regular grid of cells. This is an aerial photograph where each cell, or pixel, corresponds to 1 meter on the ground. The income for the file named "*cancer;020.dbf*" indicates that it is a table, in this case a dBase file. The file named "*cancerp020.txt*" icon shows that it is a text file. ArcView 9.1 and previous versions are capable of reading tables formatted as .dbf or comma-delimited text. In this case, the text file is a description of the map layer, "*cancer_pa.shp*" so it cannot be viewed by ArcView. Starting with version 9.2, ArcView can also read Excel (.xls) files.

Launching ArcCatalog

Shapefiles, the dominant format for vector data in ArcView, are made up of three or more separate files. Each of these will have the same name but a different extension. If you viewed them outside of ArcCatalog (in My Computer, for example), you would see all of the files listed with extensions such as .dbf, .shp, .shx.

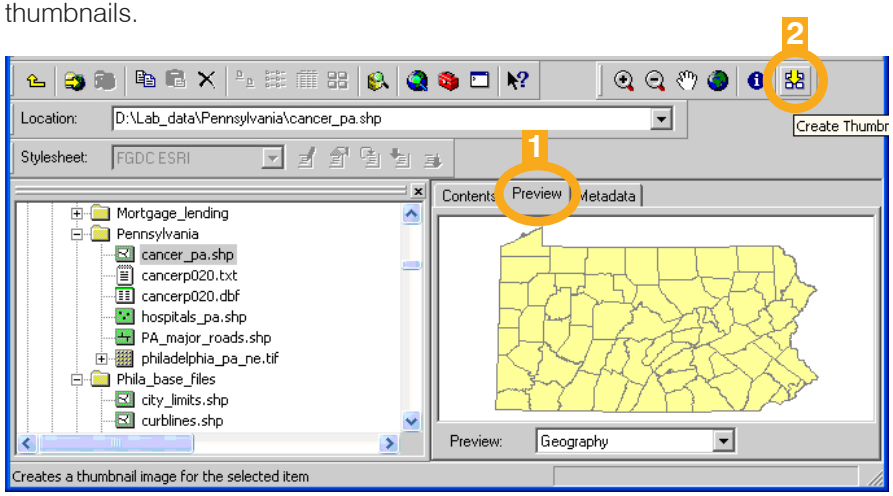


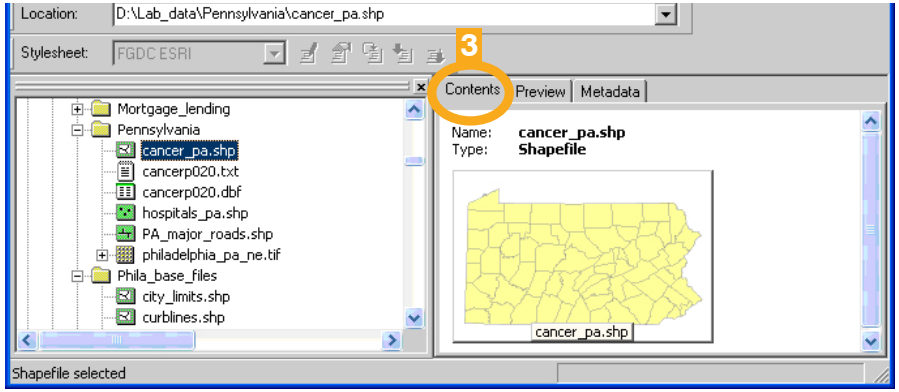
In ArcCatalog these various files will appear as a single shapefile. In other words, ArcCatalog allows you to view your data as ArcGIS sees it. This makes ArcCatalog an ideal place for copying, pasting, or renaming shapefiles. If you try to do any of these procedures using My Computer, you will have to copy, paste, or rename all of the pieces that make up the shapefile. If you fail to copy, paste, or rename even one, ArcGIS will no longer recognize it as a single map layer. The icon for the incomplete layer may have a question mark, indicating that the layer no longer has integrity.



Creating Thumbnails

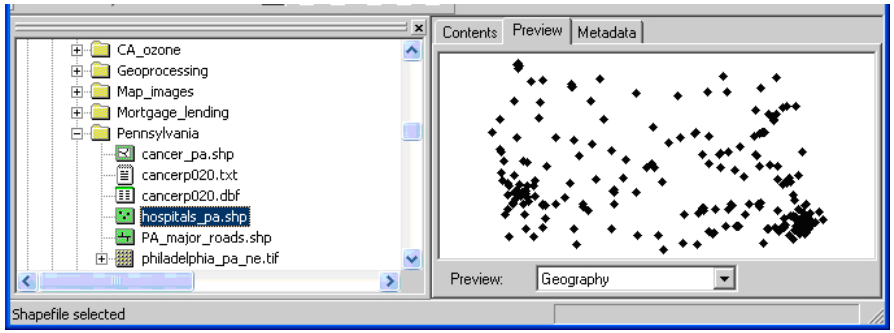
For some files, including maps and layers created in ArcMap, ArcCatalog will display a thumbnail image of your data when the "contents" tab is active. To create thumbnails for shapefiles and images (you cannot create thumbnails for tables), click the "preview" tab, highlight the shapefile name, and click on the "Create Thumbnail" button. Click on the "contents" tab in order to view thumbnails.



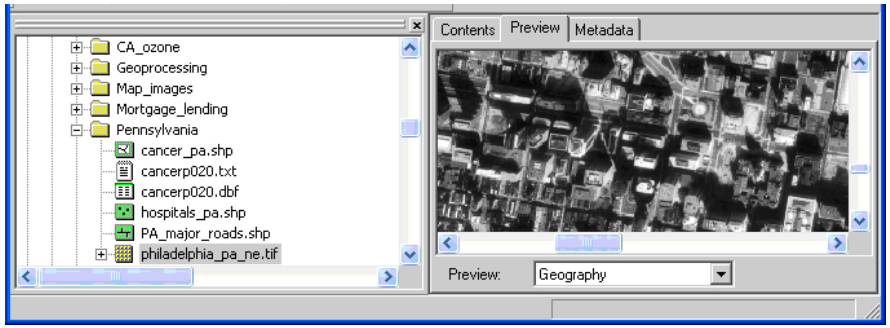


Previewing Files

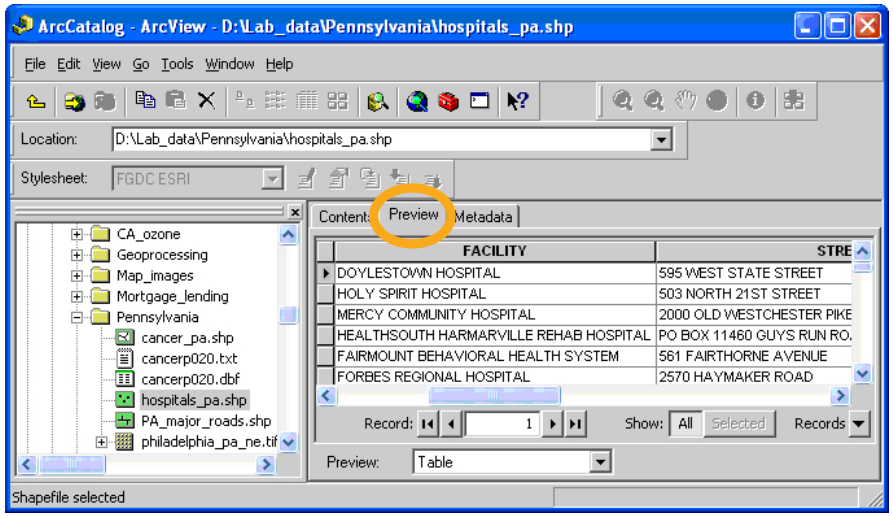
By making the "preview" tab active, you can look more carefully at files. When the preview drop-down menu at the bottom of the window on the right is set to "geography," you can see how your data looks as a map. You will only be able to see the basic points, lines, or polygon outlines—you cannot make thematic maps showing different data values across your map—but this preview feature allows you to look quickly at your data. You can zoom in and out and identify the basic attributes of the features in your map (these tools will be described in detail in the next section, on ArcMap).



You can also view images here (ArcCatalog may ask you if you want to build pyramids in order to display these more quickly, which is probably a good idea).

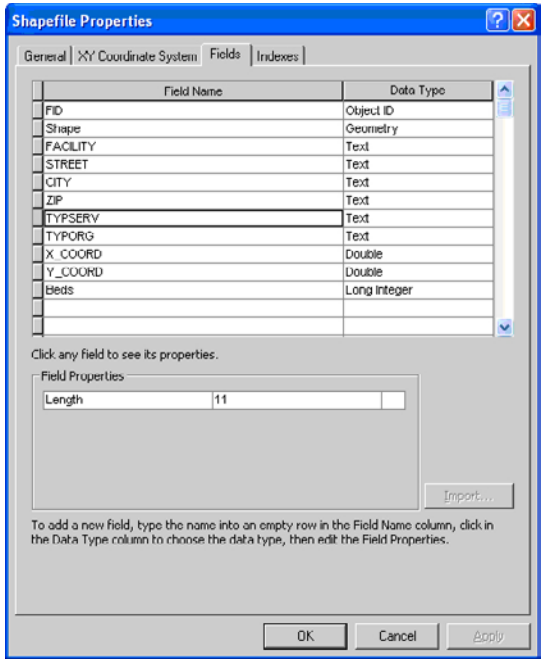


Switch the preview drop-down to "table" in order to view the attributes associated with your geographic features. Click on the "options" button to add a new field or export the table. Right clicking on a column heading allows you to access a number of other functions such as sort, freeze/unfreeze column, delete field, and statistics (the statistics option is only available for numeric fields). You can also access these functions in ArcMap.



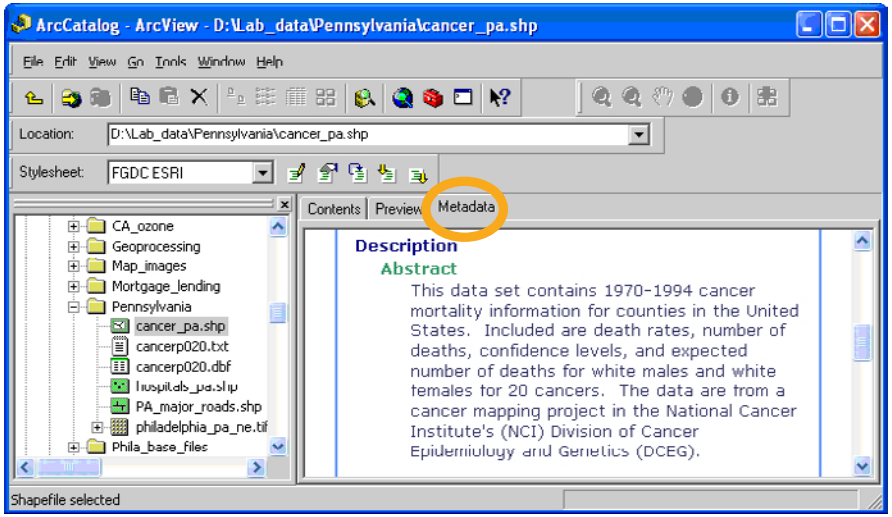
Checking Properties

Double click on the file name to bring up the shapefile or table properties (or by highlighting the file name and choosing "properties" from the File menu). With the fields tab active, you can identify the data format for each of the columns in your table. These different data formats are described in detail in the section entitled "Calculating New Values," but generally speaking, the way values are formatted in your table will dictate what kinds of functions and representations are possible. When you click on a column name, the length of the field will appear below. From the XY Coordinate System tab, you can see what datum and projection have been defined (if any). From the Indexes tab, you can create attribute or spatial indexes in order to increase the speed of searching, querying, and drawing data.



Viewing and Updating Metadata

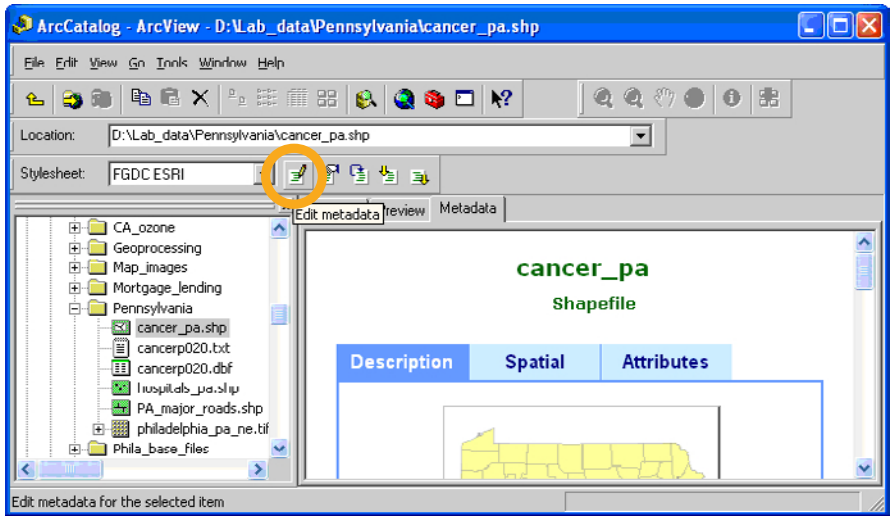
ArcCatalog also allows you to update and store metadata. Metadata are essentially data about your data, or the documentation. This includes information about who created the data, how they created it and for what purpose, and whether there are restrictions on its use. Not all data you acquire will come with metadata, but it is important to get in the habit of checking and updating metadata. Click on the "metadata" to view available information.

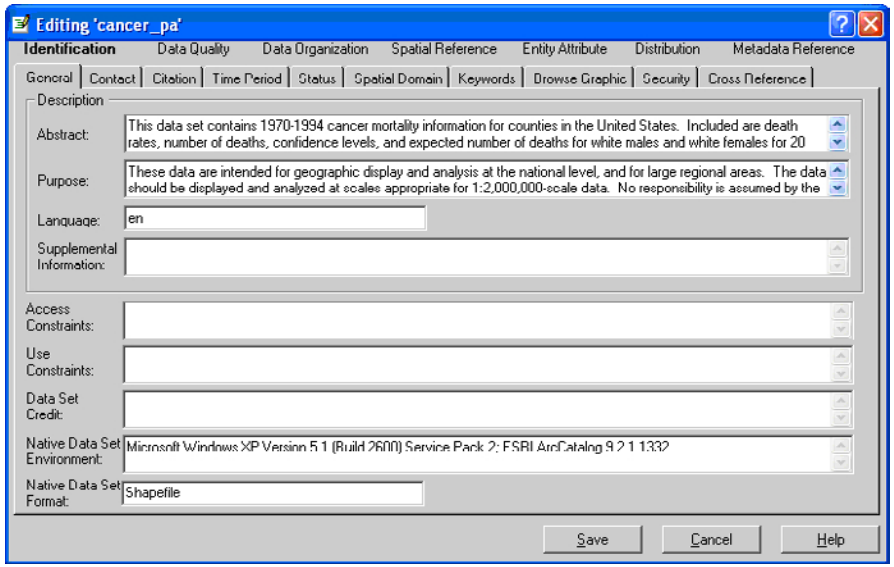


ArcCatalog offers several different stylesheets that define the types of information that can be included in the metadata documentation. The default is ESRI's stylesheet, but you can change this from the stylesheet dropdown menu.

The buttons to the right of this dropdown menu allow you to (in order) edit metadata, view metadata properties, create/update metadata, import, and export metadata. Click on the "edit metadata" button in order to add or edit

your metadata. You will probably not be able to fill in all of the requested ("required") fields, but fill in as much as you can. Most important are a description of the data (including the date, spatial extent, and geographic level), limits on access (who can use the data?), contact information (when and from whom did you acquire the data?), data values (is there a data dictionary that explains the meaning of values?), and data quality (are there known problems?).





Other ArcCatalog Functions

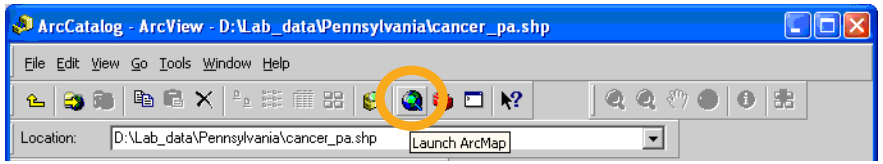
These are the basic functions in ArcCatalog—organizing and previewing data and working with metadata. ArcCatalog also has extensive search capabilities, making it possible to locate files based on name, location on your computer, geographic location, and date. You can create new shapefiles in ArcCatalog. This will be described in the section "Creating New Shapefiles."

Introduction to ArcMap

ArcMap is where you create maps and access most of the ArcGIS functionality. You can add and edit data, query and symbolize map layers, and create map layouts for printing.

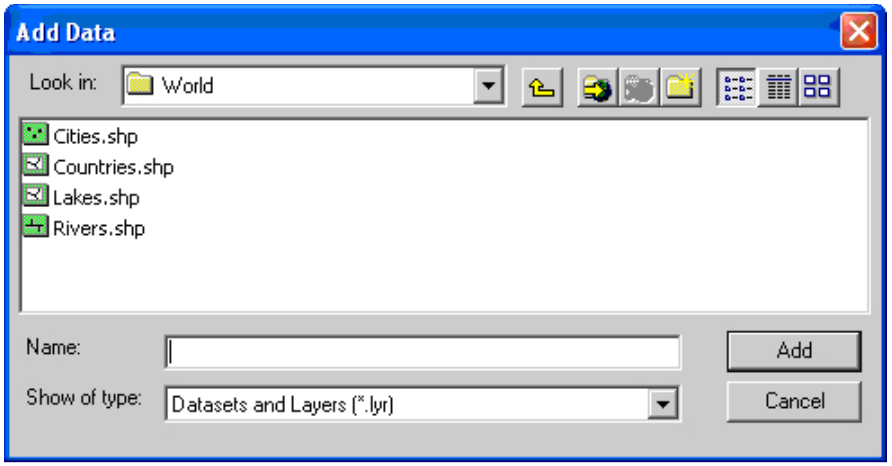
Starting ArcMap

You can launch ArcMap in several ways. If you are in ArcCatalog, click on the "Launch ArcMap" button. Alternatively, go to the start menu, then ArcGIS, then ArcMap. You might also consider creating a desktop icon for ArcMap if you plan to use it regularly. When ArcMap opens, you will be asked if you want to open an empty map, use a template, or open an existing map. You can prevent this dialog from displaying again by putting a check mark in the "do not show this dialog again" box. Otherwise, choose "open an empty map."

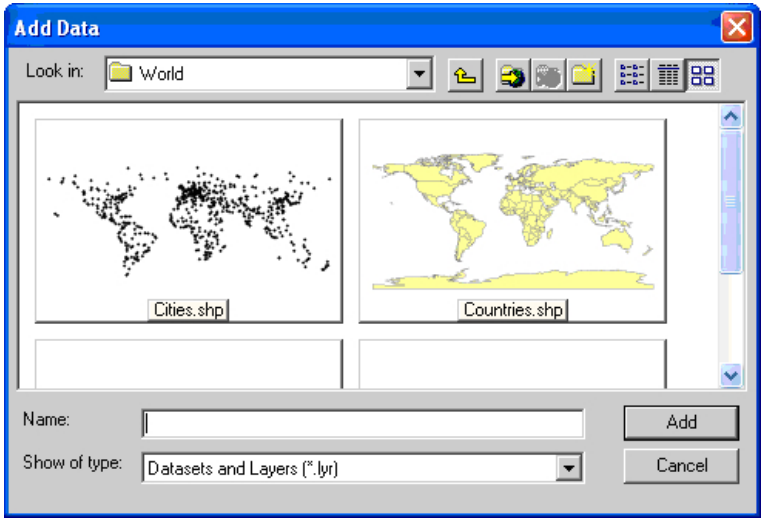


Adding Data

Unless you open an ArcView .mxd file that someone else created, you will need to add data to get started. From the file menu, go to "Add data" or click on the "Add data" button (yellow square with large black + sign) on the Standard toolbar. Navigate to the folder where you have your map layers. The default view will use the same icons that appear in ArcCatalog to represent your layers.

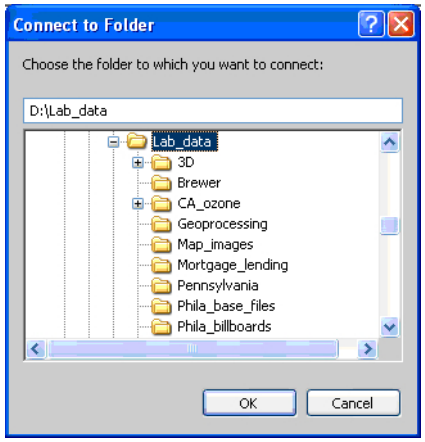


If you created thumbnails for your map layers in ArcCatalog, you can also click on the "Thumbnails" button on the far right to see the thumbnail image of each map layer. Highlight the layers you want (hold the control key down to select multiple layers), then click "Add."



Connecting to Folder

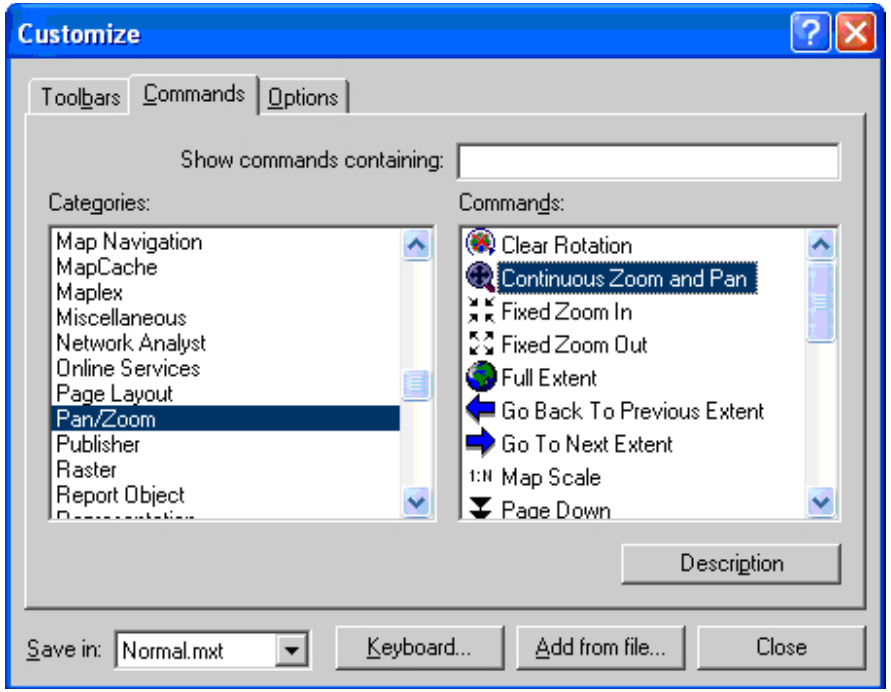
When you open ArcCatalog, a list of all the folders and sub-folders on your computer will be displayed on the left in the catalog tree. “Connect to folder” allows you to make a direct connection to the place on your computer where your GIS data are stored. From the file menu, go to “Connect Folder…” or click on the “Connect to Folder” button (yellow arrow against a globe). Navigate until you find the folder with your data and click “OK.” Your folder should now be listed under “Catalog” next to a icon. One note of caution: You do not need to do this repeatedly. Once you have established a connection to your folder, you will not need to do it again unless you change computers. If you create a new connection to the folder each time you use ArcGIS, your path options will become unmanageable.



You can delete paths using the “Disconnect from folder” button (globe with yellow X).

Customizing the Interface

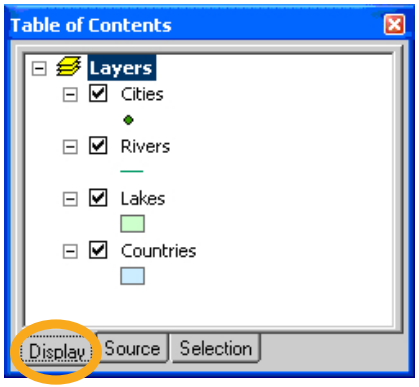
ArcMap is made up of many different windows and (dock-able) toolbars that you can resize and move around, so don’t be surprised if ArcMap looks slightly different each time you open it. The window on the left that lists your map layers is the table of contents; the window on the right that shows your map is the map display. You can close the table of contents by clicking on the “x.” To bring your table of contents back, go to the Window menu, then Table of Contents. Resize it by holding your cursor over the right edge until your cursor changes to a two-headed arrow, then left-click and drag the edge to resize this window. To move one of your toolbars, left click on the end (top or left), hold down, and move to a new location.

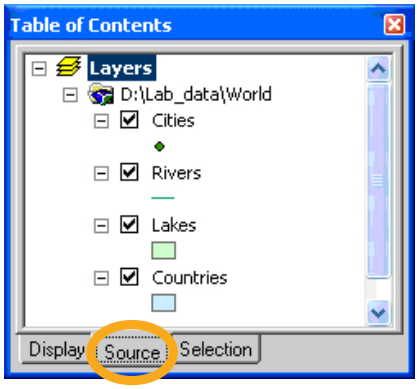


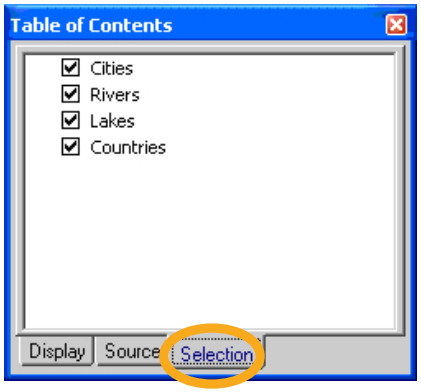
You can move a toolbar by double-clicking on it to the left of the buttons (where there is a sort of handle at the edge). You can “dock” it by moving it over any of the gray areas on the screen. To add or remove a toolbar, go to the View menu, then “toolbars” or double-click on an empty gray part of the screen. Anything with a check mark next to it will be displayed. You can add new buttons to existing toolbars from the “customize” option. Click on the “commands” button to see your options. One especially helpful button allows you to zoom continuously. Scroll down to the category on the left called “pan/zoom,” then left click on the “Continuous Pan and Zoom” button on the right and drag it to your tools toolbar (the toolbar with the outline of a hand and an image of a globe in the middle) and release (see image on previous page). You can also add new buttons and tools by importing scripts. That process is explained in a later section called “Working with scripts.”

Working with the Table of Contents

The table of contents has three tabs (at the bottom): display, source, and selection. When the display tab is active, the table of contents will only list data that can be drawn as a map layer, so you will not see your tables listed. When the source tab is active, the table of contents shows the path indicating where the data—including tables—are stored. The selection tab allows you to choose which layers you want to be “selectable.” Most of the time, you will want the “display” tab to be active. Turn on and off a layer by checking and un-checking the box next to it. Layers are drawn in the map display in the order in which they are shown in the table of contents. Map layers listed at the top will draw on top. To move a layer, left click and hold the mouse button down, then move the layer. You can only re-order layers from the display tab.







Navigating a Map

There are several tools available for zooming in and out of your map.

The **continuous zoom tool** gives you the greatest amount of control, but you have to add this by customizing your toolbar (see “Customizing the Interface” above). Click on the continuous zoom tool, then left click on your map, hold down the mouse button, and move your mouse away from you to zoom in and toward you to zoom out. If you right click and hold down, this becomes a tool for panning (moving map around without changing the extent).

Using the **non-continuous zoom tools**, you can click on your map to zoom in or out at a fixed amount or to draw a box around the area that you want to see in more or less detail. The new map will be drawn so that the area you drew the box around is in the middle of the map display.

The **fixed zoom in/fixed zoom out** tools give you the least control but also may keep you from zooming in or out too much and losing your map. Each time you click, you will zoom in or out a fixed amount.

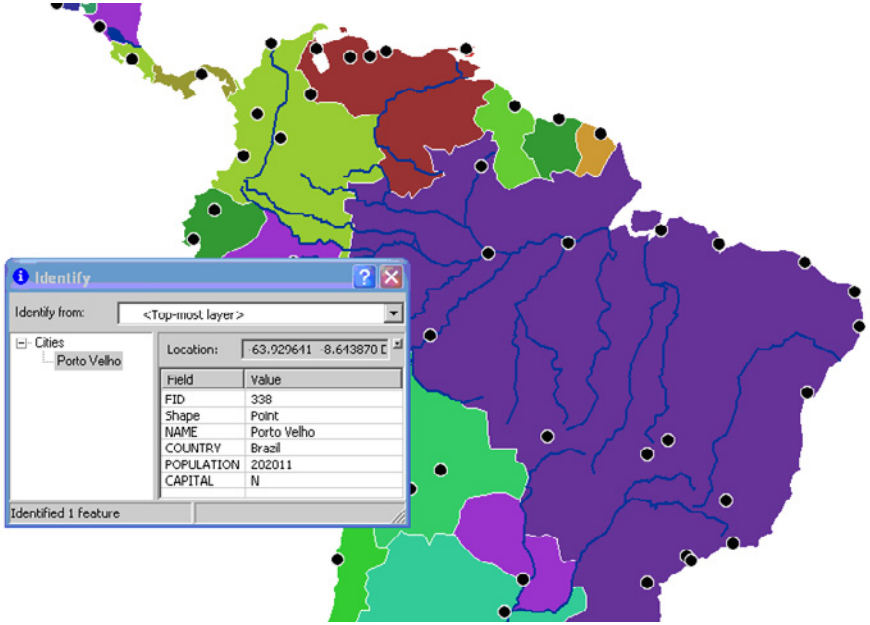
The **pan tool** works like the continuous zoom tool when you right click on it. Think of the pan tool as a sticky hand you set down on a piece of paper. You use it to move your map up, down, left or right without changing the extent (the degree to which you are zoomed in or out).

The **full extent button** will zoom in or out so that all of your active (checked) map layers can be viewed. This is very helpful when you zoom in or out too much and can’t see your map layers. You can also zoom in to a single layer by right clicking on the layer in the table of contents and choosing “zoom to layer.”

The **previous extent buttons** allow you to return to the extent you had before zooming in or out. The next extent button allows you to jump forward an extent (after you have used the previous extent button).

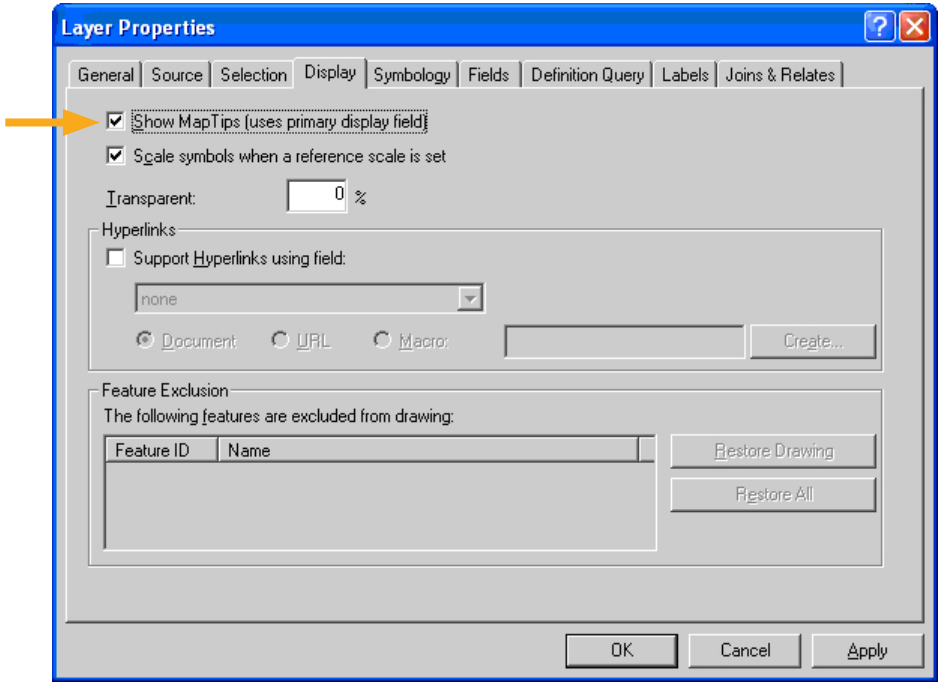
Identifying Attributes of Features

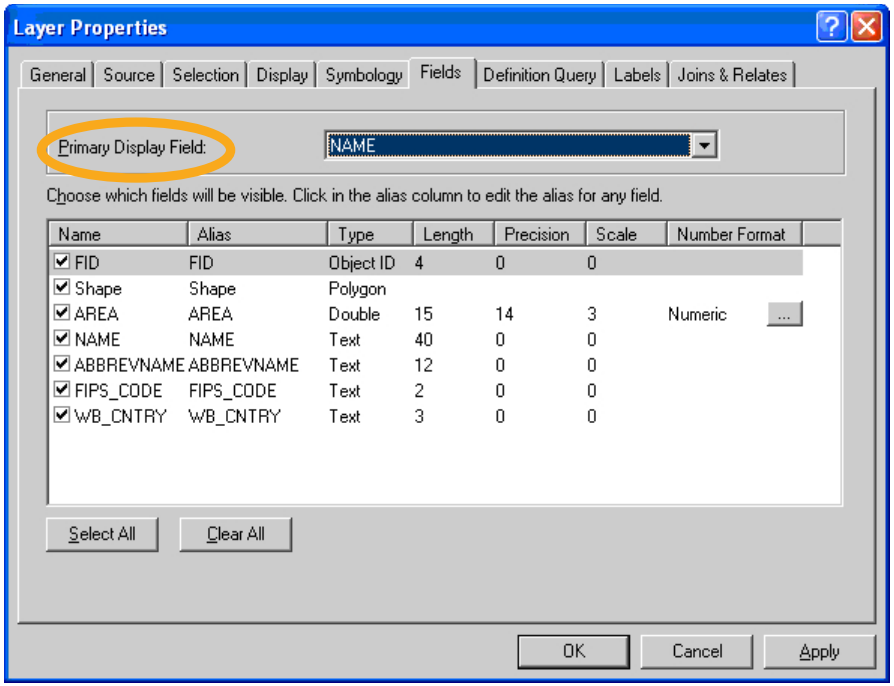
The points, lines, and polygons that make up vector map layers are all map features that have attributes stored in a table. This is part of what makes GIS unique, that it can connect attributes of a location to that location. You can access this information in several different ways. Using the identify ("i") tool, click on a map feature in the map display. An "identify results" box will display all of the information known about that feature. Notice the layers dropdown menu. The default in ArcMap is to display information only about the top-most layer. You can change this using the dropdown menu at the top of the identify pop-up box.

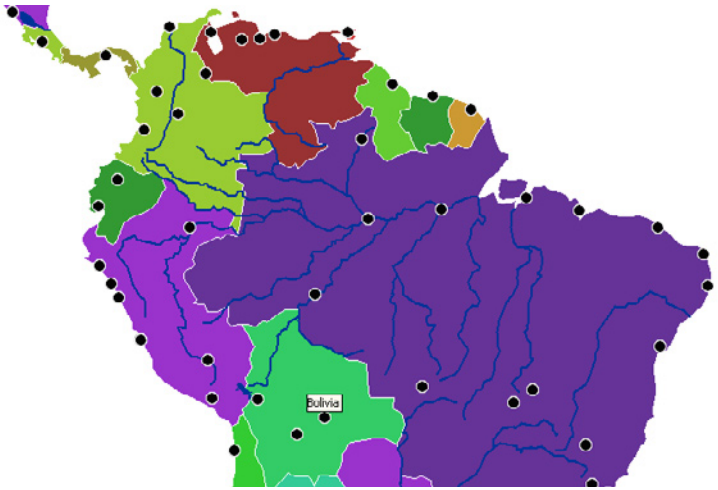


Showing Map Tips

Map tips are small text boxes that appear when you hold the cursor over a map feature. You can only see one attribute at a time (unlike the identify tool, which allows you to see all the attributes know for that map feature), but using map tips is much simpler and allows you to get a quick idea of the attributes. To turn on map tips, double click on your shapefile name in the table of contents and, from the Layer Properties, make the Display tab active. Put a check mark in the "Display Map Tips" box. To change the primary data field, make the Fields tab active and choose a field from the "primary display field" dropdown menu.

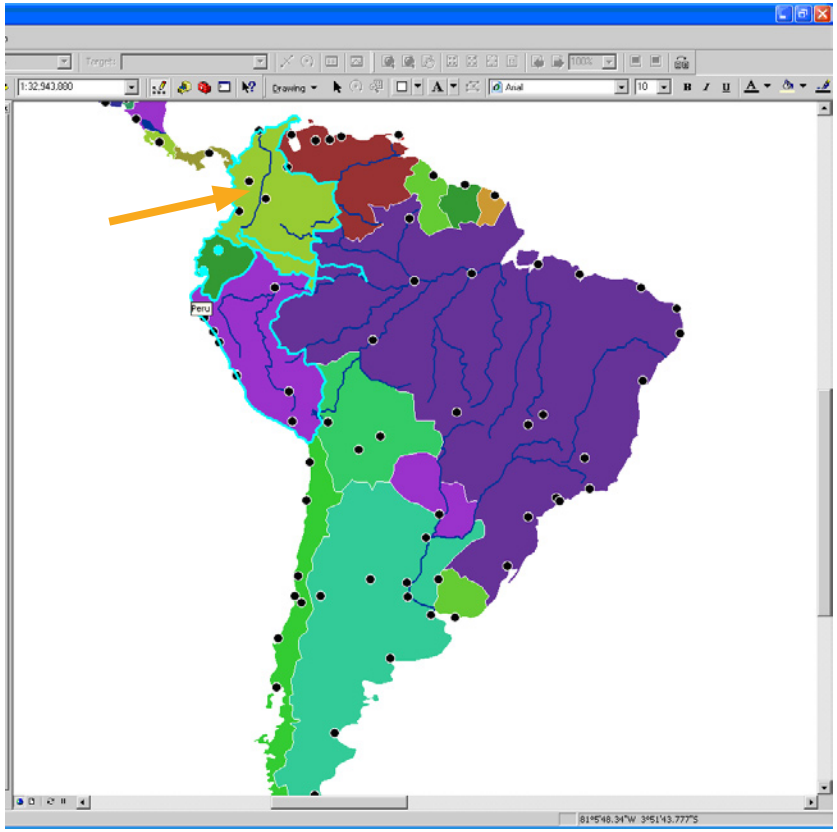


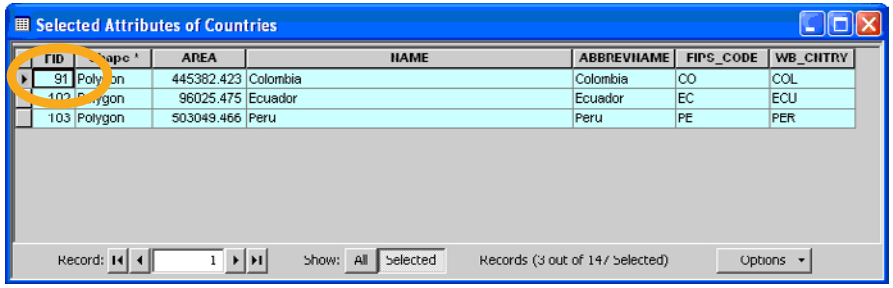




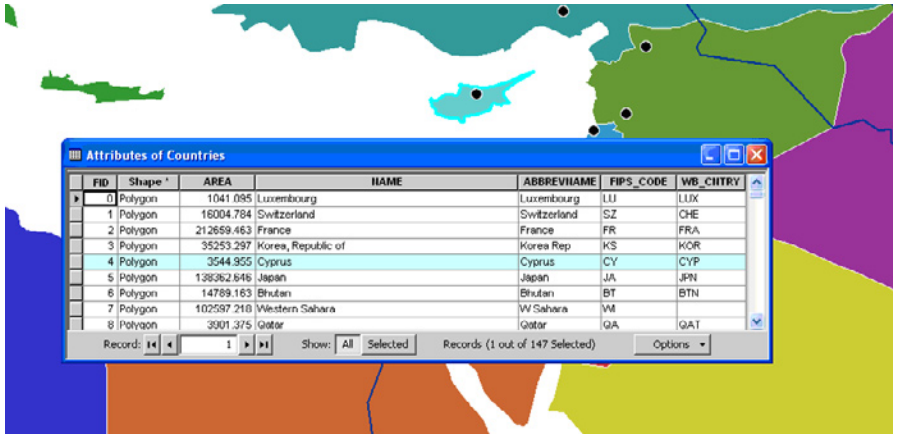
Selecting Features

You can also use the select features tool to identify attributes, either by clicking on a particular map feature or by drawing a box around the feature(s) of interest. The selected features should become highlighted with a blue outline. Right click on the map layer that contains the feature(s) that you wish to investigate and go to “open attribute table.” This table includes all the attributes of all the features in that layer. In order to view just the selected feature(s), click on the “selected” button at the bottom of the table.

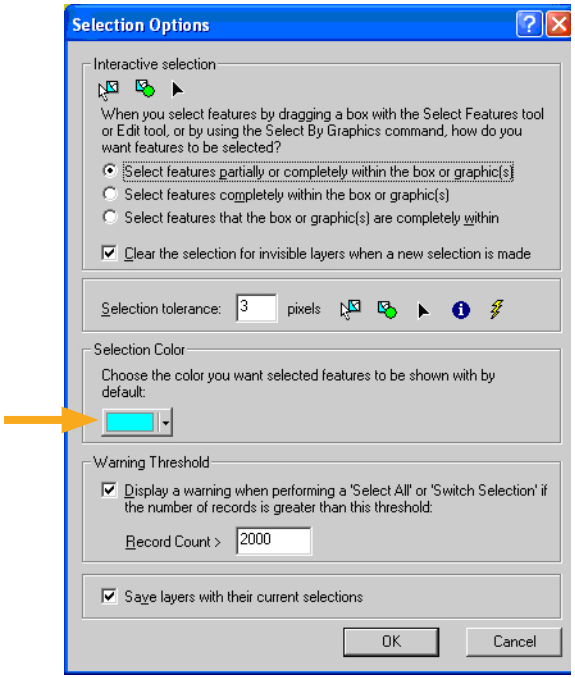


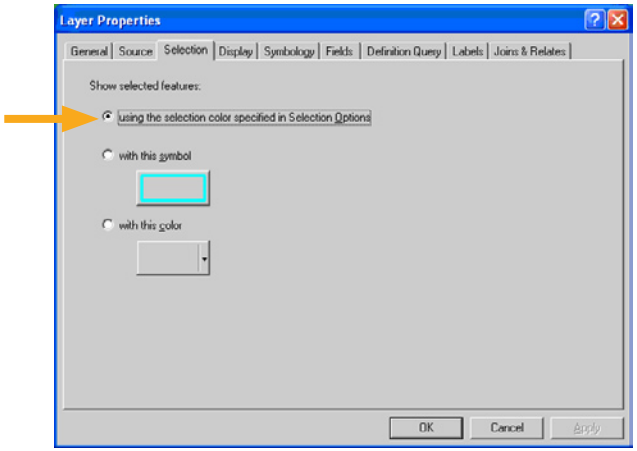


You can also highlight a feature on the map by clicking on a row in the table. This way, you can find a specific place (such as Cyprus) on your map. The “section” tab in the table of contents allows you to identify the layers you wish to select. By default, all layers will be selectable.



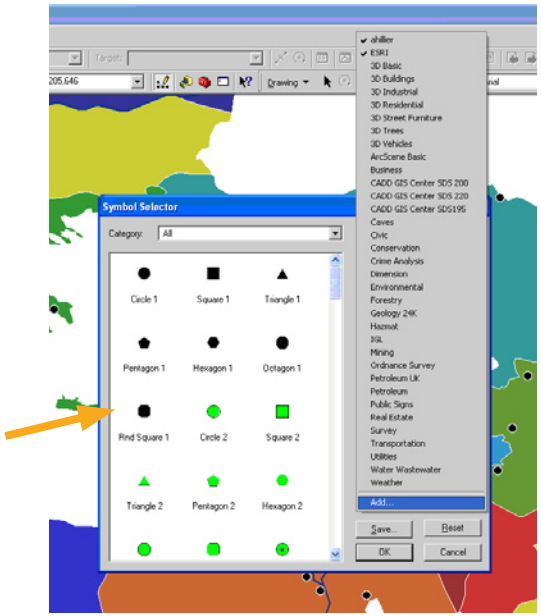
You can change the selection color from “options…” in the Selection menu. It is also possible to use different selection colors for each layer. Double click on a map layer, or right click and go to “properties.” Choose the selection tab and then select the last radio button, “Show selected features with this color.” This will only change the selection color for this map layer.


Selection Options
Interactive selection
When you select features by dragging a box with the Select Features tool or Edit tool, or by using the Select By Graphics command, how do you want features to be selected?
Select features partially or completely within the box or graphic(s)
Select features completely within the box or graphic(s)
Select features that the box or graphic(s) are completely within
Clear the selection for invisible layers when a new selection is made
Selection tolerance:
3
pixels
Selection Color
Choose the color you want selected features to be shown with by default:
Warning Threshold
Display a warning when performing a 'Select All' or 'Switch Selection' if the number of records is greater than this threshold:
Record Count >
2000
Save layers with their current selections
OK
Cancel

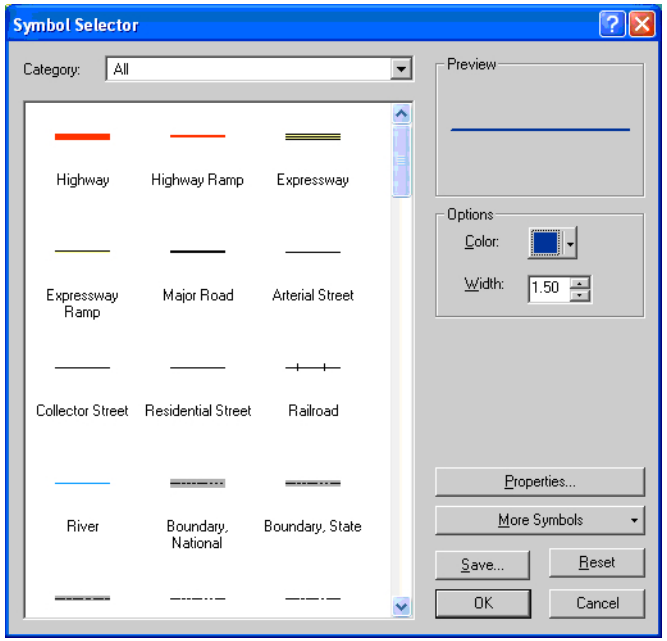

Layer Properties
General
Source
Selection
Display
Symbology
Fields
Definition Query
Labels
Joins & Relates
Show selected features:
using the selection color specified in Selection Options
with this symbol
with this color
OK
Cancel
Apply

Changing Map Symbols

ArcMap has many options for changing the way your data are displayed. Some of the simplest options involve the choice of color, fill pattern, and shape (for point data). To make changes, click on the map symbol in the table of contents. The symbol selector window that opens will look different depending upon the type of layer: point, line, or polygon. For points, you can choose a different marker from the default (which is a circle with a black outline). When you choose a new marker, the default size jumps from 4 point (quite small) to 18 point (quite large). You can find many more symbols by clicking on "more symbols." You can change the color, size, and angle using the options on the right of the window. The "reset" button will undo any changes you have made to the symbol since opening the symbol selector window.



For lines, you can choose from a variety of patterns, thicknesses, and colors. There are industry standards for things like highways, expressways, and railroads.



For polygons, you have choices about the fill pattern, fill color, and outline color. The properties button will give you additional options (and often too many options) but may be helpful in fine-tuning the crosshatch and ordered stipple patterns.

You can also symbolize your layers based on different values for each map feature. For example, you might use different size points to represent different cities around the world according to their population or use differ color markers to represent different types of hospitals. These are considered "thematic" maps and they will be discussed in the sections on displaying points, lines, and polygons.

Managing & Saving Data

Many of the frustrations of new GIS users relate to saving files. ArcGIS works differently from most software, so if you do not take care in naming and saving your files, you will not be able to find or open your work.

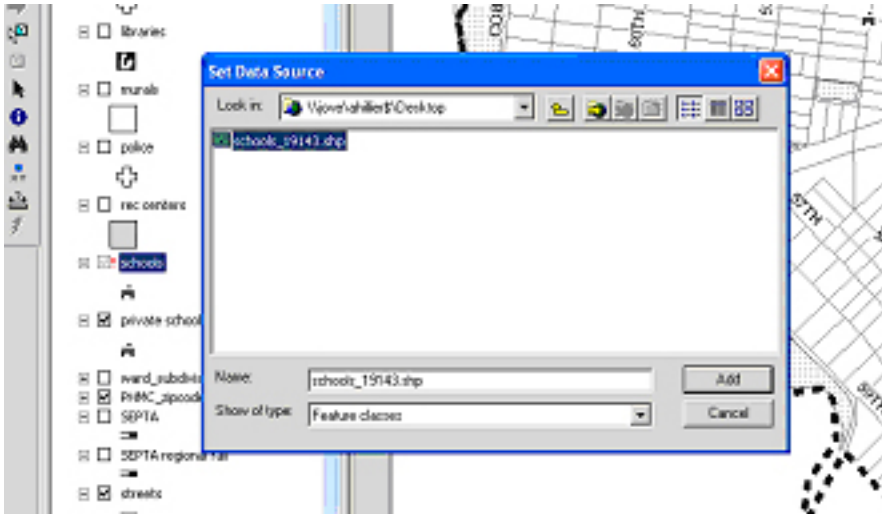
Saving ArcMap Documents

An ArcMap document is made up of all the map layers you have added and all of the functions you have applied to them. It is best to only save an ArcMap document when you have spent a significant amount of time.

Map Documents (.mxd)

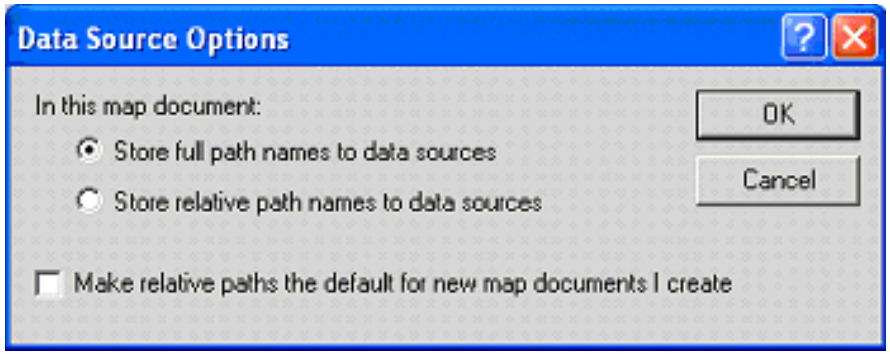
When you open ArcMap, you are prompted to specify whether you wish to open an existing map document or create a new one. Most of the time when you are learning to use ArcView, you can create a new ArcMap document. If you will need to return to your work once you start symbolizing your map layers and designing a layout for printing, you will probably want to save an ArcMap document. You do this by going to the File menu and choosing save. This file will save all of the work you have done, including the list of data you have added and the changes you have made to layer properties, symbology, and the layout.

The .mxd file does NOT save all of the data you included in your map. Instead, it includes information about the location of those files on your computer (or network, or Internet) and the formatting changes you made. This means that you cannot move the data files you've included in a map document or just put your .mxd file on a thumb drive to open on a different computer without running into problems. It also means that map documents can be difficult to transfer from one computer to another. If you do move one of the files used in your map document, that layer will be shown with a **!** next to it and will not draw when you open your map document. If you click on the grayed out check mark beside the layer name, ArcMap will bring up a dialog asking where you moved the file. Navigating to the file in its new location and clicking "add" will solve the problem.



Using Relative Paths

One way to minimize problems when you move files that are part of an ArcMap document is to use relative paths. If you specify that you want to use relative paths, ArcView will be able to find the pieces of your ArcMap document as long as you keep the files used in the .mxd ArcMap document in the same folder (so you can move that folder from one drive to another as long as you don't move the individual shapefiles out of the folder). To set relative paths, go to the File menu, choose "map properties" and click the button "Data Source Options." Choose the radio button, "Store relative path names."



Saving Map Layers

In addition to saving the entire workspace with a map document, you can save an individual map layer (.lyr). This file will store all the formatting changes you have made to the layer. This is particularly helpful if you want to use the same layer, with the same symbology, in another map document. As with the .mxd file, the .lyr file only includes information about the formatting and the path to the original data (generally a shapefile). Moving your original data, or moving the .lyr file to another computer, will create problems.

Naming Files

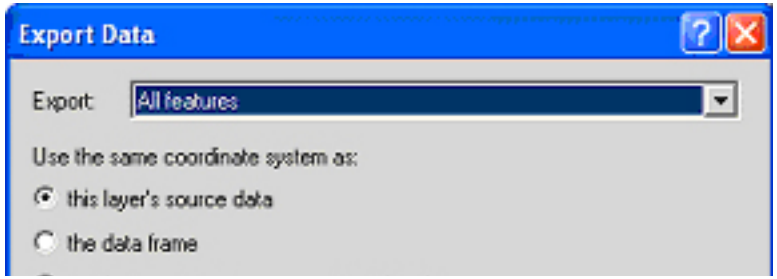
Naming your files in a clear and consistent manner will make working with ArcMap much easier. You need to develop your own naming convention that makes sense to you. You may create multiple versions of the same shapefile that are only slightly different, so your naming convention should reflect those differences (in year, projection, attributes, geographic level, etc.). For example:

Phila_tracts_2000_UTM.shp	Phila_bgroups_2000_stateplane.shp
Phila_tracts_1990_UTM.shp	NYC_tracts_1990_UTM.shp

ArcGIS can work with file names that are more than 8 characters, but really long names can be difficult to work with. ArcGIS can also work with files that have spaces in their name (such as Phila tracts.shp), but this can create problems (especially with attribute names) so it is best to avoid by using underscores (_).

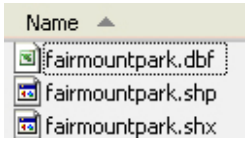
Saving and Storing Files

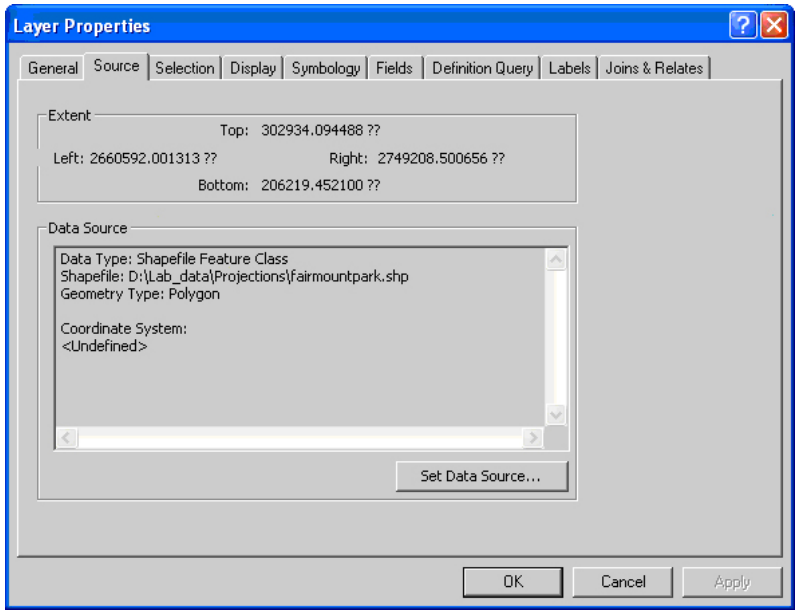
The most important thing in storing files for ArcMap is to think through a system BEFORE you start, so you can avoid moving files and disabling your map documents and layers. Consider creating a new directory for each new mapping project. Keep all map documents, map layers, and tables in that directory. Even though it will require more storage space, you may want to keep separate copies of the same map layer, such as a streets layer, in each project folder where you will be using it. As you work with ArcView, you will also be creating new tables and shapefiles. Whenever ArcView is creating a new file, you will be given an opportunity to give it a name and specify a location with a dialogue box like this:

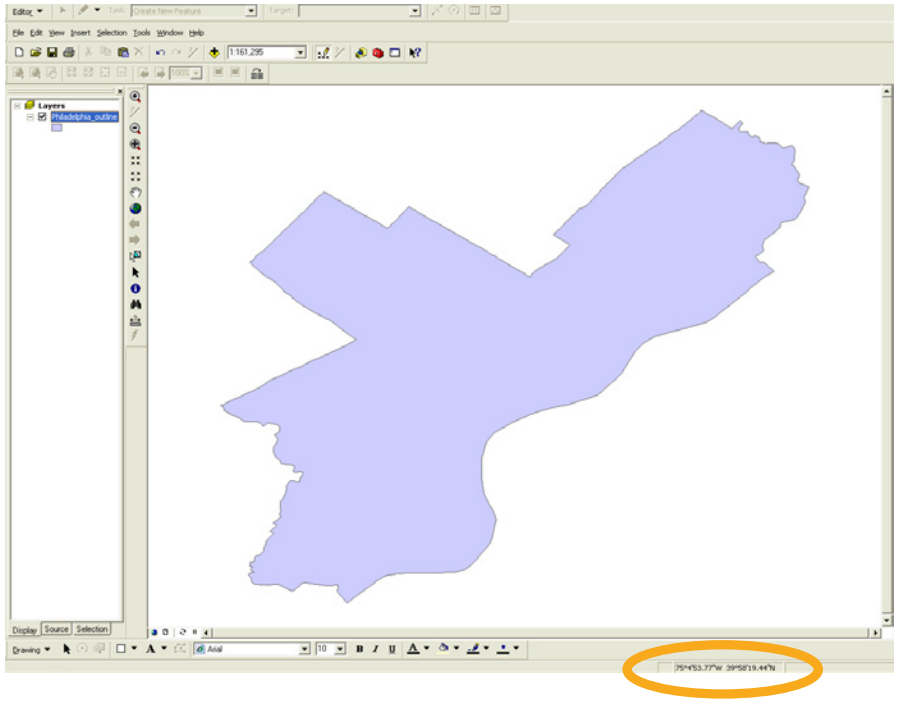


Click on the folder icon to show ArcView exactly where you want the new file and then give the file a new name. Otherwise you will end up with files called "Export_Output.shp" and other unhelpful things like that.

This layer does not have a .prj file, so there is no projection information listed under the “source” tab.







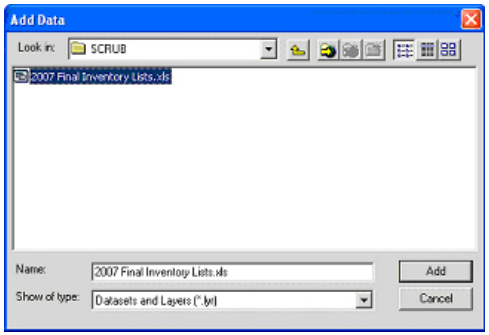
If there is no projection information, you can map the data to try to determine its coordinate system. If the map units displayed in the gray bar below your map are in degrees, seconds, and minutes, then you know the data are in a geographic coordinate system. You may also recognize this because your maps look distorted. For example, when Philadelphia map layers are in a geographic coordinate system, the image appears to be sagging to the east. Map layers in geographic coordinate systems are sometimes described as “unprojected.” Map layers downloaded from the US Census Bureau are generally in this format.

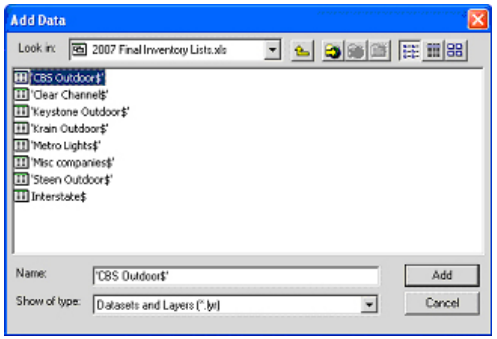
Data formats

ArcGIS can work with many different types of data, only some of which are described in this section. ArcView 9.2 can work with more different data formats than previous versions of ArcGIS.

Tabular data

Tabular data includes things like comma delimited or fixed width text files, Excel worksheets, ACCESS files, and dbase files. This is where you store attribute data, which includes any information you have about a location. Tabular data generally do not include location data, so they cannot be mapped until they are linked to a map layer. Unlike previous versions,

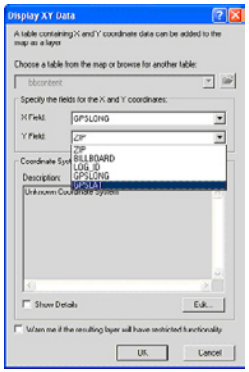




ArcView 9.3 can work with Excel files. You must specify which worksheet you wish to add. When you add data, double-click on the name of the .xls file to see the names of the worsheets. Highlight a worksheet and click "add."

Adding XY Data

Some tabular data include XY coordinates. For example, data might be collected usinga GPS device or a data vendor might sell the names and addresses of supermarkets and include XY coordinates for mapping. Converting lists of addresses to points on a map usually involves a process called geocoding and is explained elsewhere. You do not need to geocode if your table already includes XY coordinates. Simply add the table to ArcMap, right click on the table, and go to "Display XY Data…"



From the Display XY Data window, choose the field that contains the X (longitude) and Y (latitude) coordinates. If you know the projection used to collect or create the data, click on the Edit button.

Geographic data

The tabular data you use in ArcGIS can be used in other programs like Excel, SPSS, SAS, and STATA, but the geographic data you use can only be used in GIS programs. Geographic data store information about location so that they can be represented as map layers. Geographic data can be categorized as vector or raster. This manual deals primarily with vector data.

Shapefiles

Shapefiles are the most common format for vector data in ArcView. Vector data use points, lines, and polygons to represent map features. Vector GIS is excellent for representing discrete objects, such as parcels, streets, and administrative boundaries. Vector GIS is not as good for representing things that vary continuously over space, such as temperature and elevation.

ESRI created the shapefile format in order to represent vector GIS data in a simpler format than their coverage format used in ArcInfo. As with other formats of geographic data, shapefiles link information about the location and shape of the map features to their attributes. Other GIS programs will allow you to use shapefiles, but geographic files from other GIS programs must be converted to shapefiles before ArcView can read them. Shapefiles are made up of three or more files that need to be stored in the same directory in order for ArcView to recognize them as shapefiles. When you look at your shapefiles through ArcMap or ArcCatalog, you will only see one file, but if you look at them directly on your hard drive or thumb drive, you will see multiple files with the following extensions:

.shp - the file that stores the feature geometry (point, line, or polygon)

.shx - the file that stores the index of the feature geometry

.dbf - the dBASE file that stores the attribute information of features. When a shapefile is added as a theme to a view, this file is displayed as a feature table.

.sbn and **.sbx** - the files that store the spatial index of the features. These two files may not exist until you perform theme on theme selection, spatial join, or create an index on a theme's shape field.

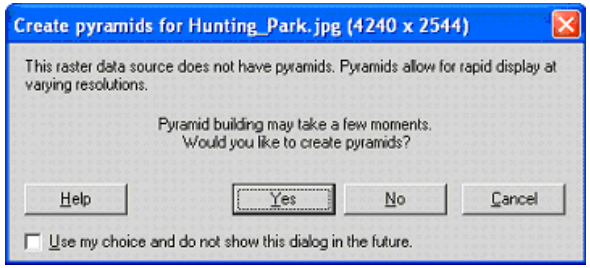
.pjr – the file that stores information about the projection. This will only exist for shape files with defined projections. The shapefile stores information about the shape of the map features, describing them in the "shape" field of the attribute table as point, line, or polygon. It also stores information about the real world location of each vertex that makes up the map features. Using this information, ArcView can calculate area and perimeter for polygon features.

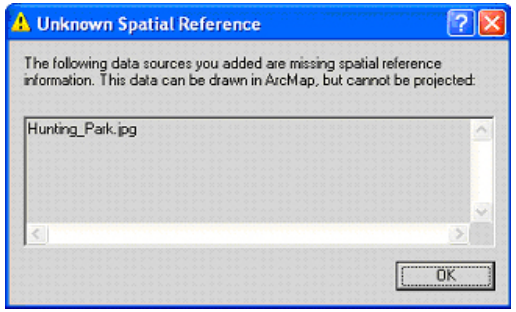
Topology

On of the biggest complaints about the shapefile format is that it does not contain information about topology. Topologic formats (like coverages used in ArcInfo) contain detailed information about the relationships among features in the same map layer. This allows for a variety of operations to ensure the integrity of lines and polygons and to carefully edit and create new geographic features. In creating the shapefile format, ESRI intentionally created something that is simpler than existing topologic formats for desktop (rather than professional) GIS users.

Images

ArcGIS allows you to import and export many different types of images. The images you import may be scanned paper maps, aerial photos, or other pictures or photos that you "hot link" to your map features. ArcMap can import a wide range of file types. You can also export finished maps in ArcMap in a number of formats: EMP, BMP, EPS, TIFF, PDF, JPEG, CGM, JPEG, PCX, and PNG. Images are like tables in that they may contain information about a particular location, but they do not store location information so they cannot be mapped. When you add a large image to ArcMap, you will often be prompted to decide whether you wish to "build pyramids." Generally you want to say "yes" because this will make it easier to work with the image in ArcMap.





You will also receive a message that ArcMap is unable to draw the image as a map layer because it is missing information about location. So why would you add an image to ArcMap in the first place? Because images like aerial photographs and scanned historical maps can be transformed into map layers through a process called georectifying.

Raster map layers

Raster data use grids made up of regular cells, or pixels, to represent spatially continuous data. They look like regular images, but each pixel is assigned real world coordinates and an attribute value (such as precipitation level or elevation), so the data can be mapped. The user defines the cell size, allowing for very fine or course raster surfaces. Even when the cell size is very small, you can see the individual square cells when you zoom in.

You can view raster layers in ArcMap without any additional extensions, but you need the Spatial Analyst extension to analyze or create new raster layers. When raster layers have the same size cells, their values can be added, subtracted, multiplied, divided and queried using map algebra (a system developed by Dana Tomlin). You can add raster data to ArcMap just as you do vector data, using the "add data." Be sure to highlight the layer you want, then click "add" (if you double click, you will see the individual bands that make up your raster lay). ArcMap saves raster layers in its GRID format. ArcCatalog recognizes GRIDs and other image formats (including BMP, JPEG, TIFF) as raster layers.

Geodatabases

ESRI has moved toward a new geographic data model called a geodatabase that used Microsoft ACCESS files to store multiple tables, shapefiles, and raster images. Geodatabases are more complicated than shapefiles and a license for ArcEditor (not just ArcView) is required to edit geodatabases. Shapefiles are generally sufficient for individual projects, but geodatabases are more appropriate for work environments where multiple people are accessing information or when advanced editing is required.

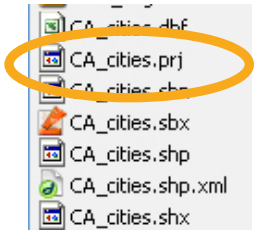
Working with Projections

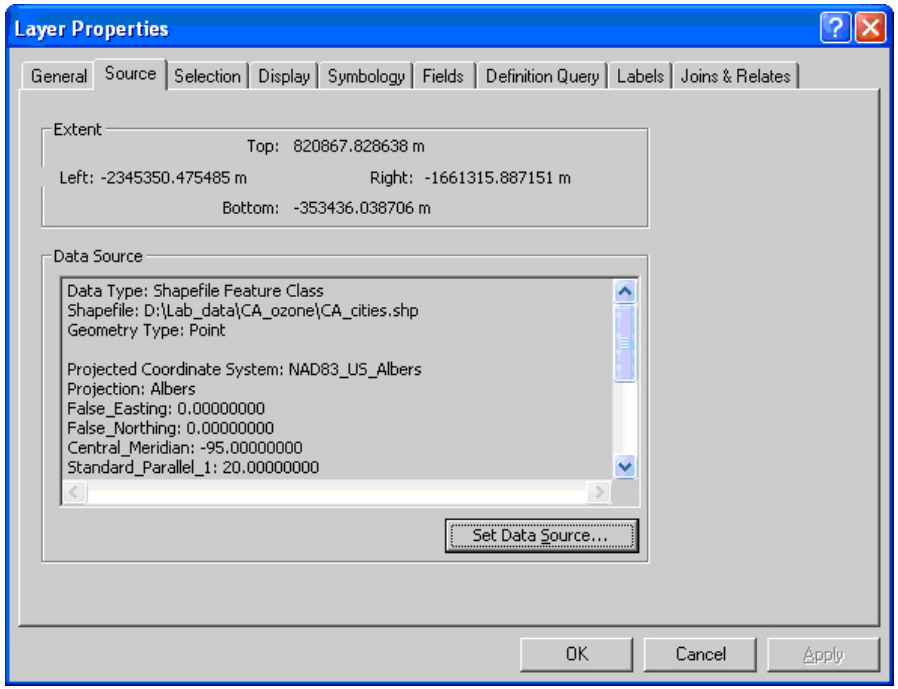
Projections manage the distortion that is inevitable when a spherical (okay, ellipsoid) earth is viewed as a flat map. All projection systems distort geography in some way—either by distorting area, shape, distance, direction, or scale. There are dozens of different projection systems in use because different systems work best in different parts of the world and, even within the same parts of the world, GIS users have different priorities and needs. When you are looking at a relatively small area, such as a single city, there is relatively little distortion because the curve of the earth is slight. But knowing and setting projections properly is also important for getting your may layers to draw together, distance units to make sense, and some of ArcView's tools to work.

Recognizing the Coordinate System

Map layers can be drawn according to a geographic coordinate system (unprojected) or projected coordinate system. Geographic coordinate systems indicate location using longitude and latitude based on a sphere (or spheroid) while projected coordinate systems use X and Y based on a plane. As long as computer screens and printed maps are flat, projected coordinate systems will be more appropriate for working with GIS data. You may not always know the coordinate system used, particularly if you inherit data or download it from the Internet. If you are lucky, the map layer will include a .proj file which contains information about the coordinate system or the metadata will explain. You can look at the information in the .prj file—the detailed spatial reference information—by clicking on the "general" tab of the layer properties from ArcMap. Alternatively, you can click on the "fields" tab of the layer properties from ArcCatalog, click inside the "shape" field and click on the "…" button to the right of "Spatial Reference." You can access the metadata through ArcCatalog.

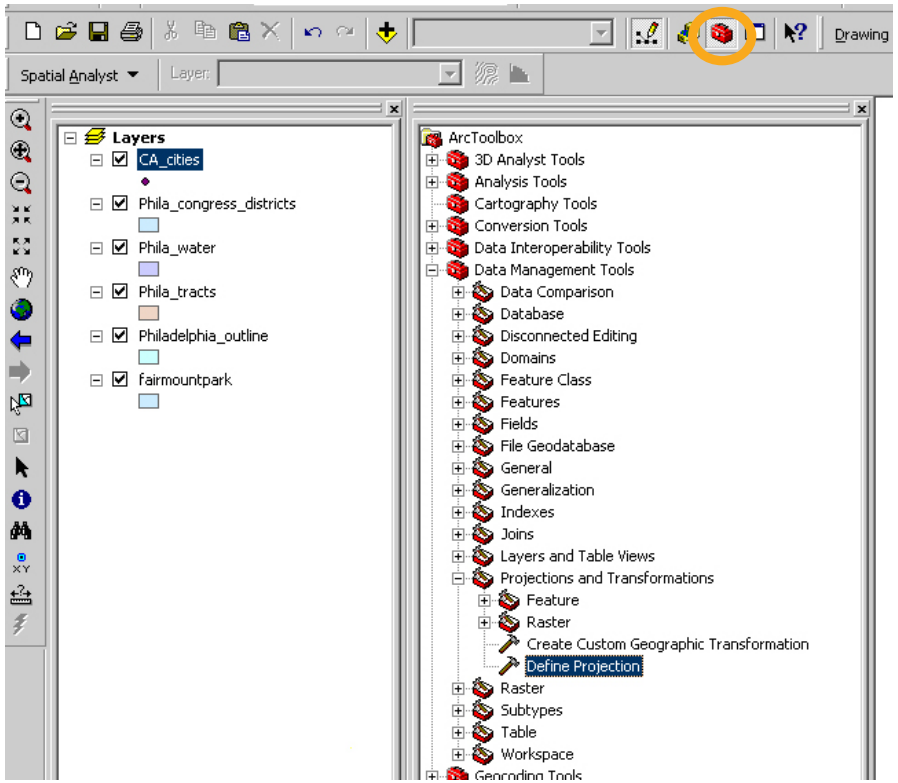
This layer has a .prj file, so there is projection information listed under the "source" tab.





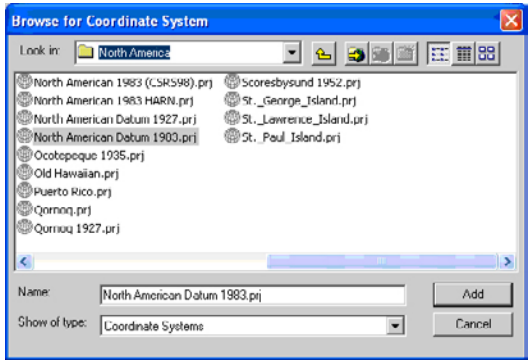
Working with “Unprojected” Layers

In most cases, you will want to convert unprojected map layers—those with a geographic coordinate system—to projected map layers. There are two steps involved in this process. First, you must create a .proj file “defining” the map layer as unprojected; then you can “project” the map layer using the projection of your choice. You can access the tools for doing this by clicking on the ArcToolbox icon inside ArcMap. Click on “data management tools” and then “projections and transformations.”



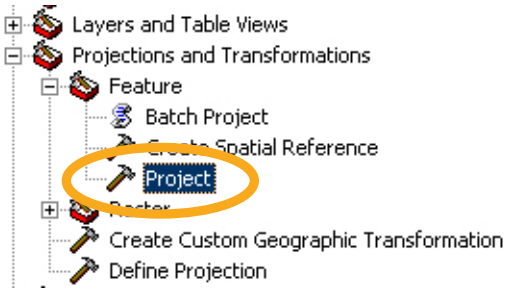
Defining projections

Defining a projection registers your map layer with a known projection. It involves reporting to ArcView the nature of the data that you have, not changing that data. To “define” the coordinate system for your unprojected map layer, click on the “Define Projection” wizard. First you will be asked to choose a data layer. If you added the relevant map layer to ArcMap, you will be able to find it in the dropdown menu. Otherwise you will need to click on the folder icon to locate your map layer. Then you can choose the coordinate system using the button. Click the “select” button on the Spatial Reference Properties. In most cases, you can choose “Geographic Coordinate Systems,” “North America,” and “NAD 1983 Datum,” then click “okay.” You should not notice a difference in how the map layer is drawn as a result of defining the coordinate system. But as a result of defining it, there is now a .proj file associated with your map layer and you can look at the detailed spatial reference information. Before you define a layer as unprojected, ArcView will refer to it as “assumed geographic.”

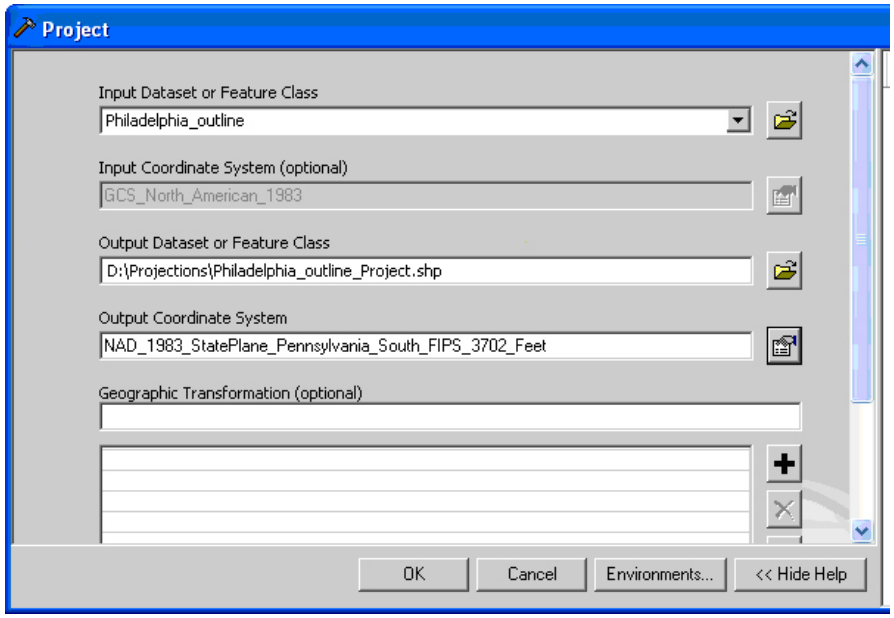


Projecting shapefiles

Projecting a shapefile changes the projection system. You can only do this if you have defined (registered) the existing projection. You can project map layers that are unprojected (geographic coordinate system) or change the projection on layers that already have a projection system. In order to project the map layer, click on the "Project" wizard. If you are projecting a shapefile, use the "Project" wizard listed under "Features." If you are projecting a raster image, use the "project" wizard listed under "raster."



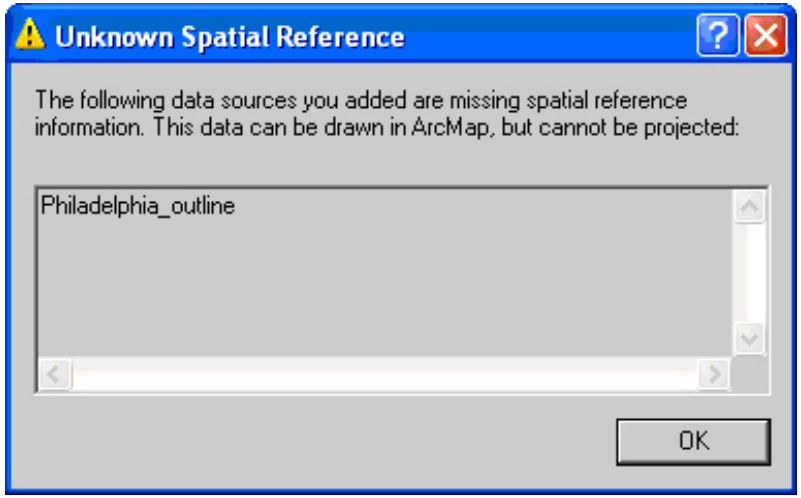
As with the "define" wizard, you will be asked to specify the map layer. Next, because you will be changing the original layer, you are asked to name the new layer that will be created. By default, ArcView will add "_Project" to the original name. You may wish to give your layer a different name. Click on the button to the right of "Output Coordinate System" to choose your projection. Click on the "select" button on the Spatial Reference Properties, then choose "Projected Coordinate Systems." Now you need to choose your projection. For relatively small areas like Philadelphia, the differences in projection systems (the distortion in shape, area, distance, direction, and scale) are minimal. You are best off choosing whatever projection system is most commonly used. In Philadelphia, that is State Plane 1983 (feet) Pennsylvania South. For the Philadelphia MSA, consider UTM zone 18N. After making your selection, click "okay." ArcView will indicate that there is a "Datum conflict between map and output." In order to map your newly projected layer, create a new ArcMap document and add the new (projected) layer. You should notice a change in the coordinates that show in the bottom right of the map.



Working with Projected Map Layers

Sometimes the map layers you acquire will already be projected but won't carry a .proj file so you won't know the projection. The best thing to do in this situation is to look at the original source for information about the projection system, either on a website, in metadata that came with the file, or by calling the person who created the data. If these approaches all fail to reveal the projection, map the data in order to guess the projection. You may recognize the projection by the units showing in the gray bar below the map. If they are not in longitude and latitude, they are probably projected. As you work with a particular projection system, you will come to recognize the map units and range of coordinate values. For example, State Plane coordinates for Philadelphia are generally in feet and look like 2691607.78, 246268.98. UTM coordinates will be in meters and look like 486850.72, 4430095.19.

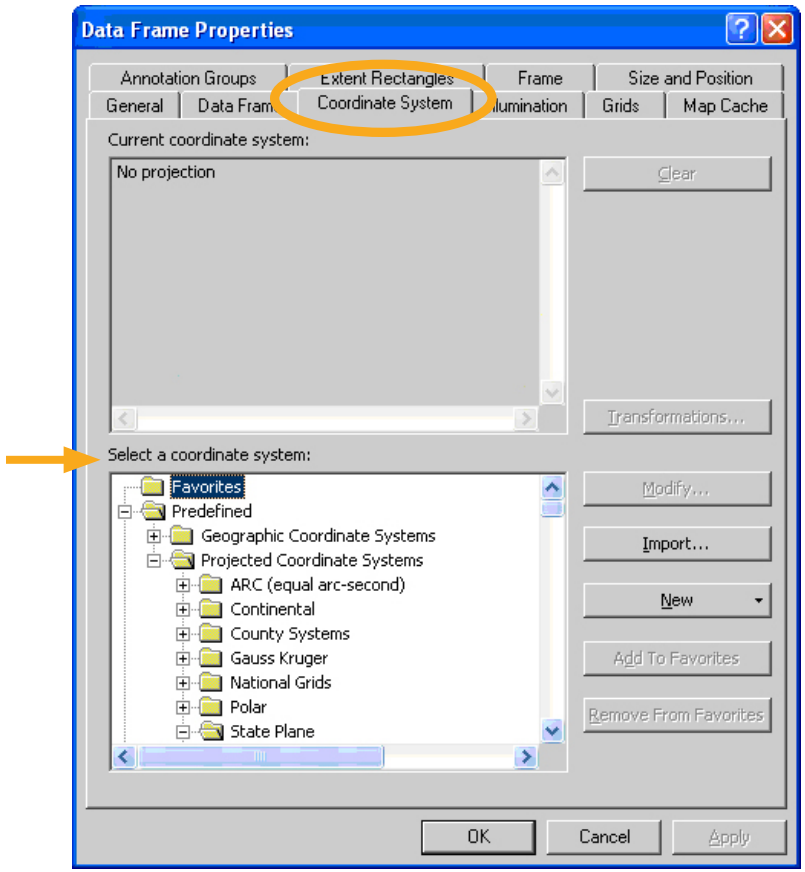
When you add a shapefile to ArcMap that the software recognizes as being projected but has no .proj file, ArcMap will usually warn you that spatial reference information is missing.

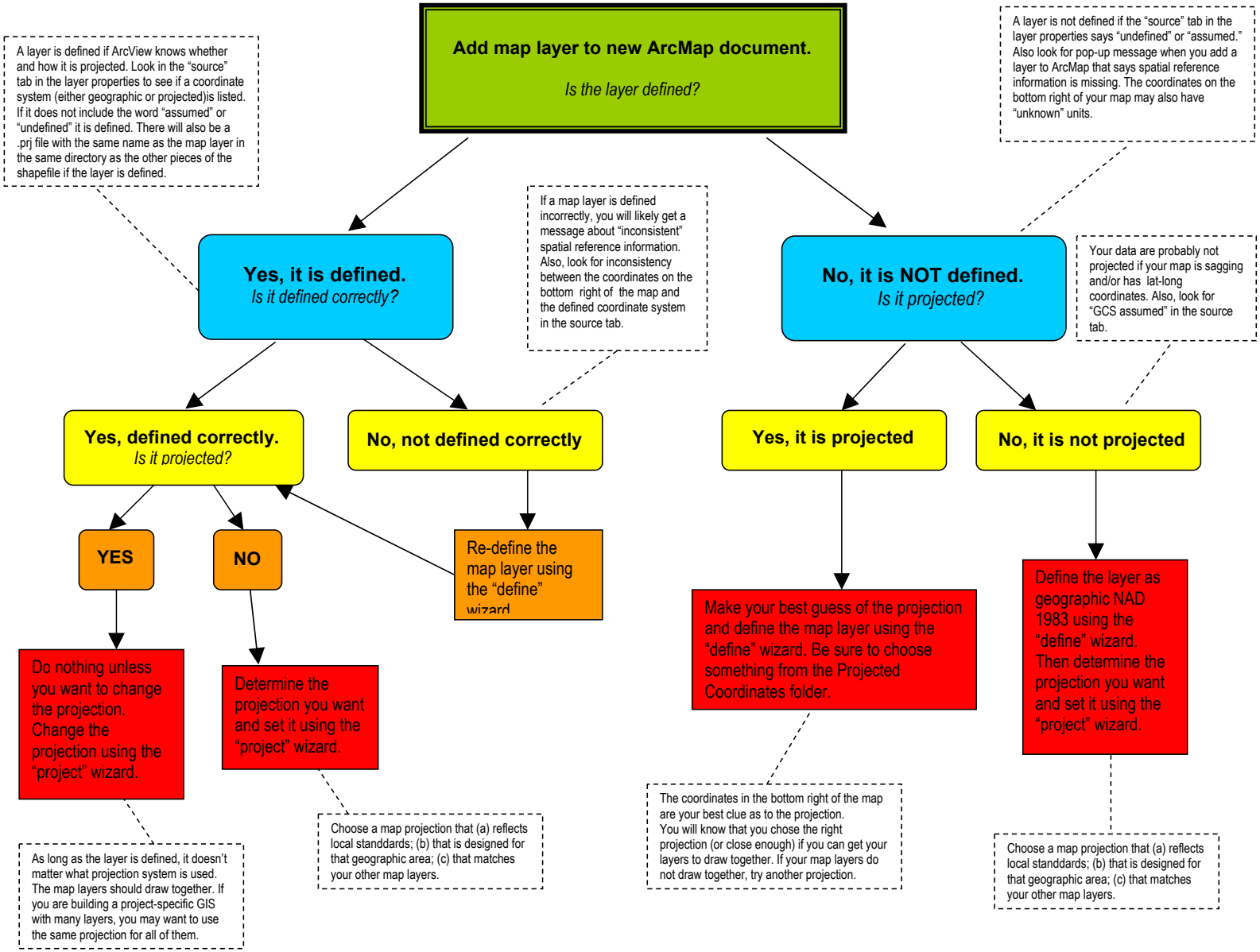


Data that are projected but missing spatial reference information will look fine when they are drawn, but you may not be able to use ArcView's "on the fly" projection capabilities, measurement tools, spatial join, or geoprocessing functions. If you know the projection, you can use the "Define Projection" wizard in the ArcToolbox. You will need to select the projection from the "Projected Coordinate Systems." If a map layer is already projected AND defined, you can change the projection using the same tool. You will need to add the reprojected map layer to a new ArcMap document in order to see the results.

Defining Projection for Data Frame

Ideally, you will know and will specify the projection of each of your map layers. Alternatively, you can set the projection for your Data Frame for your map document. All of the map layers listed under the Layers icon in your table of contents are in the same data frame (you can have multiple data frames in the same map document, although in most cases you will probably have just one). Right click on the word "Layer," go to Properties, and make the Coordinate System tab active. From here, you can choose a coordinate system (State Plane 1983 is in the "Projected Coordinate Systems" folder inside the "Predefined" folder).




Add map layer to new ArcMap document.
Is the layer defined?
A layer is defined if ArcView knows whether and how it is projected. Look in the "source" tab in the layer properties to see if a coordinate system (either geographic or projected)is listed. If it does not include the word "assumed" or "undefined" it is defined. There will also be a .prj file with the same name as the map layer in the same directory as the other pieces of the shapefile if the layer is defined.
A layer is not defined if the "source" tab in the layer properties says "undefined" or "assumed." Also look for pop-up message when you add a layer to ArcMap that says spatial reference information is missing. The coordinates on the bottom right of your map may also have "unknown" units.
Yes, it is defined.
Is it defined correctly?
If a map layer is defined incorrectly, you will likely get a message about "inconsistent" spatial reference information. Also, look for inconsistency between the coordinates on the bottom right of the map and the defined coordinate system in the source tab.
No, it is NOT defined.
Is it projected?
Your data are probably not projected if your map is sagging and/or has lat-long coordinates. Also, look for "GCS assumed" in the source tab.
Yes, defined correctly.
Is it projected?
No, not defined correctly
Yes, it is projected
No, it is not projected
YES
NO
Re-define the map layer using the "define" wizard
Do nothing unless you want to change the projection. Change the projection using the "project" wizard.
Determine the projection you want and set it using the "project" wizard.
Make your best guess of the projection and define the map layer using the "define" wizard. Be sure to choose something from the Projected Coordinates folder.
Define the layer as geographic NAD 1983 using the "define" wizard. Then determine the projection you want and set it using the "project" wizard.
As long as the layer is defined, it doesn't matter what projection system is used. The map layers should draw together. If you are building a project-specific GIS with many layers, you may want to use the same projection for all of them.
Choose a map projection that (a) reflects local standdards; (b) that is designed for that geographic area; (c) that matches your other map layers.
The coordinates in the bottom right of the map are your best clue as to the projection. You will know that you chose the right projection (or close enough) if you can get your layers to draw together. If your map layers do not draw together, try another projection.
Choose a map projection that (a) reflects local standdards; (b) that is designed for that geographic area; (c) that matches your other map layers.

Troubleshooting with Projections

If you are unable to draw your map layers together or if your distance units do not make sense, you are likely experiencing a problem with projections. It is easy to get confused while using the “Define Projection” and “Project” wizards, and frequently the more you try to fix the problem, the more mixed up your projections get. Try starting over with your original files (be sure to keep a copy of the originals before messing around with the projection). If you are not able to figure out the problem, you may want to show your shapefiles to someone with more GIS experience.

Georectifying Images

Georefectifying allows you to convert a paper map into a GIS map layer. Essentially, the process assigns X and Y coordinates to points on your digital map image, shifting, rotating, and scaling your map so that you can view it as a map layer along with your shapefiles. The simplest form of this, using onscreen tools, is explained below.

Create a raster image

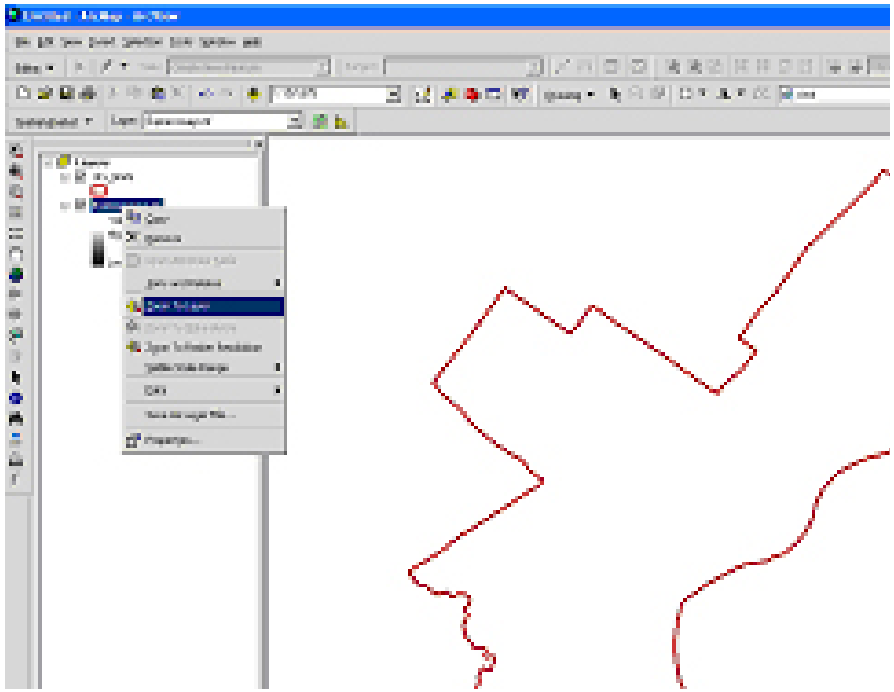
Scan your paper map. The higher resolution, the better. ArcMap can handle pretty big files, and it can work with lots of file types (.jpg, .tif, .bmp). If you have a choice, go with .tif and 300 dpi or better.

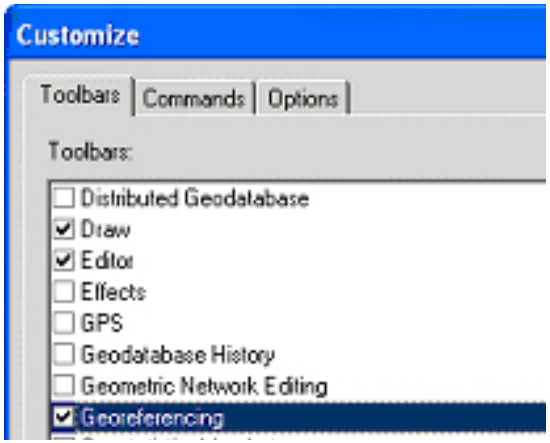
Add reference layers (shapefiles)

Before you add your scanned image, add a shapefile that covers the same geographic area. This might be a street centerline file, city boundaries, or something similar. Be sure that you can identify a few places on your scanned maps on this shapefile (such as a landmark or street intersection). Otherwise, you will not be able to use on-screen georectifying.

Add map image

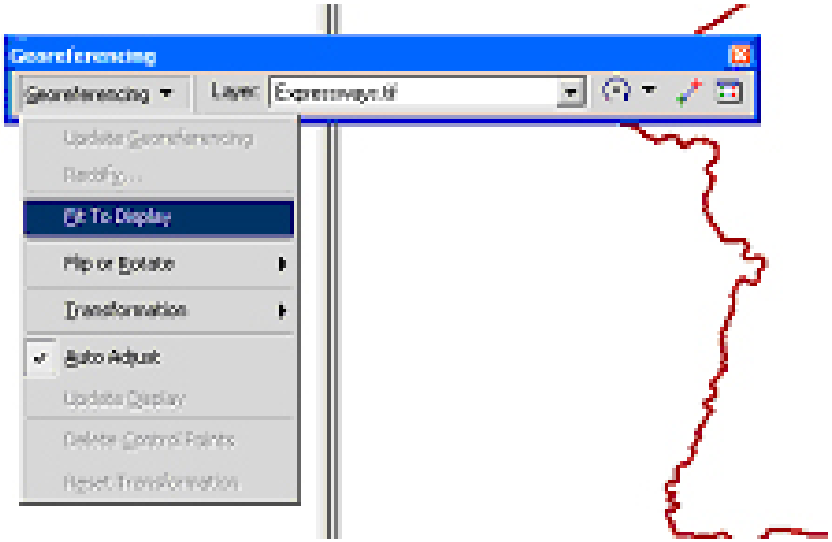
Add your image to ArcMap just as you would a shapefile or table, using the button or from the file menu, choose “add layer.” Depending upon the size of your image, a dialogue box will ask you if you’d like to add pyramids. Click “OK.” Don’t worry if you get a warning message that your image lacks projection information. At this point, your scanned map is just an image, so it shouldn’t contain any spatial information. The name of your image should now appear in the table of contents, but you will not see your image drawn with your shapefile. At this point, your image is in “pixel space” since there is no coordinate information. To see your image, right click on the name in the table of contents and choose “zoom to layer.”





In order to start georectifying, you’ll need to switch back so that you can see your shapefile, rather than your image. Right click on the shapefile and choose “zoom to layer.” From the view menu, choose toolbars, then georeference.

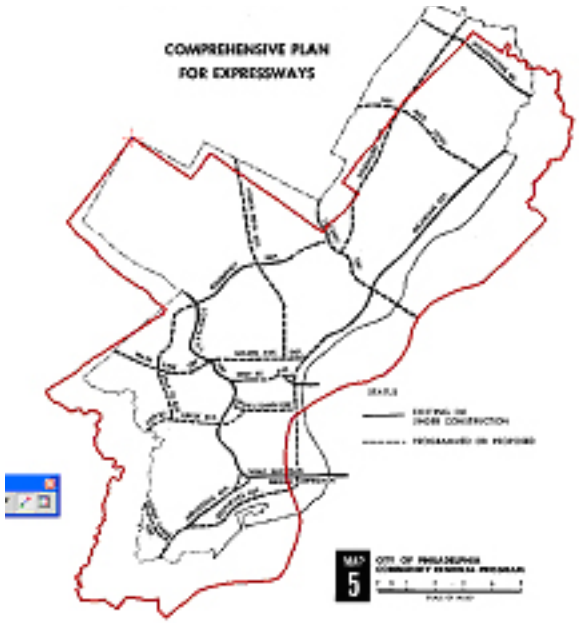
From the georeferencing menu, choose “fit to display.” Now your reference layer(s) should draw on top of your map image in the view map window. If your scanned map is upside down, use the “Flip or Rotate” tools.



Add control points

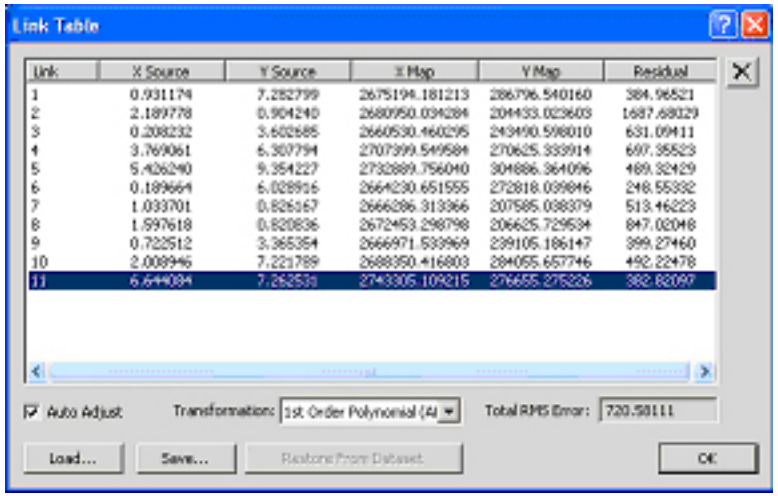
Click the “add control points” button. Create your first control point on your image by clicking once on your scanned map, then click on the shapefile in the corresponding spot. Your image should shift closer to your shapefile. If it gets further away, you probably reversed the order. Be sure to click on your scanned map first, then the shapefile. You may find it helpful to use the magnifier window (from the window menu, choose “magnifier”) so that you can see your map details without zooming in. Continue to add control points. After doing this a few times, your image should be more or less lined up with your shapefile. Continue to add control points as long as doing so improves the alignment.

Before



After

In most situations, your map image will not line up perfectly with the shapefile and you should not expect it to. The original map you scanned may have been created using a different projection system or included distortions and the map may have been further distorted or damaged over time. If the image gets further and further away from the shapefile, however, try starting over. From the georeferencing menu on the georeferencing toolbar, go to “delete control points” and “reset transformation,” then choose “fit to display” again. You can also delete a single control point using the “view links” button. The control points are listed in the order that you created them, so the most recent control point will be listed last. To delete one, hightlight it and click the delete (X) button.

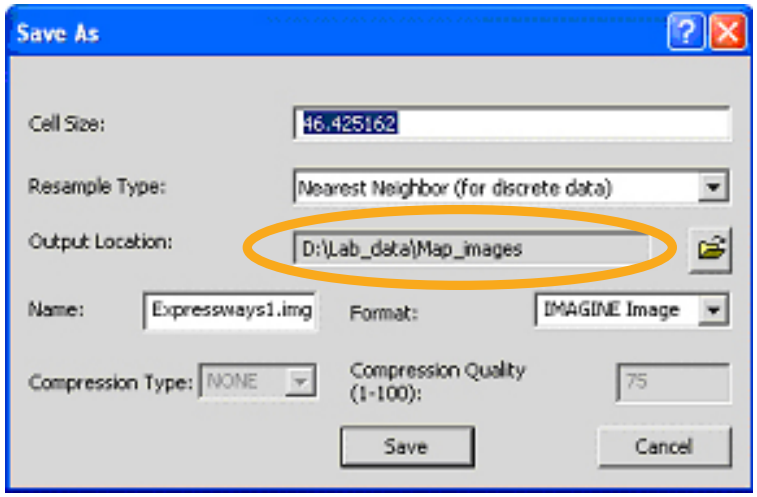


Transformations

If you have six or more control points, you can perform a second order; if you have twelve or more control points, you can perform a third order transformation. But be sure to look at how these transformations distort your map. You may be better off with the first-order transformation.

Rectify Image

In order to permanently save the transformation, choose “rectify” from the georeferencing menu. ArcMap will create a new image (rather than changing your original data). Check the ArcMap Desktop Help if you want information about choosing a resampling type. ArcView will not automatically add your new rectified map in, so go to “add data” and take a look at your new rectified map before you delete your image. If the resolution of the rectified map is much worse than your original scanned map, try rectifying it again and specifying a smaller cell size.



Symbolizing Points

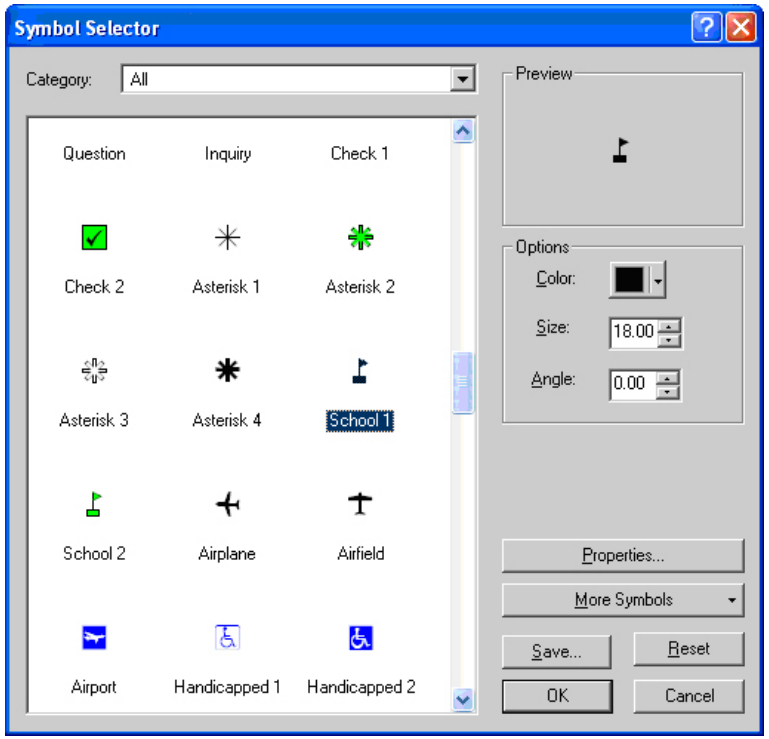
The real strength of a GIS is in allowing you to use different symbols to represent different values, linking your attribute data to your spatial data. ArcMap offers a wide range of colors and symbols for representing your point data. Keep in mind that just because there are near infinite combinations that the simplest symbols (such as block dots) may be the most effective.

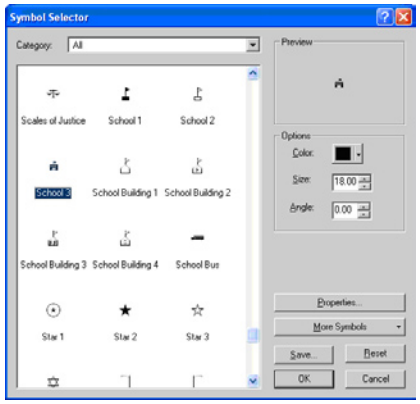
Single Symbol

The default in ArcMap is to represent all points with the same size, shape, and color symbol. This is how ArcMap will display your point shapefiles when they are first added to a map document or when you create them through geocoding or adding XY data. Open the layer properties (double click on the shapefile name or right click and go to "Properties,") and click on the "Symbology" tab. In the box on the left side, "single symbol" will be highlighted. You can change the size, shape, or color of the symbol by clicking on it, but as long as "Single symbol" is selected, all of your points will appear the same.

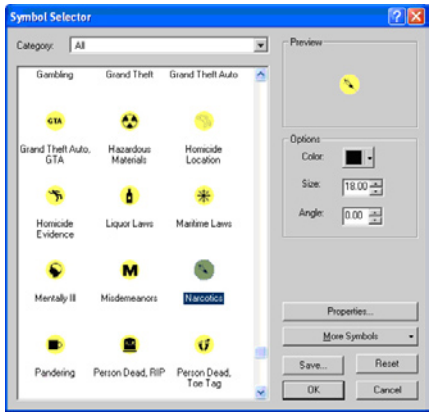
Changing the symbol

ArcView has numerous palettes of symbols used in various industries, such as conservation and policing. These specialized symbols are effective when used carefully with an audience that will recognize them as industry standards. The symbols included in the default palette may not be ideal for your map. For example, the symbol for a school bears little resemblance to a large urban school.





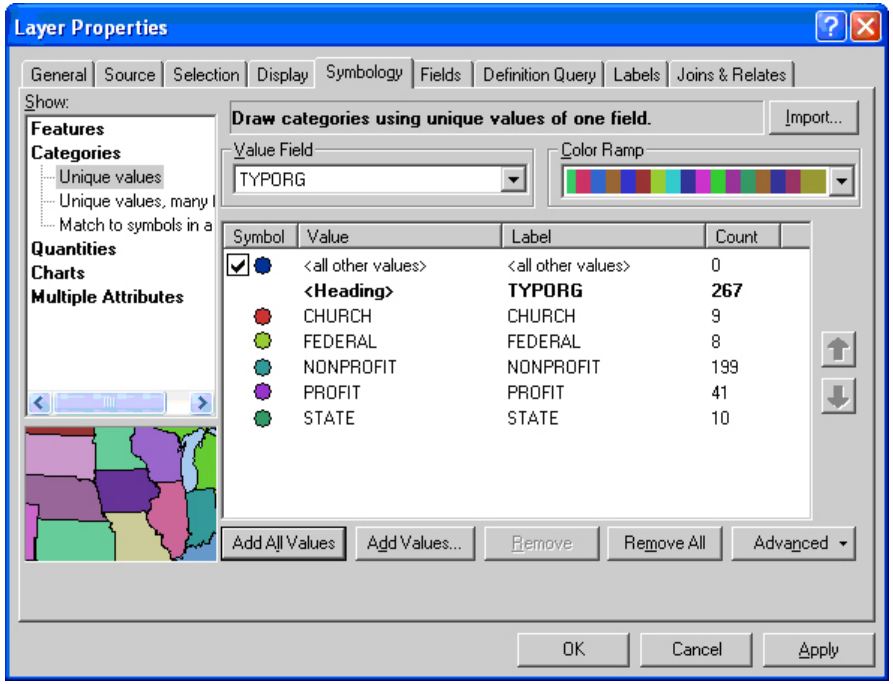
To view additional pallete, click on the "properties" button. The "civic" palette contains a number of choices for schools.



In most cases, however, you are better off sticking with the default symbols. You don't need the symbol of a needle to represent drug crimes. Resist the temptation to be too literal. These are, after all, symbols and you will be able to describe the symbol in the legend.

Categories

Categorical variables classify data into unique categories so that each observation (event, person, building, etc.) fits in only one category. For example, a hospital might be managed by a non-profit, church, federal government, state government, or for-profit entitity. The unique values option listed under "categories" in the symbology tab allows you to use a different symbol for each of the points in a shapefile based on a categorical variable. This can work well for small files (10 or fewer points) but can quickly be overwhelming for larger files. Choose the field with the values you wish to use to represent your points, then click the "Add All Values" button. ArcMap will list a symbol for "<all other values>" that you can remove by taking away the check mark. You can change the individual symbols by clicking on them. You can make changes to all of the symbols, or selected symbols (hold down the shift key to select two or more) by right clicking. To remove a value, right click on it and choose "Remove Value(s)." Use the black arrows on the far right to move values up and down (the order here will be the order your values appear in the legend on your map).

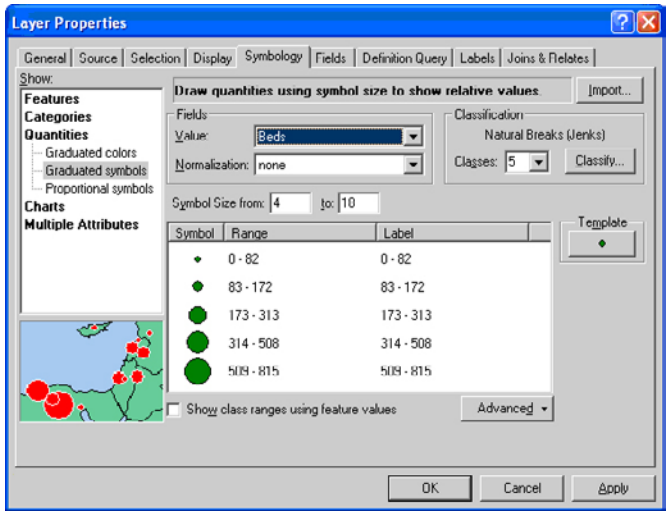


Choose colors that communicate that these are separate categories. Don't use a graduated color ramp with light to dark shades of the same color. This implies that one category is more or less than another when, in reality, they are just different. In addition to different colors, use different sizes and symbols.

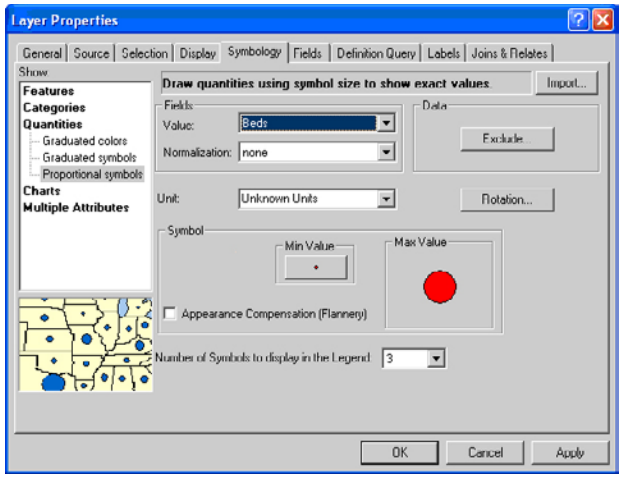
Quantities

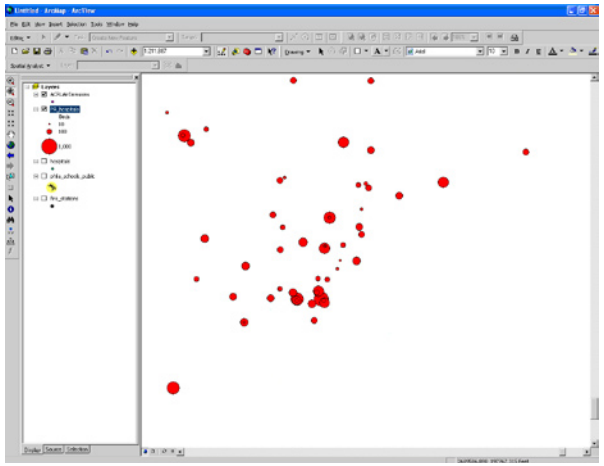
Categorical variables correspond to categories and are generally represented using text variables (or numbers used as codes for individual categories). Quantities, such as the population of a city or air emissions, are continuous and must be presented with numbers. Graduated symbols and proportional

symbols are the best choices to show different quantitative values for points. Graduated symbols allow you to have different size symbols to represent different attribute values. With the symbology tab active, click on “Quantities” and then “Graduated symbols.” From the “Values:” dropdown menu, select the field with the values you wish to use. The default is five categories, so five value ranges represented by different size dots should appear below. Use the “classes” dropdown menu to change the number of categories. There are many ways to break up value ranges into categories. The default is “Natural Breaks,” which uses Jenks optimization to identify grouping of values that minimize within group differences. To change this, click on the “Classify” button and use the Method dropdown menu to choose a different classification system. You can also adjust the cutoff points by moving the blue vertical lines in the histogram below that show the frequency of values. Alternatively, you can change values manually on the previous screen by clicking on them (you will only be able to change the ending value).



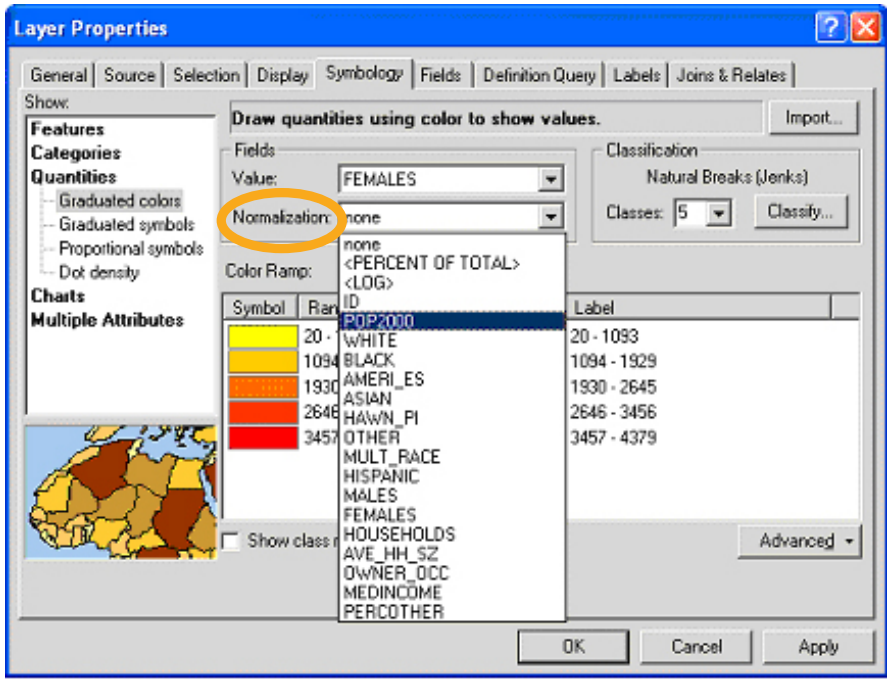
Proportional symbols are similar to graduated symbols, but the size of the symbol reflects the relative size of the quantity. For example, a hospital that has 100 beds would be represented with a symbol that is twice as large as a hospital with 50 beds. Proportional symbols are preferable except in situations where the symbols become too large and obscure other points.





Symbolizing Polygons (Area Data)

The options for symbolizing polygons (such as census tracts) are basically the same as the options for symbolizing points, but the attribute data that you have for polygons will often be different so you will utilize the same options in different ways.



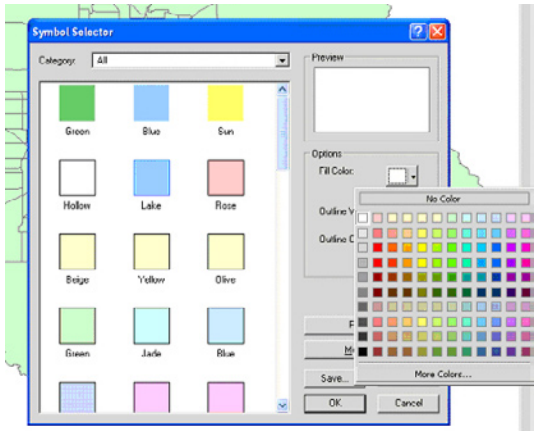
Graduated Color

You can use different colors—or different shades of the same color—to represent different continuous variables (such as household income or median age) to create choropleth maps. From "Layer Properties," click on the symbology tab. On the left side of the screen, click on "Quantities" and "Graduated Color." Choose the field with the values you wish to use. Use the "Classes" dropdown menu and the options in "Classify" to change the number of categories or method for breaking values into categories.

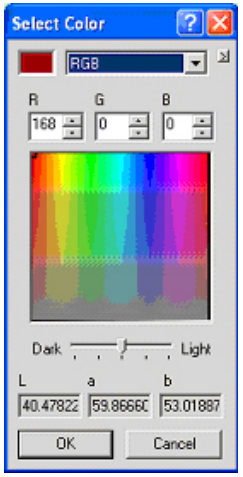
Choropleth maps are generally better at representing rates (such as percent registered voters) rather than counts (such as total voters). You can transform count data into rate data using the "Normalization" dropdown menu in the "graduate color" option. In order to use this appropriately, you will need to select the variable from your attribute table that serves as an appropriate denominator. For example, in order to show the percent of households receiving public assistance, normalize the total number of households receiving public assistance by the total number of households. Do not use the "<PERCENT OF TOTAL>" option to create a rate.

Graduated color works best when you use the same shade of a single color, with lighter shades representing lower values and darker shades representing higher values, or intuitive color schemes such as yellow to orange to red or yellow to green to blue. But keep in mind that it may be impossible to distinguish between more than four or five shades of the same color, depending upon the quality of your printer. To fine tune colors, go to “more colors” when choosing a color from the symbol selector. Here you can play with the hue(H), saturation(S), and value(V).

1



2



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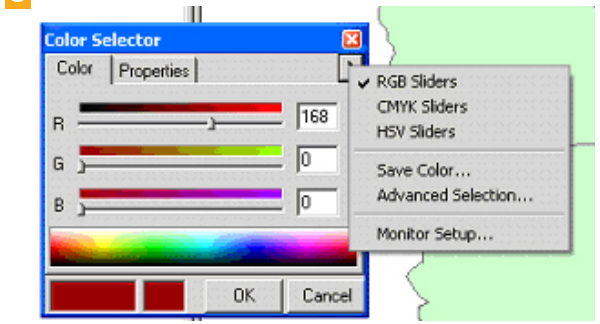
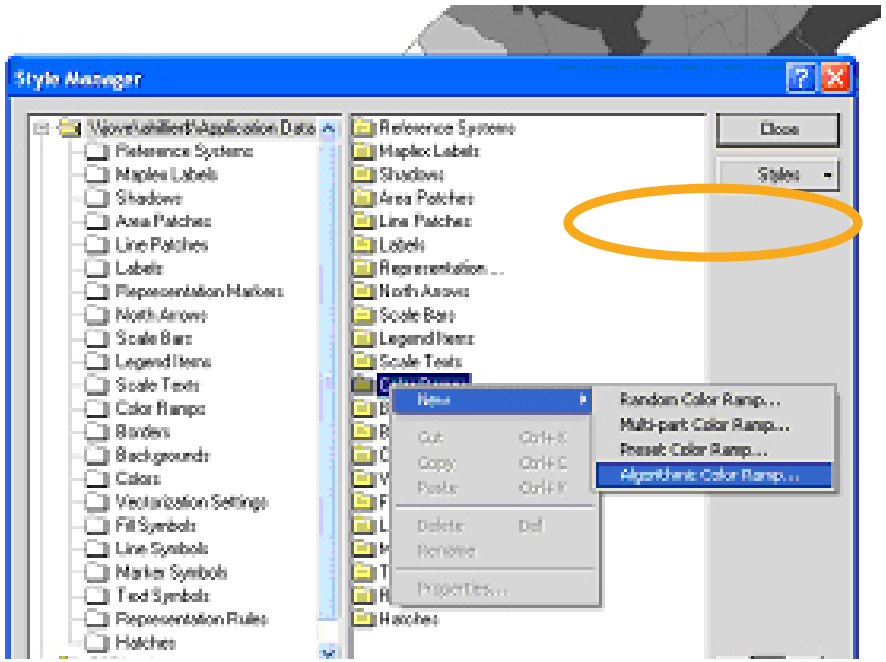
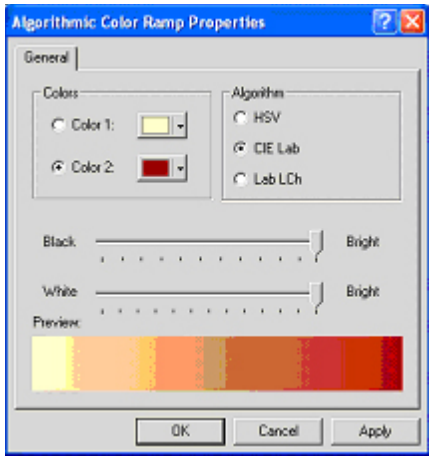
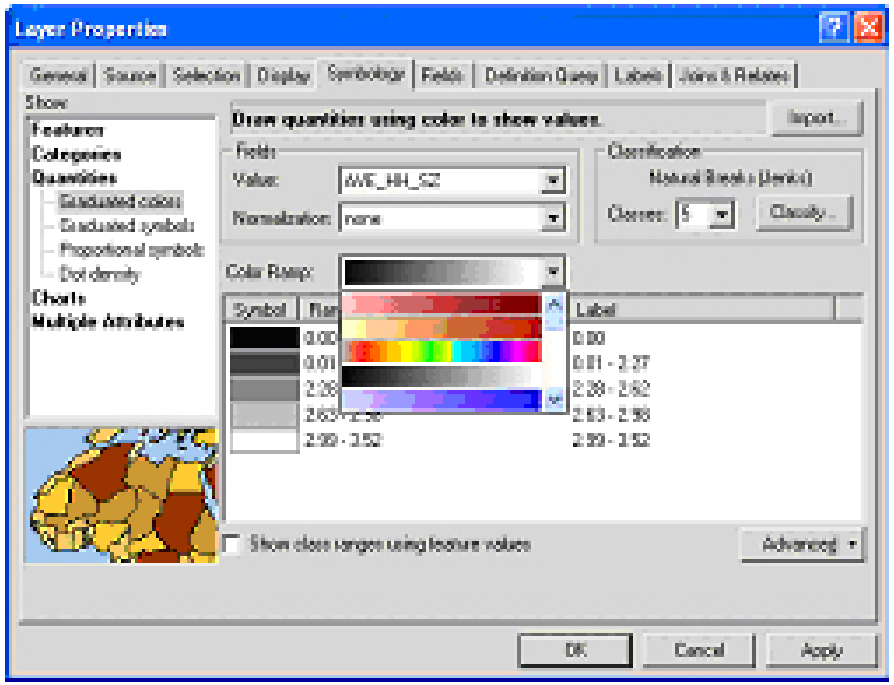


Customizing a color ramp

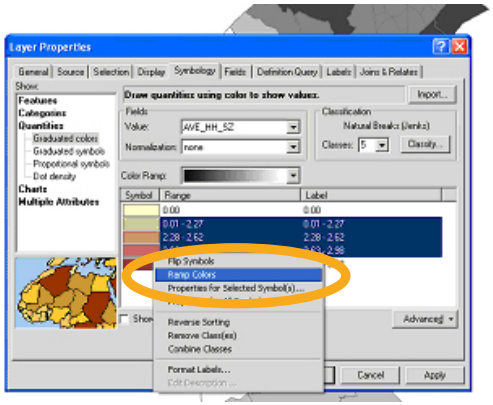
You can create your own color ramp if you are not happy with any of the default choices. To do so, go to the “Tools” menu and click on the folder called “ESRI.Styles,” then “Style Manager.” Right click the Color Ramps folder on the right, choose “new,” and elect Algorithmic Color Ramp. Select a color for Color 1 (the beginning of the color ramp), then a second color for Color 2. Give your new color ramp a name and close the Type the name of the new color in the Contents window. Your new color ramps should appear at the top of the dropdown list of color ramps in the Symbology tab.

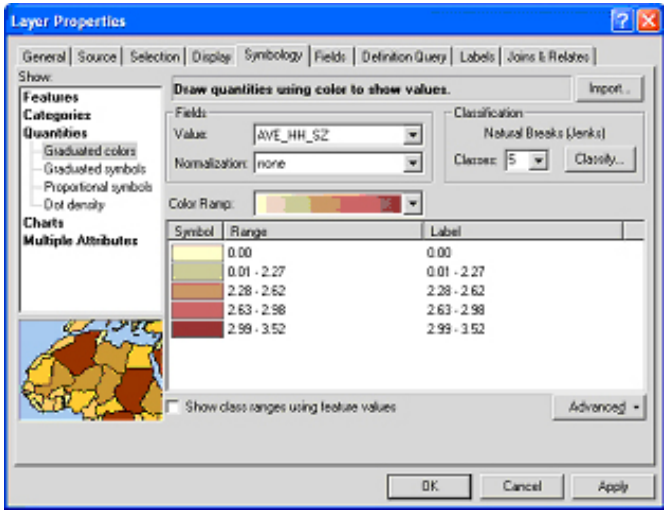






You can also create your own color ramp by manually picking colors in the Symobology tab. To make these a color ramp that you can then choose for other layers, highlight the middle (other than first and last colors) and choose "ramp colors."

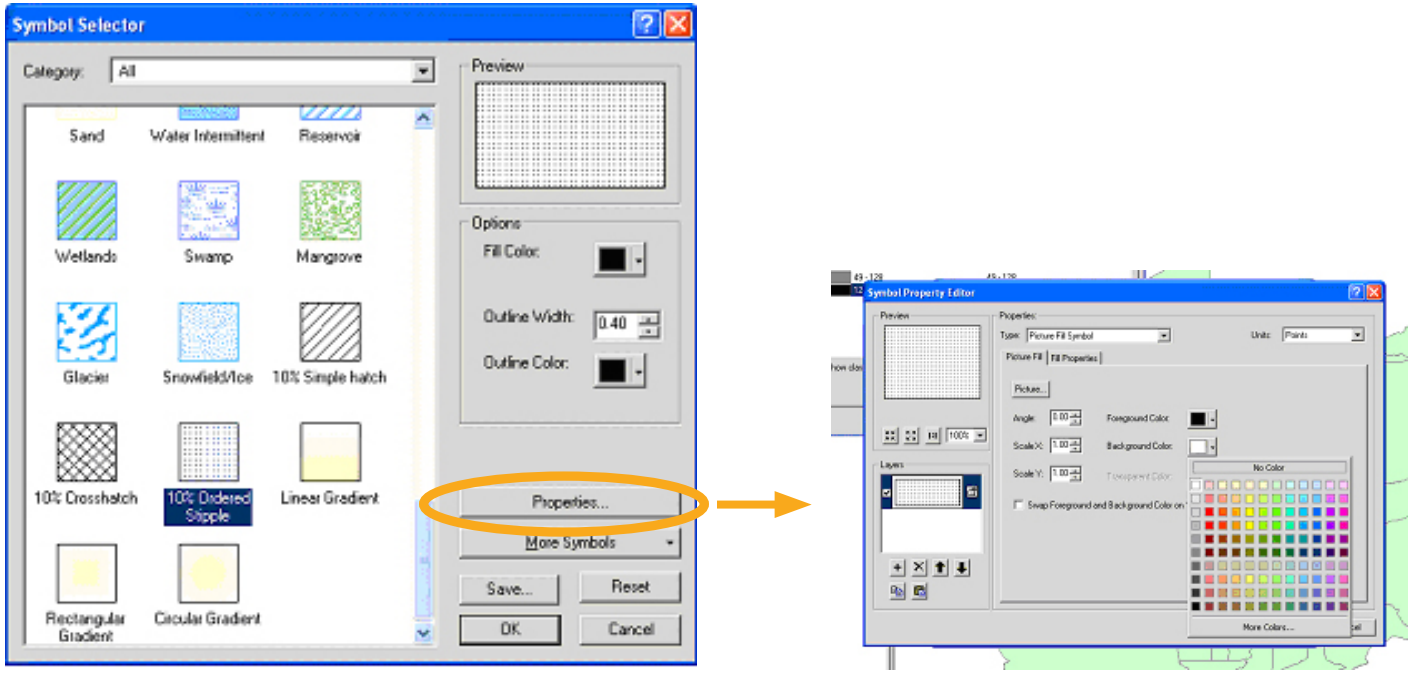




You can find a more detailed explanation of algorithmic, random, multi-part, and preset color ramps that can be created in ArcGIS in the help section.

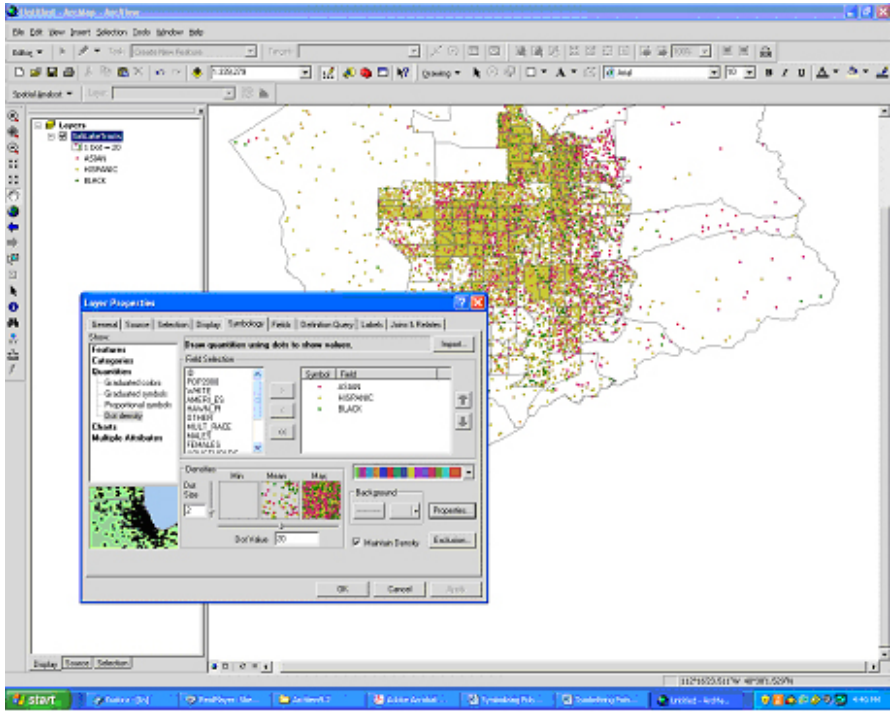
Fill Patterns

You can use different patterns in addition to, or instead of, using different colors to represent different values. Patterns are particularly helpful when you are restricted to printing maps in black and white. Choose “Graduated Colors” from the Symbology tab and select the field with the values you want to display. Set the number of classes and the method of classification, so that you are happy with the value ranges. Then click on the symbols and change the fill using the symbol selector. Click on the Properties button to fine-tune the fill pattern. This may involve changing the background from white to “No color” so you can draw a layer symbolized with a fill pattern on top of a layer with solid colors in order to see the relationship between two different attributes.



Dot Density

Dot density maps use randomly placed dots within polygons to represent different values for aggregate data. They provide an alternative to choropleth maps for count data. If you use this option, be sure to remember—and carefully communicate on your map—that the points do not represent precise locations, as they do in a point layer. Failing to do so may generate confusion and concern about data confidentiality. One major limitation of this type of map is that the dots may be distributed across parts of the polygon that don't make sense. For example, if you use dot density to show the number of foreign-born in a map of counties, the dots might appear in non-residential areas. You can avoid this problem by selecting a "mask" (such as parks and industrial areas) where dots should not be placed.

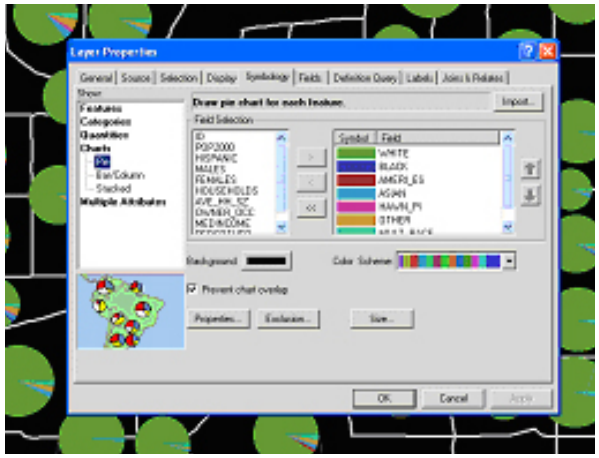


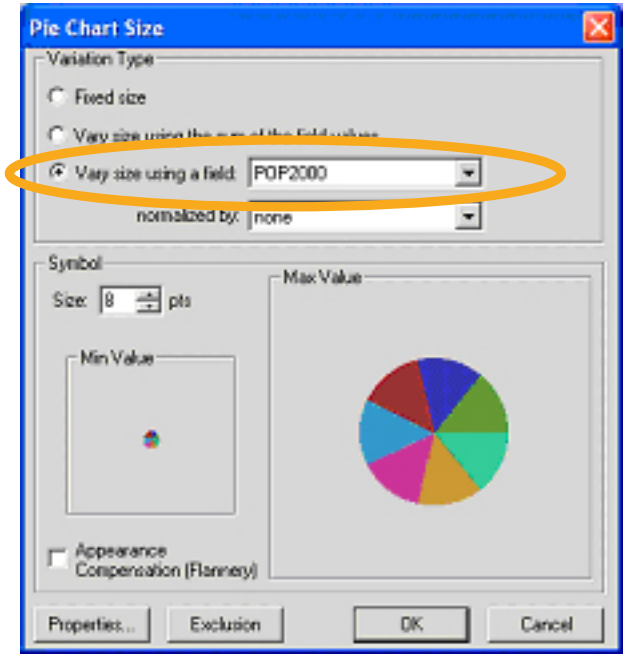
To create a dot density map, open the Layer Properties and make the Symbology tab active. Click on "Quantities" and "dot density." From "Field Selection," choose the field you wish to use as the basis for the map. Counts (such as the total number of households on public assistance) are appropriate for dot density maps, but averages, medians, and rates are not. Choose your dot size, or keep the default (which is advisable, at least to start). The "Min," "Mean," and "Max" boxes will give you a preview of how your map will look. The "Dot Value" indicates how many units each dot represents. Change this as needed to create dot densities that have enough dots to show variation but not so many that they are all on top of each other. You can change the color of the dot by clicking on it under "Symbol" in the top right part of the screen. Checking "maintain density" will ensure that the dot density looks the same as you zoom in and out (by making the dots bigger and smaller).

Pie Charts

Charts are good for showing multiple values and the relationship between values on different variables. Pie charts are especially good for showing proportions. For example, individual pie pieces can be used to show the breakdown in race for the population in a census tract. For the pies to work, you must be able to put every person into a racial group, or you must use an "other" category. Pies contain a lot of information, so it can be difficult to display them clearly. To create pie charts, click on "Charts" and "Pie" from the Symbology tab. Holding down the shift key, select the fields that you want to include. Make sure that together, they add up to 100 percent (you may need to create and calculate a new "other" field in your attribute table before using charts). Click on the "Background" button to change the color or fill ("Hollow" or white backgrounds might be best, so that you don't have too many colors in your map). If you check "Prevent Chart Overlap," ArcView will use "leader lines" to indicate where the pie charts belong if there is no room to display them within the map feature. Click on the Properties button to make adjustments to the look of the pie (3D, rotation, height).

Click on the Size button if you want to have different size pie charts depending upon the total (such as total population). If you choose to "Vary size using a field," you may need to exclude records with a zero value. To do this, click on the Exclusion button and, using the appropriate field name, create an expression such as "[TotalPop] = 0." You may need to play with the minimum size on the previous screen to make the maximum size pie chart a reasonable size.



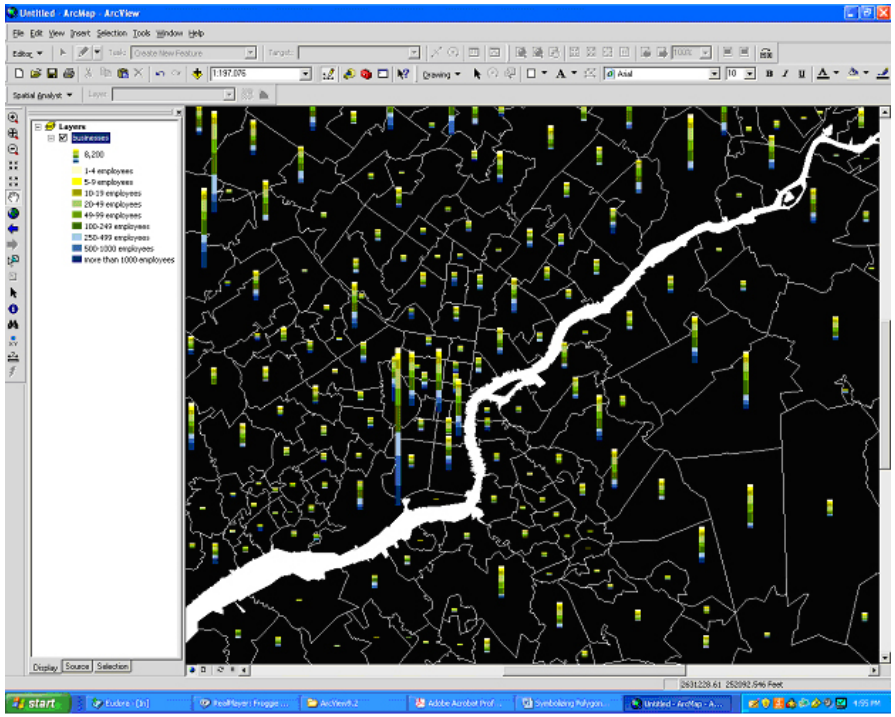


Bar/Column Charts

Bar charts can be used to compare values on two or more variables that do not represent proportions (they don't have to be subsets that add to 100 percent). For example, the map on the right compares the total population by block group to the total number of households. To switch from column (vertical) to bar (horizontal) charts, go to Properties on the Symbology tab of Layer Properties and switch the radio button under "Orientation."

Stacked Charts

Stacked charts can be used to compare values on two or more variables (such as race) that are subsets of a larger variable (such as total population) when you don't know, or don't want to display, all of the subsets. You have many of the same options for formatting (size, color) that you have with the other types of charts.

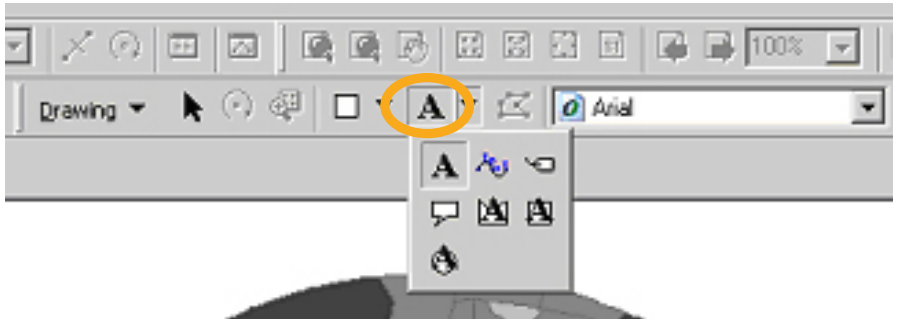


Labeling Features

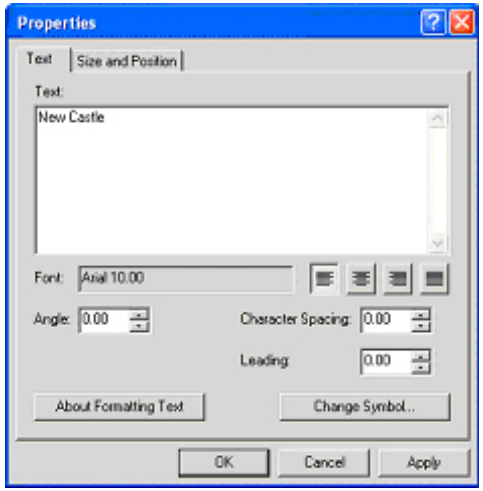
Labeling features can be frustrating and tedious, but labeling features well is important to making your maps readable and communicating their meaning, so it's worth the effort to learn.

Using Text Boxes to Label Features

You can place text on a map in order to label map features. The text tools require that you type the feature name yourself while the label tools take advantage of feature names stored in the attribute table. The text tool can work well if you only have a few map features to label. Click on the button marked "A" on the drawing toolbar.

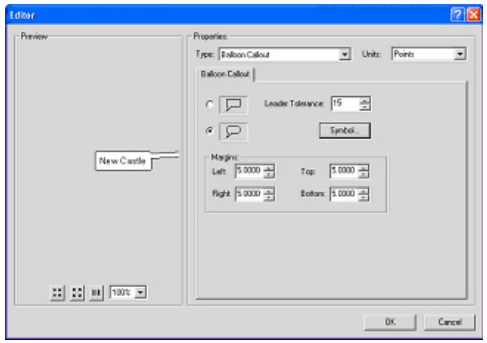


This will bring up seven different text and label options. Click on the "A." Click on your map where you want your text to appear and type your label in the text box. Hit the enter key, or click your cursor outside the text box to complete. You can move the text around using the "Select Elements" tool. Double clicking on the text will bring up the Properties, where you can change the size and font (using the "Change Symbol" button).



The callout text tool works similarly, except that it allows you to place your text away from the map feature while still indicating what is being labeled. Click on the tool and then click on your map feature. Before letting go, you can move the cursor to where you would like the label to be. Type your label. Using the "Select Items" tool, you can move the text box so that it is closer or further from the map feature. The yellow background with black text may not be what you want (actually, it probably won't be what you want).

From the “text properties” dialogue box, choose “change symbol,” then “properties,” then the “advanced text” tab, then the “properties” button below “text background”. From here, you can choose between two different style callouts. Click on the “symbol” button to change the background color.

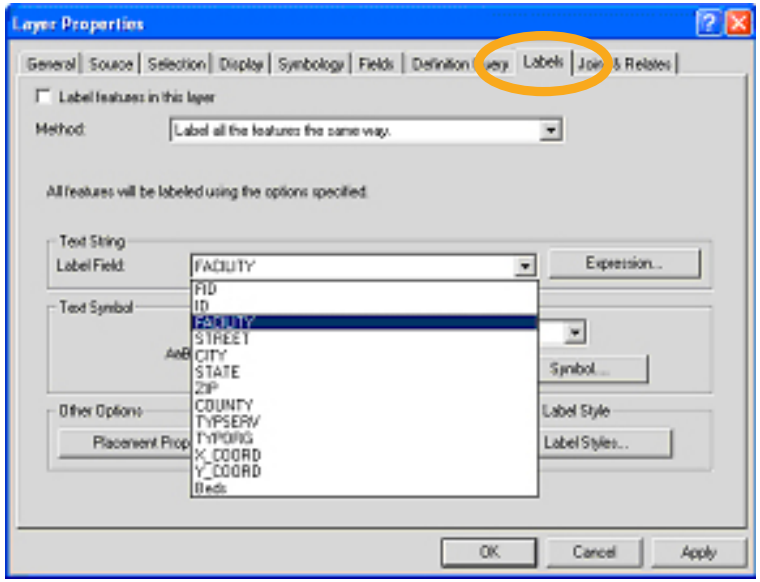


A third option is the spline text tool. This allows you to write text along a curved line. This works well for labeling rivers and curvy roads. Click on the spline tool, then click on the starting point for your label. Continue to click along the curve (you don’t need to make many clicks) and double click to finish. Then type your label in the text box. You will probably need to try this several times to get a label with which you are happy (just click on the label with the “Select Elements” tool and hit the “delete” key to delete a label).

Manually Placing Labels

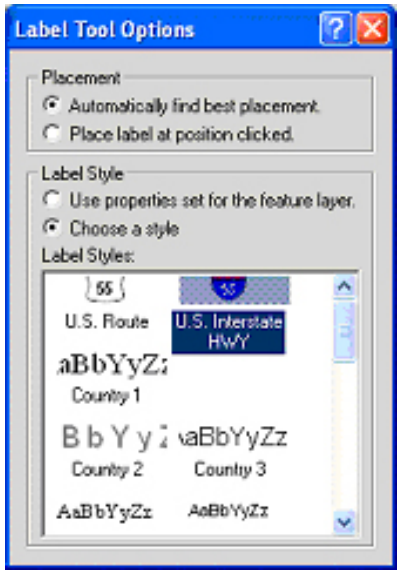
Using the label tools in ArcMap, rather than the text tools, allows you to use the values in a layer’s attribute table for your labels (in other words, you don’t have to type the label out as you do with the text tools). By manually placing labels, you also avoid having your labels act as a group (which happens with auto labeling), so it’s easier to move or edit a single label.

Before you can use the label tools in ArcMap, you need to indicate which field in the attribute table of your map layer you want to use as the basis for labels. From Layer Properties, click on the “Labels” tab. Leave the “label features in this layer” box empty (clicking this creates auto labels). Choose the appropriate field from the Label Field dropdown menu. Click on symbol to change the size, style, or font for your labels. (Guessing what size to make your labels is difficult and you will probably need to make small adjustments



after seeing what works). Using the “Placement Properties” button, you can instruct ArcView what to do about duplicate labels. The “Scale Range” allows you to instruct ArcView when to draw or not draw labels, depending on the extent. In order to do this, you need to know the exact scales you’ll be using (so you probably just want to leave this alone). The “Label Styles” button gives you access to some fancier label options. The highway labels are particularly helpful. Now you can use the label tool to manually label your map features.

Close the “Layer Properties” dialog box. Click on the button marked “A” on the drawing toolbar and choose the “Label” tool.



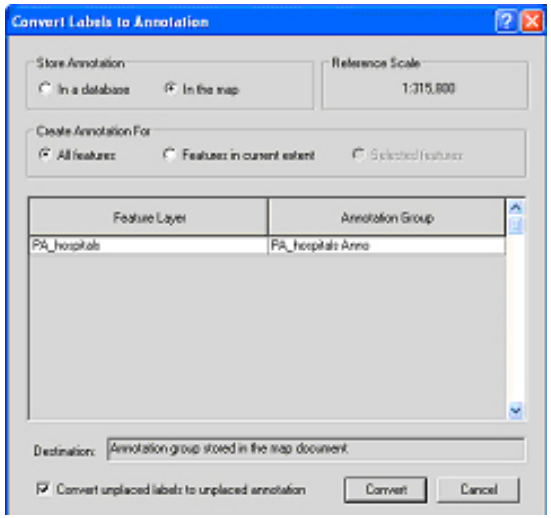
The “Labeling Options” window will open. Decide if you want ArcView to decide the best label position or if you want to determine that yourself. The “Choose a style” radio button gives you access to those fancier labels again. You can move these labels (using the “Select Elements” tool) and change their size and style (double click to bring up Properties). You can delete a label by clicking on it and pressing the delete key.

Auto Labeling

You may find it easier to automatically label all of your features. This saves time if you are happy with the way the labels look, but it offers you much less control over the label placement. When you automatically label features, the labels are “dynamic” so changes you make to one (moving it, changing the style) are made to all. To label your map features automatically, go to Layer Properties, click on the Label tab, and put a check mark in the “Label Features in this layer” box. You can also label automatically by right clicking a map layer and going to “Label Features.” To delete your labels, you’ll need to return to the Label Properties box and remove the check mark from “Label Features in this layer” box or right click and go to “Label Features.” You can select “In the map” as a place to store the annotation.

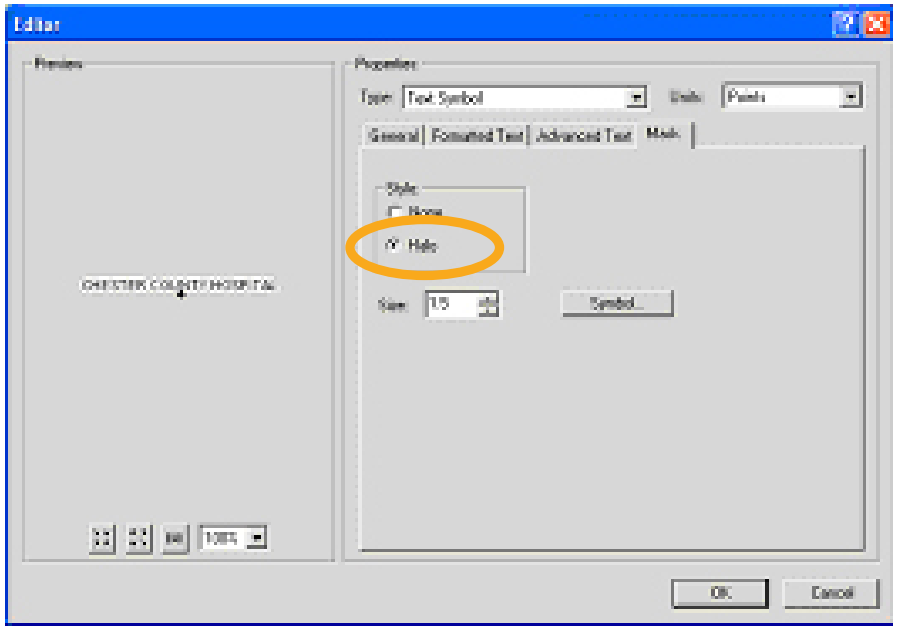
Converting Labels to Annotation

One solution to the problem that auto labeling presents with groups of labels is to convert them to annotation. This allows them to function as individual text boxes so you can change the style for a single label. To do this, right click on your map layer after labeling it and go to “Convert Labels to Annotation.”



Using a Halo with Labels

Sometimes labels are difficult to see on top of a map that includes many different shades and colors. By creating a halo around the label, it will stand out. To create a halo, double-click on the label text to bring up the “Properties” dialog box, then click “change symbol,” “properties,” and select the “mask” tab. Choose the “halo” radio button. You can select a halo color other than white and adjust the thickness (1.5 point may be enough).

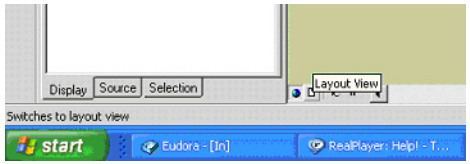


Designing Map Layouts

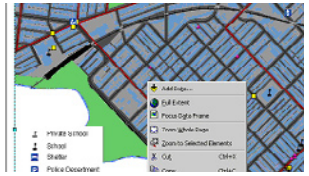
Displaying data so that you can analyze spatial patterns on a computer screen is one thing; printing out a map for other people to look at is quite another. ArcMap thinks of these as distinct functions and makes available a series of tools for designing map layouts that you don't need until you are ready to print.

Layout View

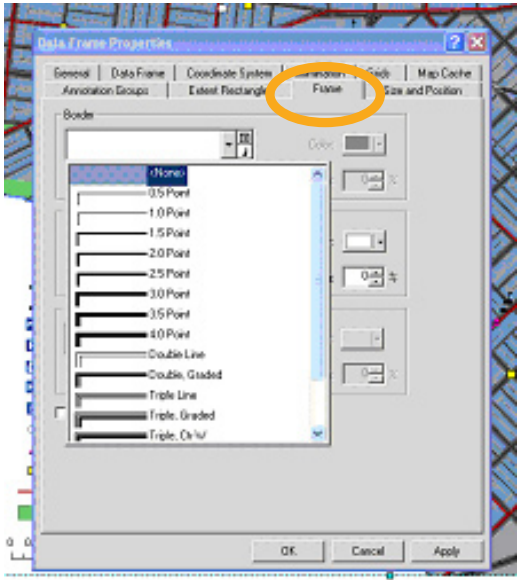
When you open ArcMap, you are in "Data View" and use the Tools toolbar to navigate your map. When you switch to the Layout View, you have access to a different range of tools and use the Layout toolbar to navigate. To switch to "Layout View," click on the icon at the bottom of your map display that looks like a piece of paper (next to the globe icon) or, from the View menu, go to Layout View.



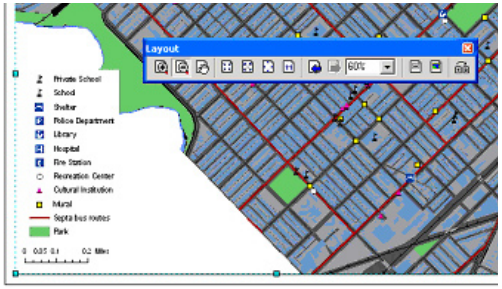
In Layout View, you get a much better idea of how your map will look when it's printed. ArcMap will automatically place a border ("neat line") around your map. You can remove this by right clicking on the border (so the line is turquoise and perforated) and going to "Properties."



Click on the "Frame" tab. From here you can choose a different style or color frame (to get rid of it altogether, choose "no color" from the color selector). You can also change the background color and add a shadow (to add a shadow, you'll need to change the X and Y offset to something other than 0).



To make your map larger or smaller on the page, you can use the zoom tools on the Tools toolbar or on the Layout toolbar. The Layout toolbar also includes a pan tool that you can use to move your whole layout. To move just your map (and not the whole page), use the pan tool in the Tools toolbar. The fixed zoom tools in the Layout toolbar work like the ones on the Tools toolbar. The "Zoom to whole page" button is especially useful. One of the biggest differences in Layout View is that many more options in the "Insert" menu become active. These options allow you to add elements—including a title, legend, north arrow, scale bar, and image—to your layout. Each of these will be separate objects in your



layout that can be moved and resized through their Properties. You won't see any of them if you switch back to Data View since they are meant to clarify printed maps, not help you interpret your map on screen (in fact, the layout view is probably more confusing to look at from the screen because it adds so many elements and usually shrinks your map). You can add text in the Layout View, but you are better off trying to label features from the Data View, using the label or text tools.

Working with Grids and Rulers

You can bring up a number of options aimed at helping you to place the objects within your layout by right clicking in your layout outside of the neat lines. From "Options," you can specify ruler units and turn on and off rulers and grids when the "Layout Options" tab is highlighted. Choosing to "snap" to the grid or rulers will help you to line up objects, but it will also limit your ability to make fine-level adjustments.

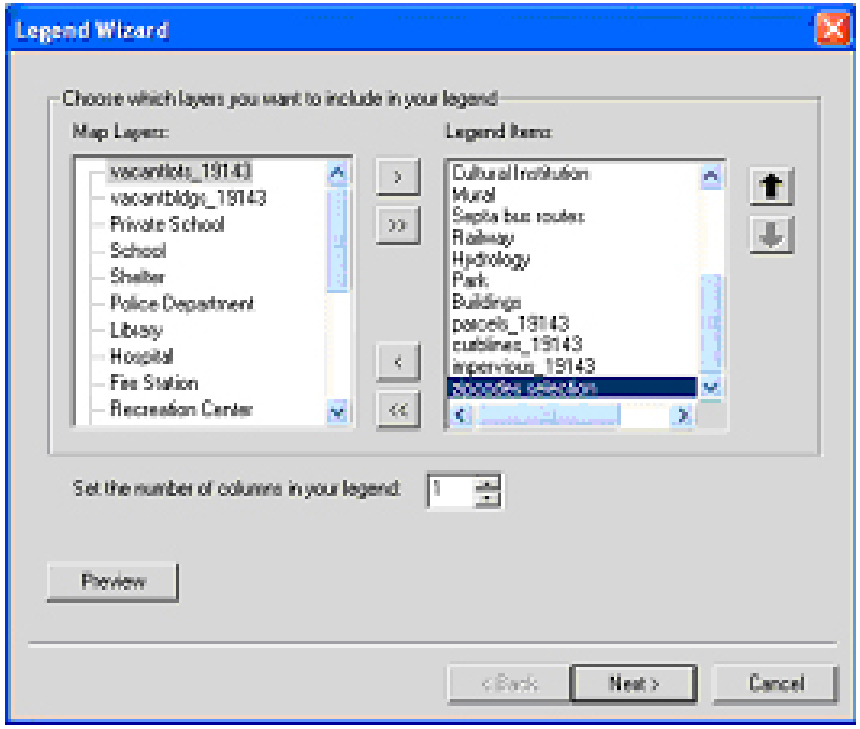
Adding a Title

To add a title, from the Insert menu go to "Title." Type your title in the text box and hit the enter key or click the cursor outside the text box. Double click on the title to bring up the Properties where you can make changes to the text and formatting.

Adding a Legend

Unless your labels are able to fully explain your map features, you will want a legend on your layout. ArcMap gives you great flexibility in formatting your legend, and all the choices can be overwhelming. To add a legend, from the Insert menu go to "Legend." Your first choice is what map layers you want included. ArcView will guess that you want to include all active layers. This may not be the case if you have layers such as a county boundary, rivers, or other obvious features that don't need to be included in the legend. To remove a layer from the legend, click on its name on the right side of this first screen and click on the "<" button. The order your layers are listed under "Legend Items" will correspond to the order in which they appear in your legend. To change the order, click on the name and hit the up or down arrows (don't worry; this won't affect the order in which they are drawn).

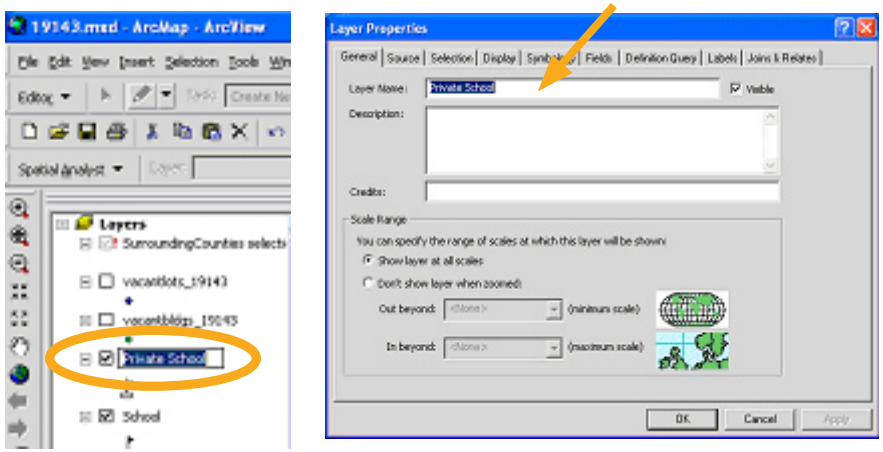
If you want more than one column in your legend, make the adjustment here. To see what your legend will look like (before working your way through the rest of the screens), click the "Preview" button. If you are satisfied with it, you can click the Finish button and skip the other steps. Otherwise, click the "Preview" button again and click "Next." On the second screen of the Legend



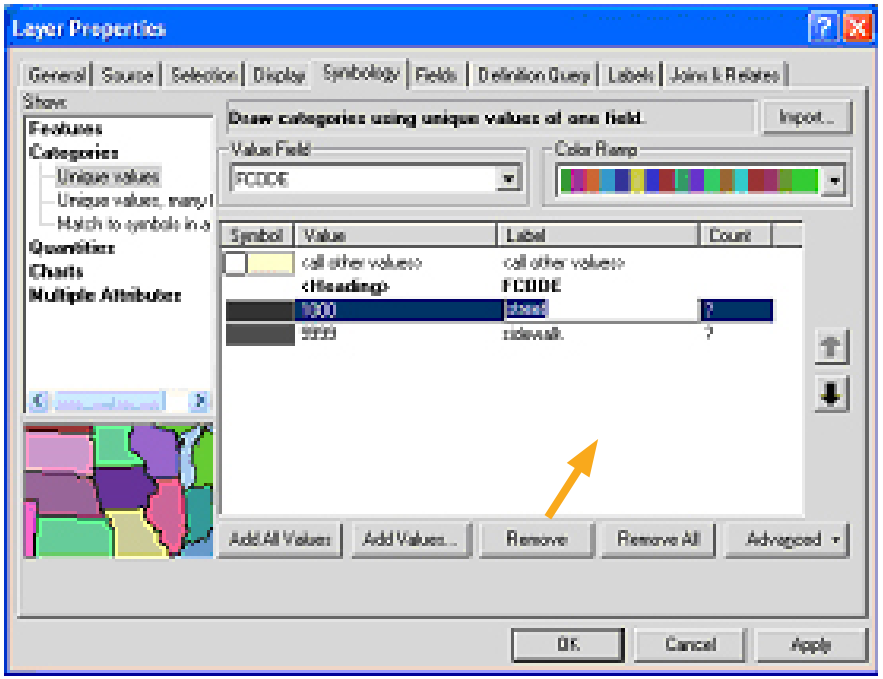
Wizard, you can give your legend a title or leave the word “Legend” as the title (or just leave it blank). The third screen allows you to create a frame and shadow around your legend (not necessary, but depending upon your layout it may be helpful, particularly if you gave your layout a background color). On the fourth screen, you can change the symbols and symbol size used to represent lines and polygons in your layout. On the final screen, you can make adjustments to the spacing between items in your legend. Click “Finish.” To make changes after you have created your legend, double click on it to bring up Properties.

Cleaning up your map legend

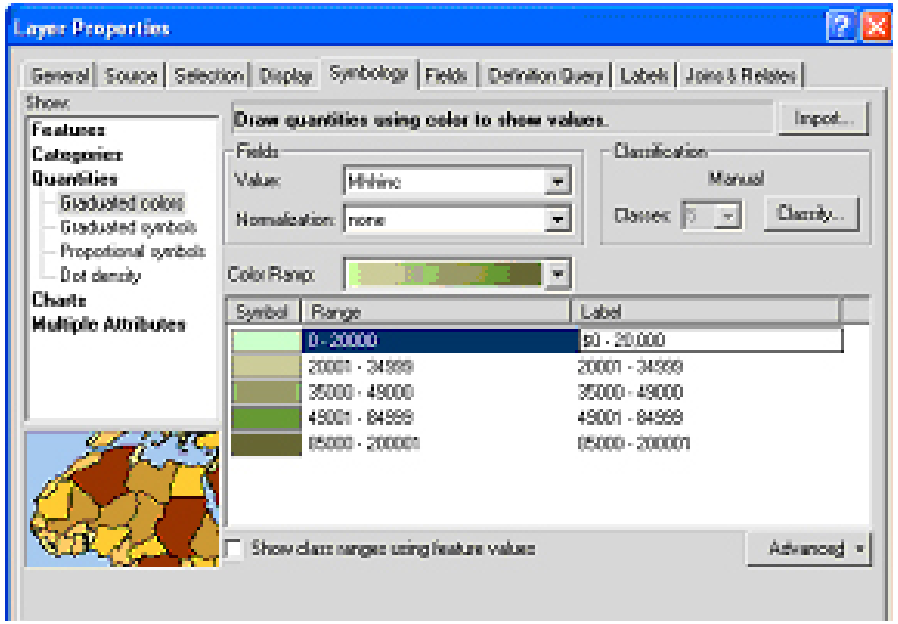
Chances are that you’ll need to clean up your legend at this point. Some of your map layer names may have underscores or other cryptic notations. The legend will use the same names that appear in the table of contents. You can change the label names in the table of contents without changing the name of the shapefiles on your computer. From the table of contents, click once on the map layer name, then click again (but not quickly). The label name should become highlighted, allowing you to make changes. You can also change the map label names from the “Layer Properties” dialog box, from the “General” tab.



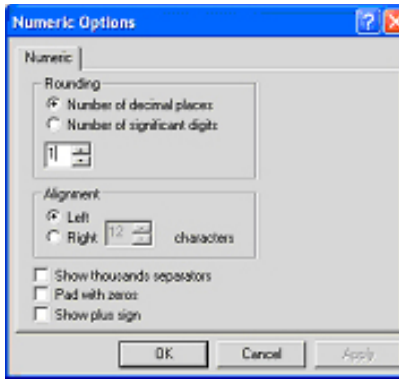
You may also need to translate some of the values that appear in your legend. For example, you may choose to symbolize a parcel shapefile with two different colors for the codes “1000” and “9999” which represent streets and sidewalks, respectively. From the “Symbology” tab, type in “street” and “sidewalk” under the Labels. Be careful not to change the numbers listed

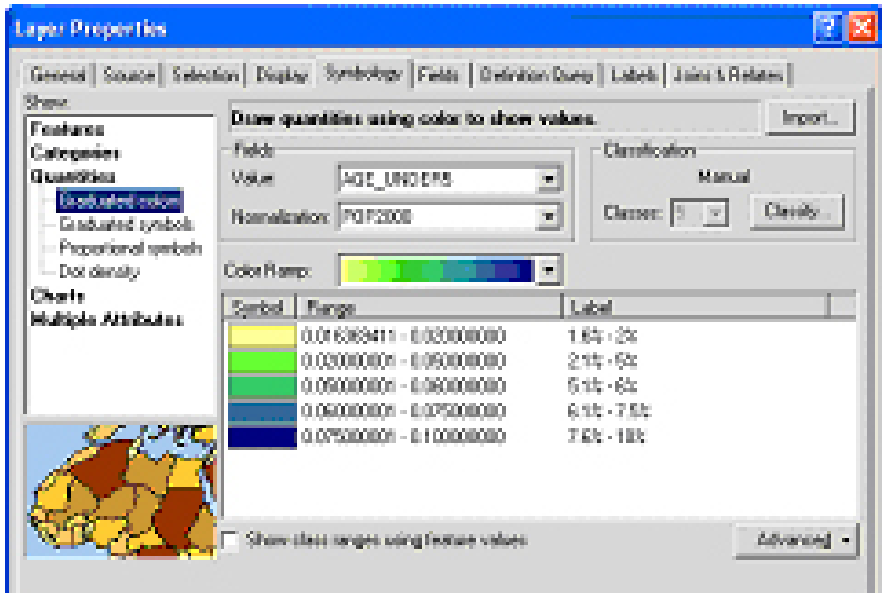


under “Value” because this will change your map. For maps symbolized using graduate colors, you may also want to make adjustments using the “Label” section of the “Symbology” tab. For income, be sure to add $ and commas.



For percentages, click on the word “Label” in the “Symbology” tab and choose “format labels.” Select “percentage” from the right. If your number looks like a decimal (0.15 for 15%), choose the second radio button and click on “Numeric option.” Here you can change the number of decimals (in most cases, you can use 1 or no digits after the decimal place. Including too many makes your map confusing and deceiving, since your data is not that precise).





Adding a North Arrow

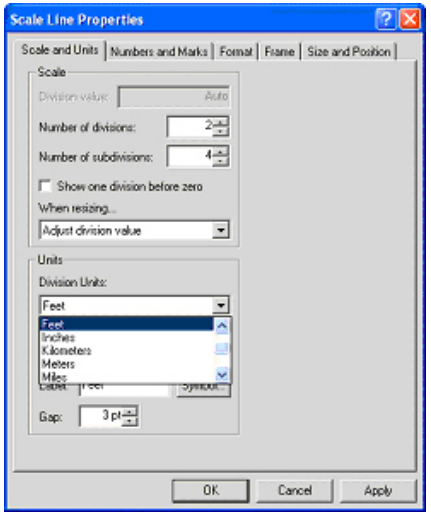
You may decide that a north arrow is not necessary (unless you choose to rotate your map so that north is no longer towards the top of the page; in that case, it is definitely necessary). If you do wish to add a north arrow, from the Insert menu go to "North Arrow." Choose a style from the "North Arrow Selector" (preferably something simple, and small). You can move it around on your layout by clicking on it. Double click to change the size or style. Consider a small north arrow and one that is discreet.

No

Yes

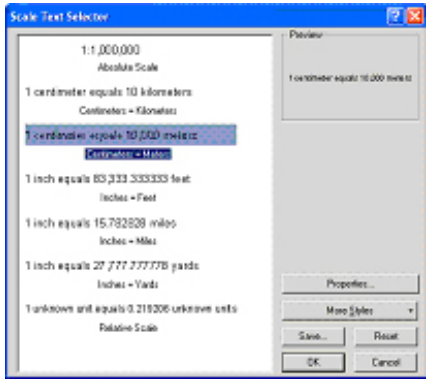
Adding a Scale Bar

To add a scale bar, you must identify the appropriate units for your map. You can set these from the Data View or Layout View. From Layout View, right click in the layout (anywhere inside the neat lines), go to Properties, and make the General tab active. From the map units dropdown menu, choose the units used for the original map projection (see "Working with Projections"). Once this is set, you can choose any display units you want. To add your scale bar, from the Insert menu, go to "Scale bar." Click on a style and hit "OK." Your scale bar should appear on your map. You can move or resize it by clicking on it. Double click to bring up the Properties, where you can change the number of divisions and as well as the font size (by clicking the Symbol button or from the format tab). You can also change the division units, from feet to miles or km, here. If your units read "unknown units," you will need to define your map projection before proceeding.



Adding Scale Text

You may wish to include a text description of the map scale, particularly if this is important to your audience and you deliberately chose a scale (as opposed to maximizing the size of your map based on the size of your page). To add scale text, from the Insert menu go to "Scale Text." Double click on the scale text in your layout to bring up the Properties, where you can make changes to the format and units.



Rotating a Map

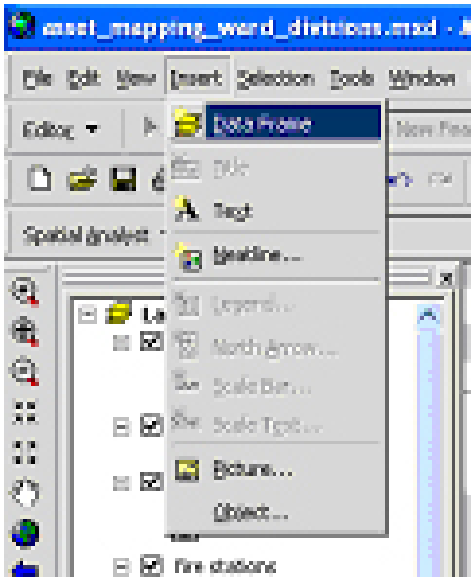
You can rotate your map to better fit the page or to make it easier to read (just because you can do this doesn't mean it's a good idea). If you do this, make sure that you have a north arrow on your map. As you rotate your map, your north arrow will adjust to indicate which direction is north. From the View menu, go to Toolbars (or just right click on a gray part of the GUI) and Data Frame Tools. Click on the "Rotate Data Frame" button, then click and hold down on your map, moving your map to change the rotation. To restore the original orientation, click on the "Clear Rotation" button.

Multiple-map Layouts

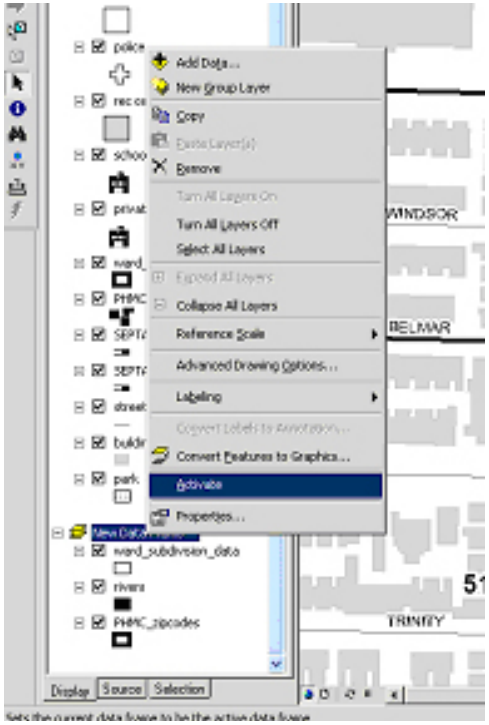
You may need to create a printed map that includes more than one map, either because you can't fit everything (such as Alaska and Hawaii) on your main map, you want to show a series of small multiples (same map with different variables), or because you want to zoom into a small area for your main map and indicate on a smaller overview map what area the larger map covers.

Adding Group Layers

Most of the time you will only need one data frame in a map document. Working with data frames can make your map document complicated and prone to crash. But if you need to include more than one map in your layout (including the same map at a different extent), you'll need two or more data frames. When you open ArcMap, you'll just have one data frame (called "Layer") and every map layer you add to your map document becomes part of this frame. To create a second data frame, from the Insert Menu go to "Add Group Layer."



To add new data to a particular data frame, right click on its name and go to "Add Data" or highlight its name and use the Add Data button (or, from the Insert menu, go to "Add Data"). If you want to move a layer to a different data frame once it is in ArcMap, right click on it and go to "Copy." Then right click on the name of the data frame where you want to move it and go to "Paste Layer." The layers in only one data frame can be displayed in the map view at a given time. It does not matter which one is listed first in the table of contents; it matters which one is active. To display the layers in a data frame, right click on its name and go to "Activate."

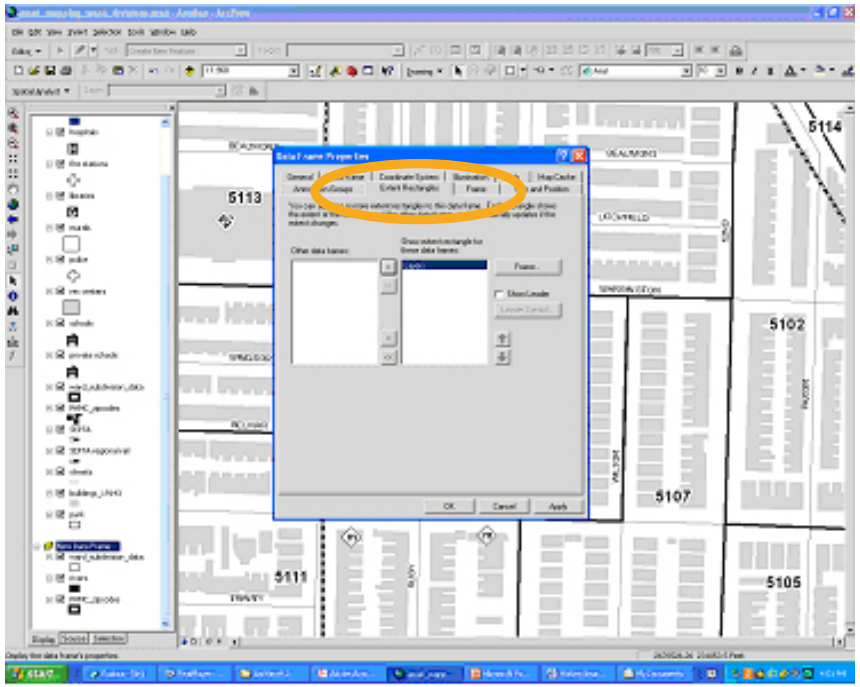


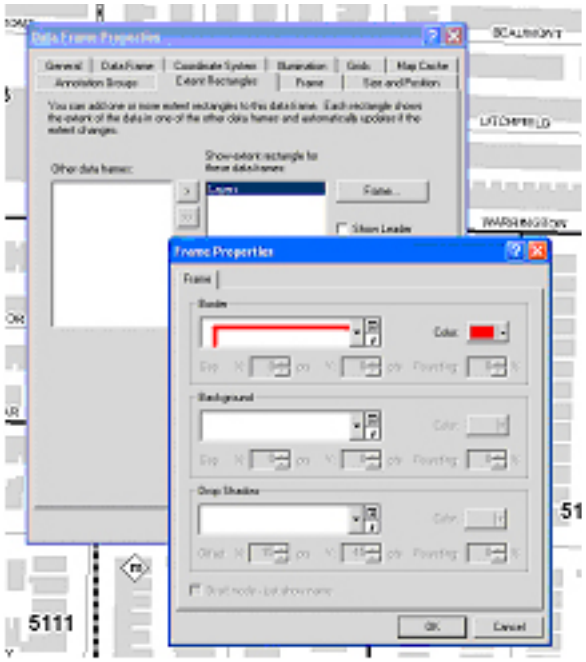
When you switch to the layout view, you will see that there are two map images, one for each data frame. You will likely need to resize and move these to fit together.

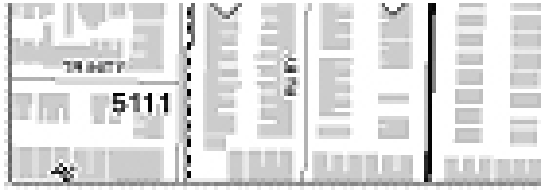
Creating Inset Maps

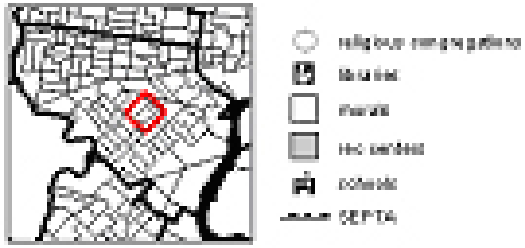
If you want to have an overview map that shows on a larger map the outline of the area your detailed map includes, you'll need to create an extant rectangle. To do this, follow the instructions above to create two map layers: a detail layer and an overview layer.

Zoom in on your detail layer in the map view and resize it in the layout view so that it looks the way you want. Then right click on the overview layer in your table of contents. From "Properties" click on the "Extent Rectangle" tab. Move your detail layer from the left to the right side. Click on the "Frame" button to make changes to the outline of your box.









Exporting Maps

If you just need paper copies of your maps, you will probably have the best results printing them from ArcView. But if you need to insert maps into Power Point or word processing files, will need to export your maps.

Exporting Process

You can export a map from ArcMap when you are in Data View or Layout View. However, if you want your exported map to include titles, legends, scale bars, north arrows, and anything else you added to the layout, you'll want to export from Layout View. From the File menu, go to "Export Map." There are many options for export formats in the "Save as type" drop downmenu.

.PDF: The .pdf format allows you to open the map directly (without inserting it into PowerPoint or MS Word) as long as you have Acrobat Reader. This is probably the best option if you need to send someone a map or post a map on the Internet.

.JPG: The .jpg format will compromise the quality of your image, so be sure to click on the "options' button when you export and increase the resolution to at least 200 dpi (300 dpi will be as good as you need for most things). The .jpg format is good because it stores your map in a fairly small file.

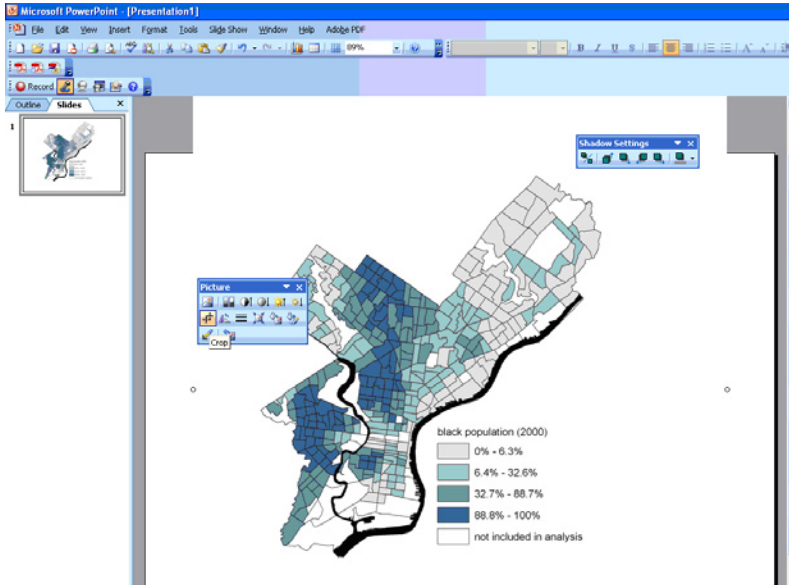
.TIF and .EPS*:* The .tif and .eps formats work well if you are going to open your maps in a graphics software package, but they result in larger files.

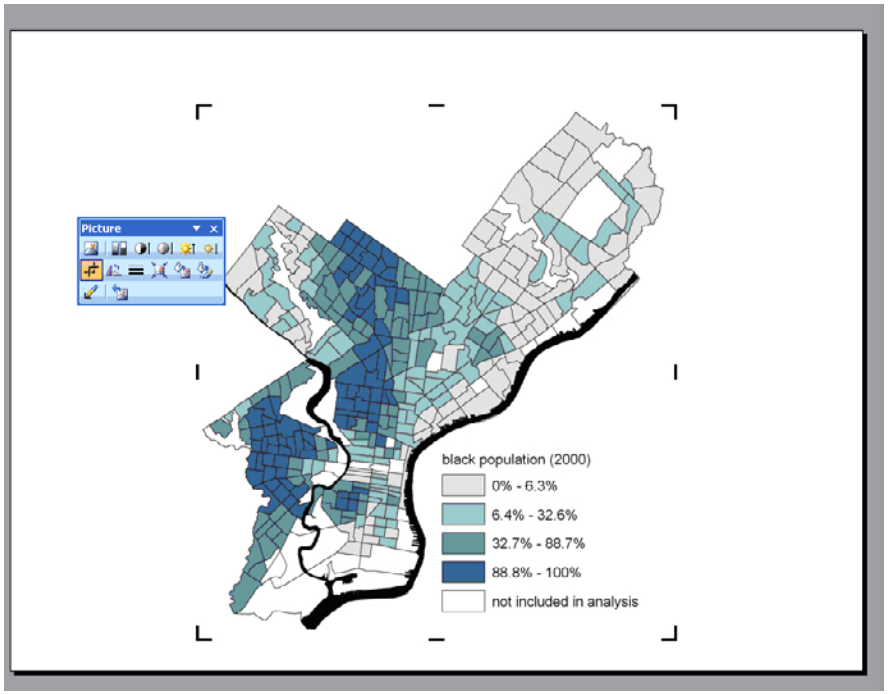
Screen Capture*:* If all else fails, you can take a screen capture (push the print screen button or alt + print screen buttons, then choose "paste") and crop the image, but this will not result in a presentation-quality map.

Inserting Maps into Power Point

Save your map as an .jpg. With Power Point open, go to the Insert menu, “Picture,” and “from file,” then Navigate to you map image and click “Insert.” You may notice that there is a lot of white space around your map. Eliminate this using the crop tool. You must have the map image active (click on it so that you see small squares at the corners). Click on the crop tool and crop the image by clicking on one of the small boxes and dragging the cursor (if you do this without having the crop tool active, you will shrink the whole image).

You are probably better off creating map titles in Power Point rather than ArcView. Also, if you are making a map specifically for Power Point, consider making the legend larger than usual (14 points or more) so that your audience can read it.





Inserting Maps into Microsoft Word

Follow the same procedures for inserting a map into Microsoft Word. You may have less flexibility in moving the map around than in PowerPoint, but you should be able to crop and resize it.

Working with Tables

Attribute Tables for Shapefiles

Every shapefile has an attribute table associated with it. You can open the table by right clicking on the shapefile name and going to "open attribute table." The table will have as many rows, or records, as it does map features. The total number of records will be shown at the bottom of your table. There can be any number of columns (fields). Two columns are standard: FID, the feature ID, and Shape, which can be point, polyline, or polygon. The rest of the fields will vary. In most cases, there will also be a column that identifies each map feature with a unique name, such as a census tract number or neighborhood name. There may be additional fields identifying attributes of the map feature (type of crime at a particular address, number of people living in a census tract).

FID	Shape *	BRANCH_NAM	TYPE	ADDRESS
0	Point	Myers Francis Rec Center	Recreation	58 & Kingsessing
1	Point	Woodland PLGD	Recreation	48 & Woodland
2	Point	Kingsessing Rec Center	Recreation	5100 Chester Ave
3	Point	Christy Rec Center	Recreation	56 & Christian
4	Point	Morris Rec Center	Recreation	59 & Spruce

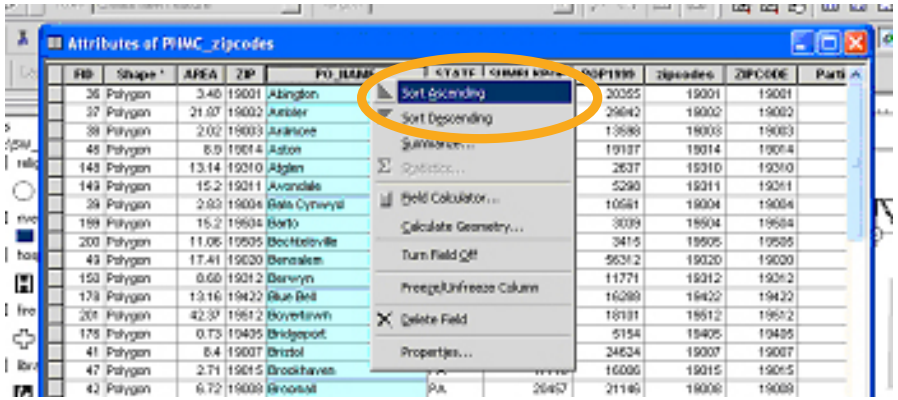
Other Attribute Tables

Often you will have attribute data in a table separate from your shapefile. For example, you may have a census tract shapefile with no attribute information and a table with all of the 2000 census tract data. ArcMap can read Excel (.xls), dBase (.dbf), comma-delimited (.txt or .csv) and tab-delimited (.tab) text tables but will only allow editing for .dbf tables (you can convert .txt tables to .dbf in EXCEL, SPSS, ACCESS, or in ArcMap). You can add attribute tables to ArcMap just as you do shapefiles, using the "add data" button or, from the file menu, "Add Data." When you add a table, ArcMap will switch the table of contents from the "display" to "source" tab. You can only see tables listed when the "source" tab is active.

Open the table by right clicking on its name in the table of contents and going to "open." Your table should have at least one column that contains geographic information. This might be a street address, X and Y coordinates, census tract number, zip code, or other identifier that will allow you to match the information in your attribute table to map features in a shapefile. You can work with tables—sort values, freeze columns, generate summary statistics, select records, and export tables—without worrying about corrupting your data. You cannot change any of the data in your table unless you go to "start editing" from the editor toolbar… except to add new fields or delete existing fields.

Sorting Records

You can sort values in an attribute table by right clicking on the field name and going to “sort ascending” or “sort descending.”

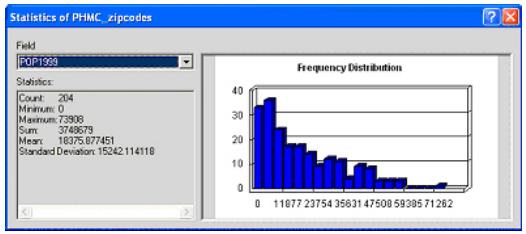


Freezing Columns

Freeze a column (meaning that it will remain in view even as you scroll) by right clicking on the field name and going to “Freeze/Unfreeze Column.”

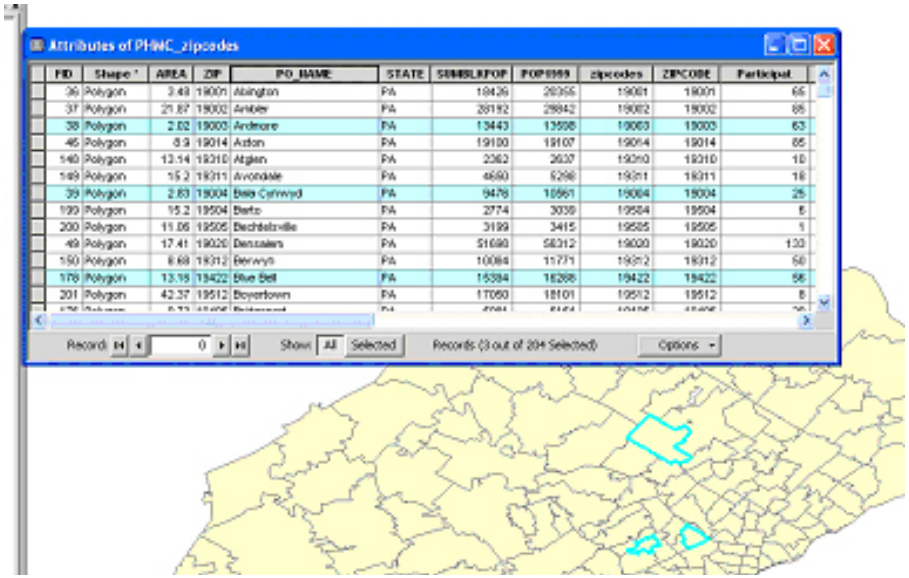
Summary Statistics

You can bring up summary statistics for any numeric field (numeric fields will be justified right) by right clicking on the field name and choosing “Statistics.” You can obtain summary statistics on additional fields from the drop down menu.



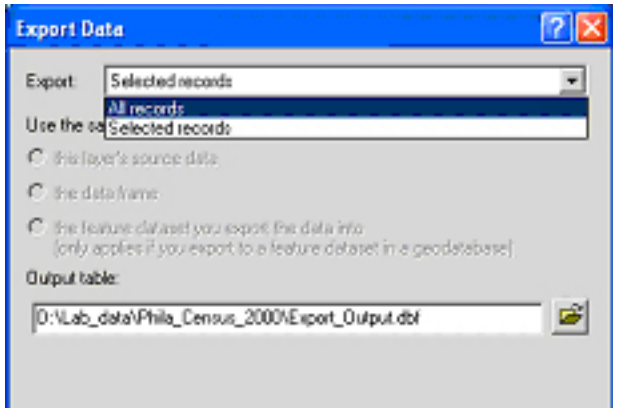
Selecting Records

You can select a subset of your records to look at more closely in a number of different ways. You can highlight an individual record (row) by clicking in the gray area at the far left side of the table. To highlight multiple records, hold the control key down. At the bottom of the table, ArcMap will indicate how many of the total records are highlighted. Click on the “Selected” button to view only the selected records. You can switch the selection, so that all of the highlighted records become un-highlighted and all un-highlighted records become highlighted. From the options menu, choose “Switch Selection.” You can also select all records or clear selection from the options menu.



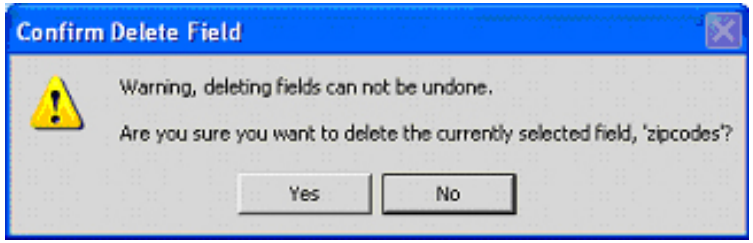
Exporting Tables

You may need to export your table from ArcMap, because you have made changes, need to convert a .txt table to .dbf, or for any other reason. With your table open, go to the options menu and "Export." If you have some records highlighted, you can choose to export just the selected records or all of the records.



Delete Field

You can delete a field by right clicking on its name and going to "Delete Field." ArcMap will give you a warning that the deletion is permanent and not reversible. Do this with caution. Changes will be permanent not just within your map document, but in your original file on your hard drive, as well.



Calculating Values in Tables

You may find it easier to edit your attribute tables outside of ArcView, but ArcView has fairly sophisticated tools for calculating values. In ArcView, you can edit values in an existing field or create a new field and calculate new values. Keep in mind that you cannot change the format (text, integer, long integer) of an existing column, so if you need to transform the format of a column, you will need to create a new field.

Creating a New Field

To create a new field, open your table in ArcMap (you can also add fields from ArcCatalog). This can be a free-standing table or one that is associated with a map layer, but only .dbf tables can be edited. Click on the "options" button (if you do not see the options button, make your table bigger; it's in the lower right corner). Go to "Add Field." If this option is grayed out, you do not have permission to edit the table. Most likely, this is because the "read only" box is checked in the table properties. This may happen automatically when you copy data off a cd. To change this, find your table on your hard-drive (through Windows Explorer or My Computer, not through ArcCatalog), right click, and go to "properties." Remove the check mark next to "read only."

From "Add Field," give your field a name. Do not use ?,&,$,#,@,*,!,~ or spaces and keep your field name to 10 or fewer characters. From the dropdown menu, choose the type of field. Different field types allow different types of values:

Short integer: numeric, no decimal place, up to 19 characters

Long integer: numeric, no decimal place, up to 19 characters

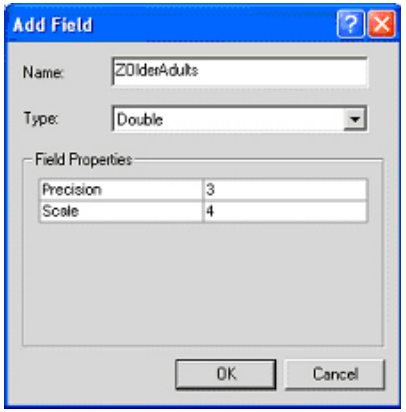
Float: numeric, with decimal place, (default is one place before

decimal and 11 after) Double: numeric, with decimal place (default is 7 places before the decimal and 11 after)

Text: numbers or letters, specify length (default = 50 characters)

Date: can include time and date

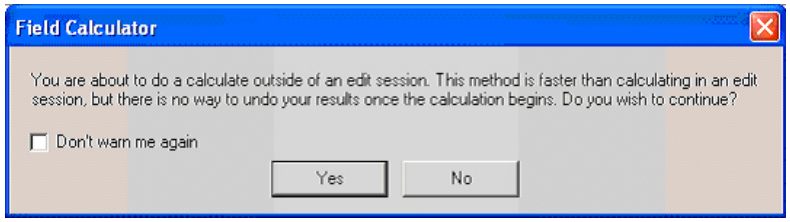
Depending upon the field, you may need to specific the scale (number of places) and precision (number of places to the right of the decimal point), or accept the defaults by leaving them 0. NOTE: You can also add a new field from ArcToolbox (under "Data Management Tools", then "Add Field").



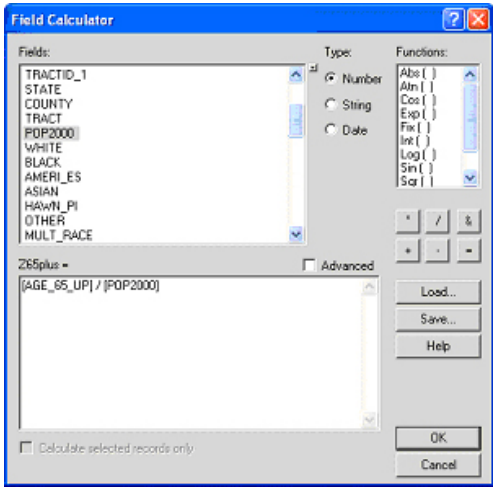
Calculating Values Outside an Edit Session

To calculate the value of your new field (or an old field), right click on its name and go to "Calculate Values." ArcMap will ask you if you are sure that you want to calculate values outside an edit session, warning that you will not be able to undo your results. Say "yes."

ArcMap will bring up the Field Calculator. If your value is a constant, you can simply type the value in the box at the bottom. More likely, your new value will be based on values in other fields, so you will need to use the calculator. You can create an expression by double clicking on the field names. For example, to calculate the percent of the population 65 and up, click on the

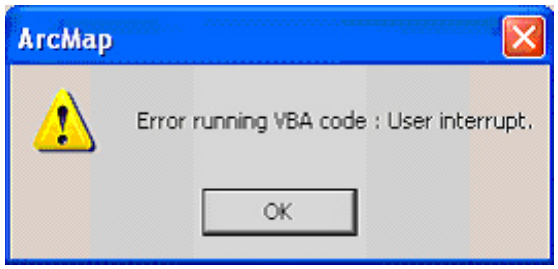


field name with the total 65 and up, click on the "/" button, and click on the field name with the total population. If any of the records in your table are highlighted, ArcMap will only perform calculations on the highlighted records. You can also calculate values from ArcToolbox (under "Data Management Tools", then "Calculate Field").

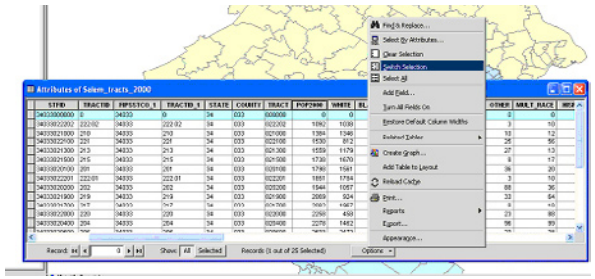


Calculating Values on Selected Records

You can get an error while calculating values for many different reasons. ArcMap will not allow you to divide by zero, so if the denominator (total population in example above) is zero for any of your records, ArcMap will not calculate any of the values.

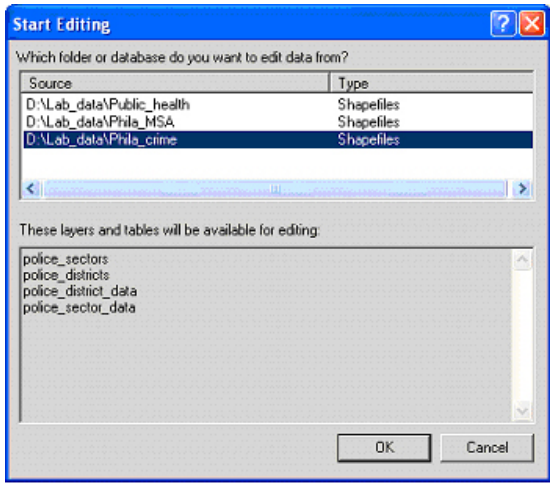


To get around this problem, you need to select only the records where the denominator is something other than zero. Start by selecting the records with a zero in the denominator (because there are fewer of these). Do this by right clicking the field with your denominator and sorting ascending. Hold down the control key and highlight all the records with a zero. From the options menu, choose "Switch Selection" so that all of the records with non-zero values are highlighted. Now you should be able to proceed with calculating values.



Calculating Values Inside an Edit Session

When you need to calculate a new variable, the best approach is to calculate a value outside an edit session, just described. But when you need to change the value on just one or two values, you may want to try editing inside an edit session. Go the Edit toolbar and, from the edit menu, choose "start editing." You can only edit the contents of one directory at a time in an edit session, so you need to identify the directory that contains the table you wish to edit.



Open your table and double-click on the value in your table you wish to edit. When you are finished, go to "stop editing" in the edit toolbar and say "yes" to saving edits.

Finding & Replacing Values

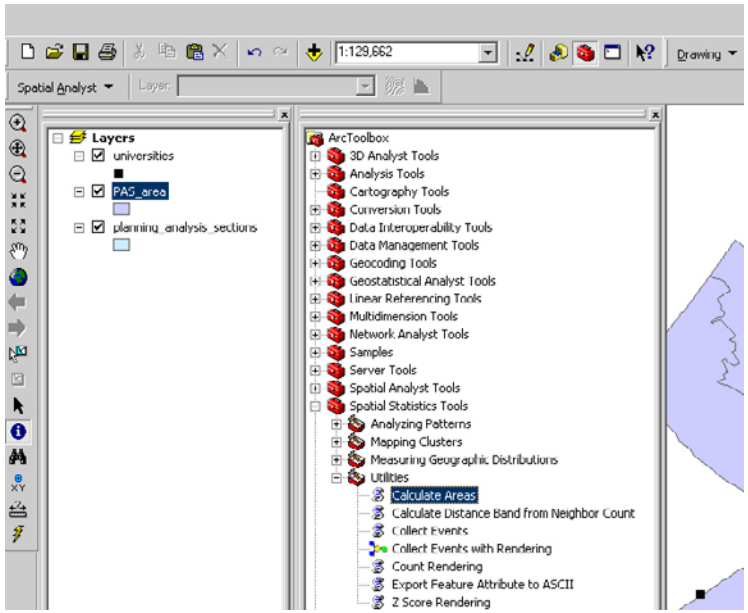
You can find and replace values in a table systematically from the options menu. In order to replace values, you must be have started an edit session (from the edit toolbar, go to "start editing").

Calculating Area, Perimeter & Length

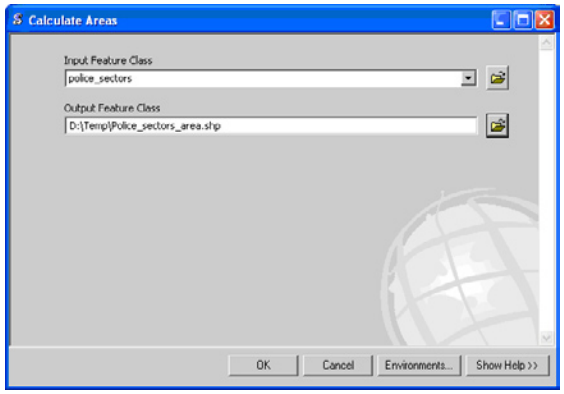
Calculating Area

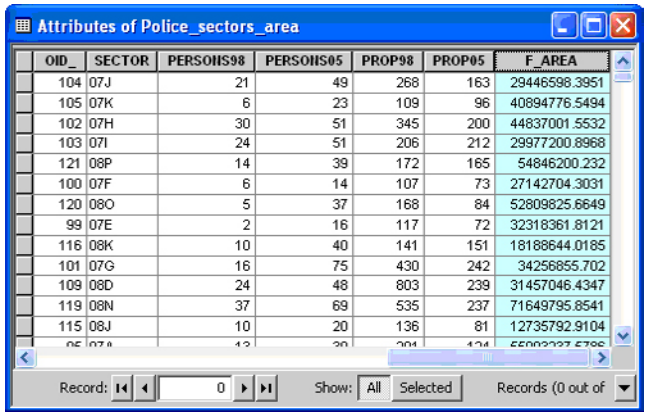
Usually there will be a field called “area” in a shapefile when you receive it that indicates the area of each polygon map feature. If your shapefile is missing this field or if you have edited the shape and size of the map features, you will need to calculate area, yourself. Area can be especially helpful when you are trying to normalize values and create densities (calculating persons per square mile, for example).

You can calculate area through ArcToolbox or through the Field Calculator, but it is easier using ArcToolbox. “Calculate Area” can be found in the Spatial Statistics Tools section, under “Utilities.”



Choose the polygon layer for which you want to calculate area, then determine a name and location for the new shapefile you will create. The new layer will be added automatically to the table of contents when ArcView is done calculating the area. The units will be what is used by the projection system for that map layer.





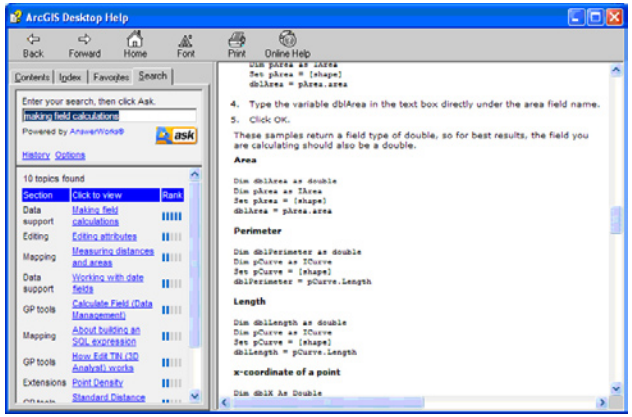
OID_	SECTOR	PERSONS98	PERSONS05	PROP98	PROP05	F_AREA
104	07J	21	49	268	163	29446598.3951
105	07K	6	23	109	96	40894776.5494
102	07H	30	51	345	200	44837001.5532
103	07I	24	51	206	212	29977200.8968
121	08P	14	39	172	165	54846200.232
100	07F	6	14	107	73	27142704.3031
120	08O	5	37	168	84	52809825.6649
99	07E	2	16	117	72	32318361.8121
116	08K	10	40	141	151	18188644.0185
101	07G	16	75	430	242	34256855.702
109	08D	24	48	803	239	31457046.4347
119	08N	37	69	535	237	71649795.8541
115	08J	10	20	136	81	12735792.9104

You can also calculate are using the Field Calculator. First, open the attribute table associated with your polygon shapefile (right click on the name in the table of contents and go to “Open Attribute Table”). From the options menu, go to “Add Field.” Call your field “Area” or “New_Area” if a field called “Area” already exists. Choose “double” as the style and click “ok.” Right click on your new field and go to “Field Calculator.” Check “Advanced” and type the following in the first text box:

Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area

Type “dblArea” in the next box and click “OK”.

You can copy and paste this script directly from the ArcView help (or from this manual). From the ArcView help menu, click on the “search” tab and type “making field calculations.”



Calculating Perimeter

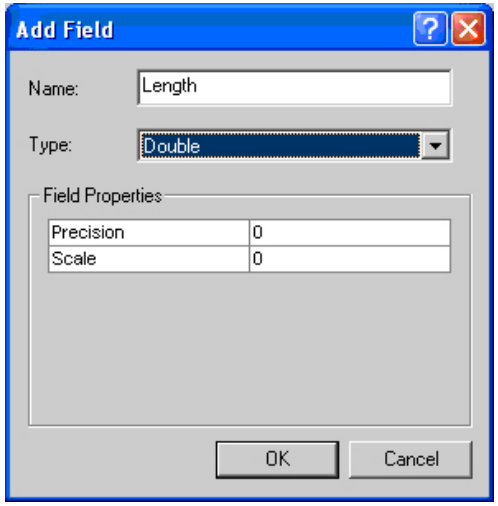
As with area, you may inherit polygon shapefiles with a perimeter field. If not, or if you need to recalculate it, proceed as you would to calculate area. You will need to use the Field Calculator to calculate perimeter. Open the attribute table, click on “Options” and go to “Add Field.” Create a field called “Perimeter,” choose “double” for the style, and click “OK.” Right click on the heading of your new column and go to “Field Calculator.” Check “Advanced” and type the following into the first text box:

Dim dblPerimeter as double
Dim pCurve as ICurve
Set pCurve = [shape]
dblPerimeter = pCurve.Length

Type “dblPerimeter” in the second text box and click “OK.”

Calculating Length

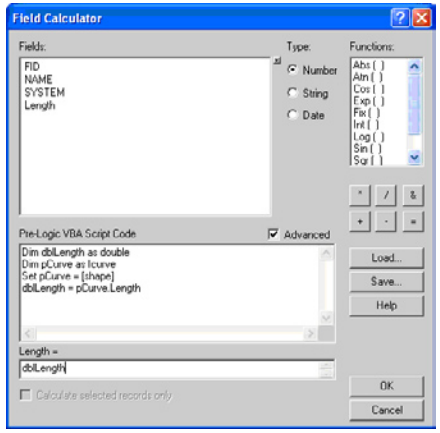
You may also need to calculate, or recalculate, the length of the line segments that make up a line shapefile (such as streets or railroad tracks). Open the attribute table, click on “Options” and go to “Add Field.” Create a field called “Length,” choose “double” for the style, and click “OK.”

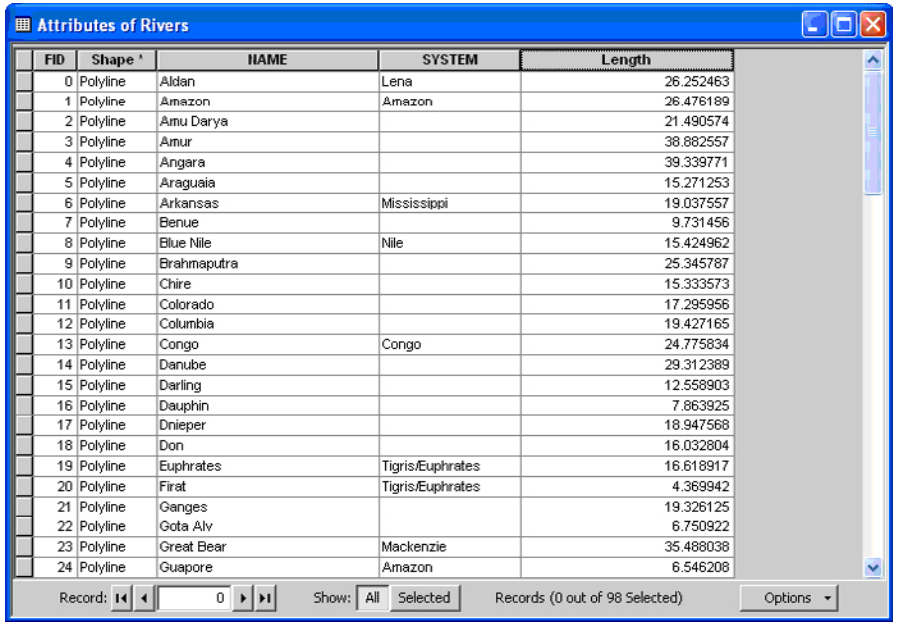


Right click on the heading of your new column and go to “Field Calculator.” Check “Advanced” and type the following into the first text box:

Dim dblLength as double
Dim pCurve as Icurve
Set pCurve = [shape]
dblLength = pCurve.Length

Type “dblLength” in the second text box and click “OK.”





FID	Shape *	NAME	SYSTEM	Length
0	Polyline	Aldan	Lena	26.252463
1	Polyline	Amazon	Amazon	26.476189
2	Polyline	Amu Darya		21.490574
3	Polyline	Amur		38.882557
4	Polyline	Angara		39.339771
5	Polyline	Araguaia		15.271253
6	Polyline	Arkansas	Mississippi	19.037557
7	Polyline	Benue		9.731456
8	Polyline	Blue Nile	Nile	15.424962
9	Polyline	Brahmaputra		25.345787
10	Polyline	Chire		15.333573
11	Polyline	Colorado		17.295956
12	Polyline	Columbia		19.427165
13	Polyline	Congo	Congo	24.775834
14	Polyline	Danube		29.312389
15	Polyline	Darling		12.558903
16	Polyline	Dauphin		7.863925
17	Polyline	Dnieper		18.947568
18	Polyline	Don		16.032804
19	Polyline	Euphrates	Tigris/Euphrates	16.618917
20	Polyline	Firat	Tigris/Euphrates	4.369942
21	Polyline	Ganges		19.326125
22	Polyline	Gota Alv		6.750922
23	Polyline	Great Bear	Mackenzie	35.488038
24	Polyline	Guapore	Amazon	6.546208

Changing Units

ArcMap will calculate area based on the map units used for the projection in which the shapefile is stored. For unprojected data, this is decimal degrees (not particularly helpful for understanding area). For projected shapefiles, the most common map units are meters and feet. If you are not sure what units ArcMap is using, check the spatial reference properties. From ArcCatalog, right click on the shapefile name and go to “Properties.” With the “Fields” tab active, click on the field name “Shape” and then click on the “…” next to the “Spatial Reference” at the bottom of the Field Properties. Look for the unit listed next to “Linear Unit.”

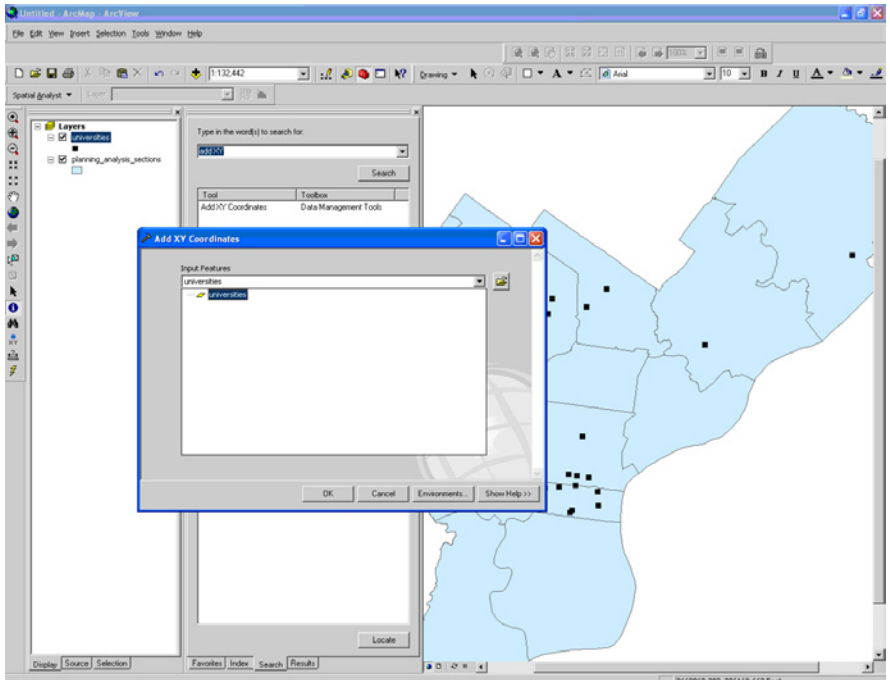
Most likely, your data will be in projections using feet or meters as the map unit. To convert feet to miles (for perimeter and length), divide the area by 5,280. To convert meters to miles, divide by 1,609.344. To convert square feet to square miles, divide the area by (5,280*5,280) = 27,878,400. To convert square meters to square miles, divide by (1,609.344 *1,609.344) = 2,589,988.110336. For more on conversions, visit

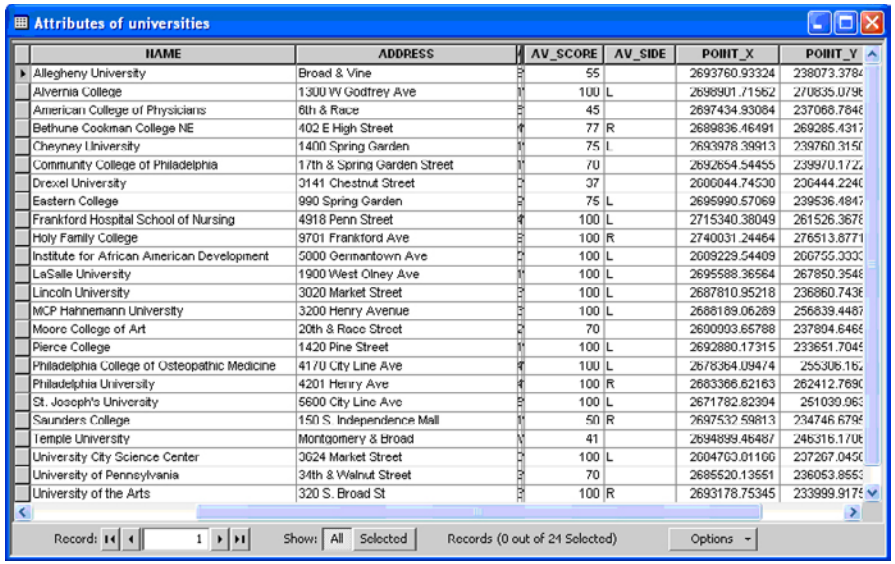
http://www.onlineconversion.com/length.htm or
http://www.translatum.gr/converter/measurements.htm.

Creating XY Coordinates

Adding XY Coordinates to a Point Layer

Just as you may need to convert a table with XY data into a map layer, you may need to add XY coordinates to an existing layer containing points. The easiest way to do this is by using “Add XY Coordinates” in ArcToolbox (under “Data Management Tools” go to “Features” to fine “Add XY Coordinates”). Simply choose the point layer you want to assign XY coordinates and click “OK.” The coordinates will be in whatever units are defined by your projection (often feet or meters).





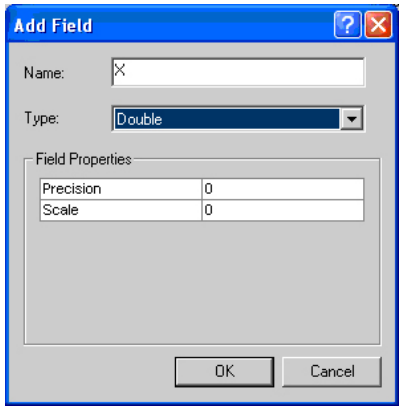
Attributes of universities

NAME	ADDRESS	AV_SCORE	AV_SIDE	POINT_X	POINT_Y
Allegheny University	Broad & Vine	55		2693760.93324	238073.3784
Alvernia College	1300 W Godfrey Ave	100	L	2698901.71562	270835.0798
American College of Physicians	6th & Race	45		2697434.93084	237068.7848
Bethune Cookman College NE	402 E High Street	77	R	2689836.46491	269285.4317
Cheyney University	1400 Spring Garden	75	L	2693978.39913	239760.3150
Community College of Philadelphia	17th & Spring Garden Street	70		2692654.54455	239970.1722
Drexel University	3141 Chestnut Street	37		2690044.74530	236444.2240
Eastern College	990 Spring Garden	75	L	2695990.57069	239536.4847
Frankford Hospital School of Nursing	4918 Penn Street	100	L	2715340.38049	261526.3678
Holy Family College	9701 Frankford Ave	100	R	2740031.24464	276513.8771
Institute for African American Development	5000 Germantown Ave	100	L	2689229.54409	266755.3333
LaSalle University	1900 West Olney Ave	100	L	2695588.36564	267850.3548
Lincoln University	3020 Market Street	100	L	2687810.95218	236860.7438
MCP Hahnemann University	3200 Henry Avenue	100	L	2688189.06289	256839.4487
Moore College of Art	20th & Race Street	70		2690993.65788	237804.6465
Pierce College	1420 Pine Street	100	L	2692880.17315	233651.7045
Philadelphia College of Osteopathic Medicine	4170 City Line Ave	100	L	2678364.09474	255306.162
Philadelphia University	4201 Henry Ave	100	R	2683366.62163	262412.7690
St. Joseph's University	5600 City Line Ave	100	L	2671782.82394	251039.063
Saunders College	150 S. Independence Mall	50	R	2697532.59813	234746.6795
Temple University	Montgomery & Broad	41		2694899.46487	246316.1706
University City Science Center	3624 Market Street	100	L	2684763.01166	237267.0456
University of Pennsylvania	34th & Walnut Street	70		2685520.13551	236053.8553
University of the Arts	320 S. Broad St	100	R	2693178.75345	233999.9175

Record: 1 Show: All Selected Records (0 out of 24 Selected) Options

You can check the new XY coordinates by mapping them. With you table open, click on “Options,” and go to “Export.” Say “yes” and add the new table to your existing map, then close the table. From the tools menu, go to “Add XY Data” and select your table from the drop down menu (ArcMap will probably have done this for you already). Click “ok.” Your table of contents should now show two identical point layers.

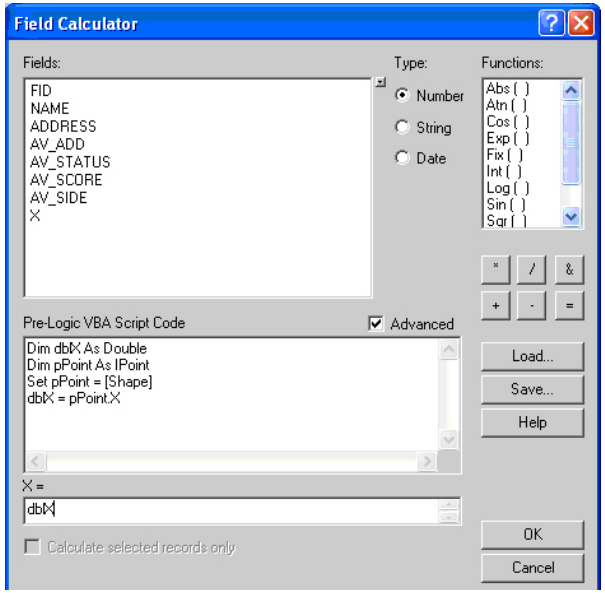
You can also add XY coordinates through the new X and Y columns and using a Visual Basic script to calculating the X and Y values (coordinates). With your attribute table open, go to options, add new field called “X,” type “Double.”



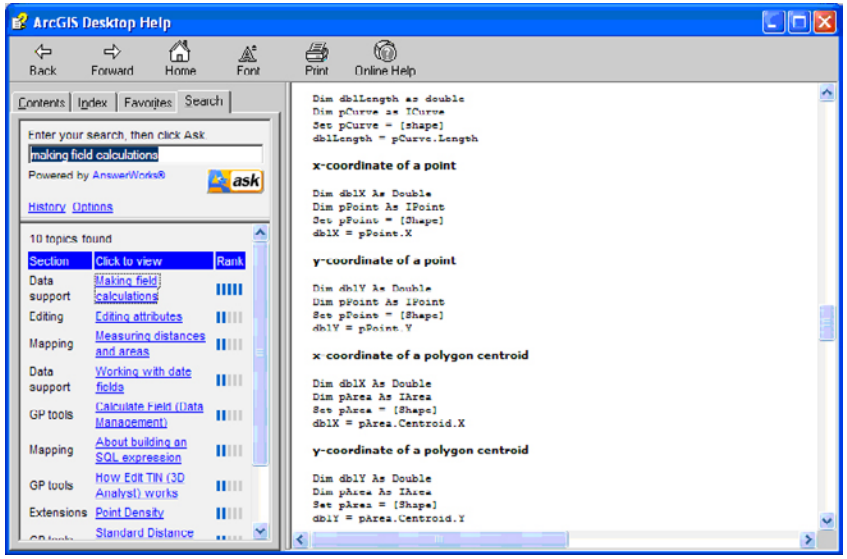
Right click at the top of your new column and go to "Field Calculator…" Check "Advanced" and type the following in the first box (that says "Pre-logic VBA Script Code"):

Dim dblX As Double
Dim pPoint As IPoint
Set pPoint = [Shape]
dblX = pPoint.X

Then type "dblX" in the smaller text box (that says "X =") in the text box directly under the X field name. Click "ok." Follow the same steps to create and calculate a Y field, changing the Xs in the VB script to Y.



The script for calculating XY coordinates can be found in ArcGIS Desktop Help by clicking on the "search" tab, the typing "making field calculations." Accessing the script this way will allow you to copy and paste the script.



Adding XY Centroid Coordinates to Polygon Layer

Adding the X and Y coordinates of the centroids of polygons is similar to adding X and Y coordinates to a point layer. With your attribute table open, go to options, add new field called "X," type "Double." Right click at the top of your new column and go to "Calculate Values…" Check "Advanced" and type the following in the first box (that says "Pre-logic VBA Script Code"):

```
Dim dblX As Double
Dim pArea As IArea
Set pArea = [Shape]
dblX = pArea.Centroid.X
```

Then type "dblX" in the smaller text box (that says "X =") in the text box directly under the X field name. Click "ok." Follow the same steps to create and calculate a Y field, changing the Xs in the VB script to Y.

You can check the new XY coordinates by mapping them. With you table open, click on "Options," and go to "Export." Say "yes" and add the new table to your existing map, then close the table. From the tools menu, go to "Add XY Data" and select your table from the drop down menu (ArcMap will probably have done this for you already). Click "ok." Your table of contents should now show a new point layer that represents the centroid of your polygon layer.

The script for calculating XY centroids can be found in ArcGIS Desktop Help by clicking on the "search" tab, the typing "making field calculations." Accessing the script this way will allow you to copy and paste the script.

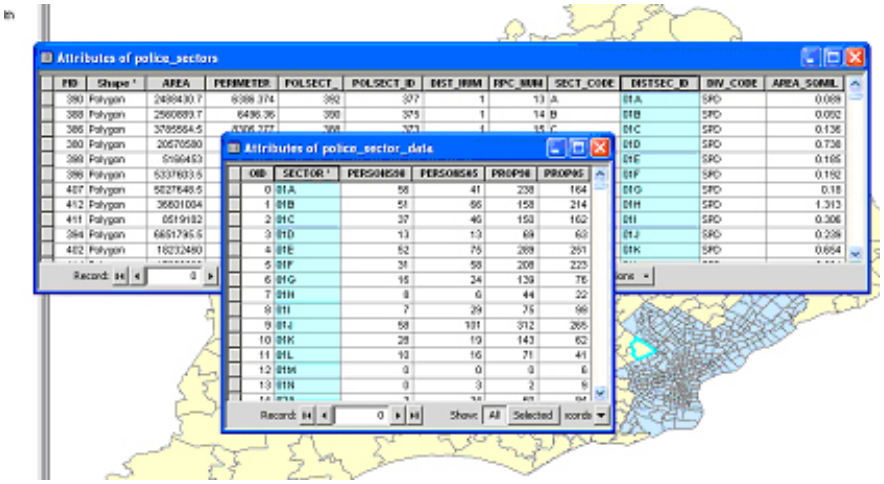
Joining Tables

You can link map features to their attributes in GIS but only when your attributes are in the same file as your geographic data. Often you will have attributes stored in a separate table that you will need to join to a shapefile in order to symbolize your map with the data. You might think of a shapefile as a series of containers that can hold attribute data. Often you will obtain shapefiles that have no attribute data—in effect, empty containers. This is especially common with census data, when you will often obtain shapefiles for census tracts and blockgroups in separate files from the census attribute data (SF1 or SF3).

Identifying a key

In order to join an attribute table to a shapefile, you will need to identify a field that is common to your attribute table and the attribute table associated with your shapefile. This field is known as a key, or unique identifier, because it uniquely identifies each record in your table and shapefile on which ArcView can join, or match, your data. The values must be formatted in an identical way. If they are not, you must edit one of the fields or create a new field and recalculate the values so that they match perfectly.

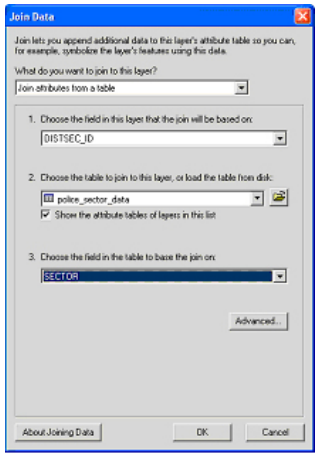
Tables with census data may contain multiple fields that uniquely identify each record that may have names such as “TRT2000,” “STFID,” and “TRACTID.” The field name doesn’t have to be the same in the attribute table and the shapefile in order to join them; they just have to be formatted in the same way. While you may perform joins on census data most frequently, you can join attributes to shapefiles for other data: zipcodes, councilmanic districts, counties. You can join on a name (such as neighborhood name, or the name of an institution), although keep in mind that differences in spelling and spacing will keep records from joining.



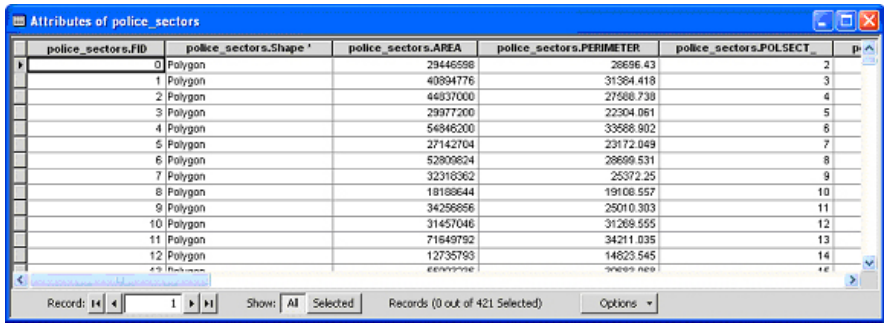
To make sure that both columns are formatted the same way, look and see how they are justified. Left justified columns are formatted as text; right justified columns are formatted as numbers.

Joining a table

To join attribute data to a shapefile, you must add the shapefile to ArcMap. Right click on its name in the table of contents, go to “Joins and Relates,” and then “Join…”. Choose “Join attributes from a table” in the first dropdown menu. In the second dropdown menu, identify the key you’ll use in your shapefile. Next, choose the table you wish to join (this does not need to be added to ArcMap). Finally, identify the key in this table. Keep in mind that ArcView is not checking to make sure that these keys match, so you should double-check them (by opening both tables) before performing the join.

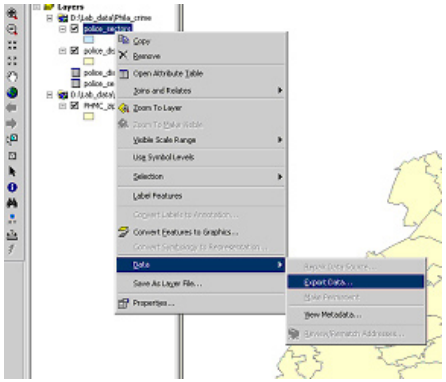


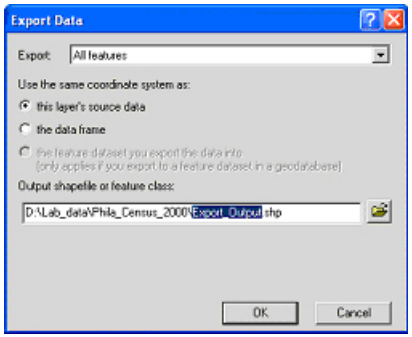
From "Advanced," you can indicate what you want ArcView to do if all of the map features in the shapefile don't have a match in the attribute table, or vice versa. The default is to keep all records, meaning that some map features might have no values for some fields. Individual records might not match because of problems with the key or because there are different numbers of records in each of your files. When you open your shapefile, there should be new fields that contain the data from your attribute table. The new field names will include the name of the attribute table from which it came.



police_sectors.FID	police_sectors.Shape *	police_sectors.AREA	police_sectors.PERIMETER	police_sectors.POLSECT_
0	Polygon	29446598	28696.43	2
1	Polygon	40894776	31384.418	3
2	Polygon	46837000	27588.738	4
3	Polygon	29977200	22304.061	5
4	Polygon	54846200	33588.902	6
5	Polygon	27142704	23172.049	7
6	Polygon	52809824	28699.531	8
7	Polygon	32318362	25372.25	9
8	Polygon	18188644	19108.557	10
9	Polygon	34258856	25010.303	11
10	Polygon	31457046	31269.555	12
11	Polygon	71649792	34211.035	13
12	Polygon	12735793	14823.545	14

The join holding the data together is not permanent, so if you add the shapefile to another map document, you will not have the appended data. To make the join permanent, right click on the shapefile name, go to "Data," and choose "Export Data…" This works like a "save as," so it creates a new shapefile. Give your new file a name (do not accept the default, "Export_Output.shp") and location. The resulting shapefile will have variable names that are much shorter than those in the table created during the temporary join.

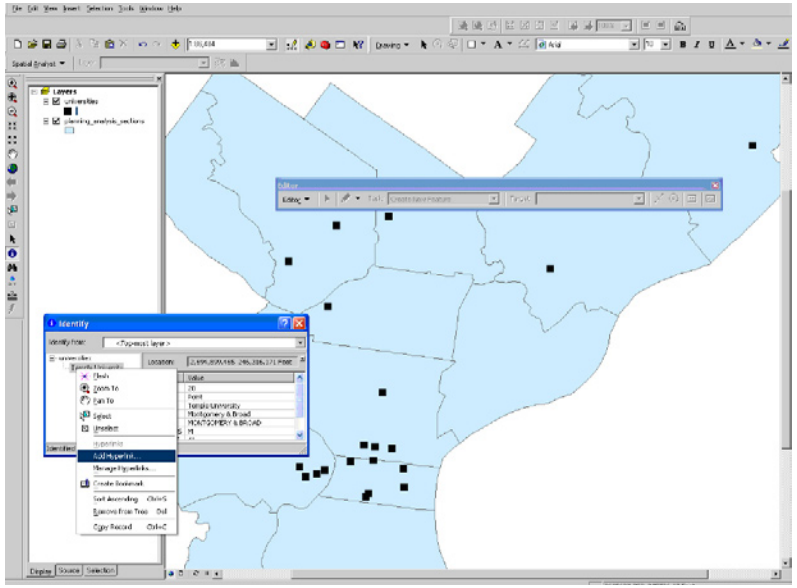




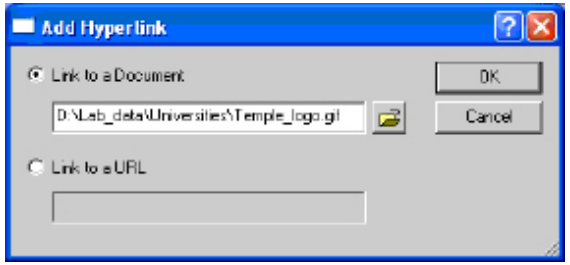
Adding Hyperlinks

Hyperlinks allow you to click on a map feature and bring up a relevant image (or website) rather than just the attribute values stored in your attribute table. This is of limited use because the links will only work from inside ArcGIS. ESRI and other vendors have developed a wide range of interactive online map systems that provide much greater utility than hyperlinks. But for presentations using ArcGIS, this hyperlink feature can be helpful.

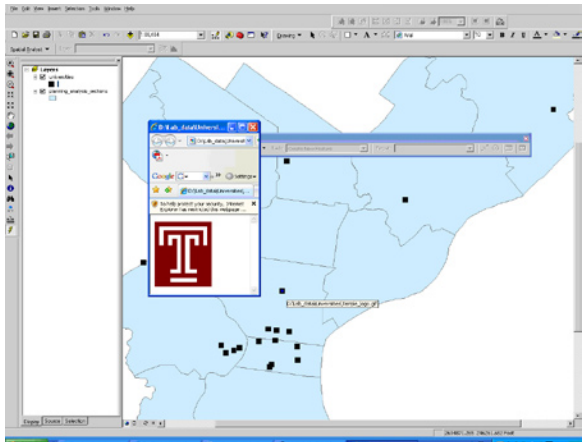
Click on the map feature you wish to link with the identify tool. Make sure that the "Identify Results" table brings up information relating to the right map layer. Right click on the text in the box on the left and go to "Add Hyperlink." From the "Add Hyperlinks" box, click on the folder icon and navigate to the image you wish to link to. Click "OK" and "OK," then close the "Identify Results" box.



You should now see a lightning bolt button in your Tools toolbar (previously it would be grayed out). Click on the lightning bolt and move the cursor over your map. When the cursor is over the map feature with the hyperlink, you should see the path name for the image appear. Click on the map feature and your image should appear.

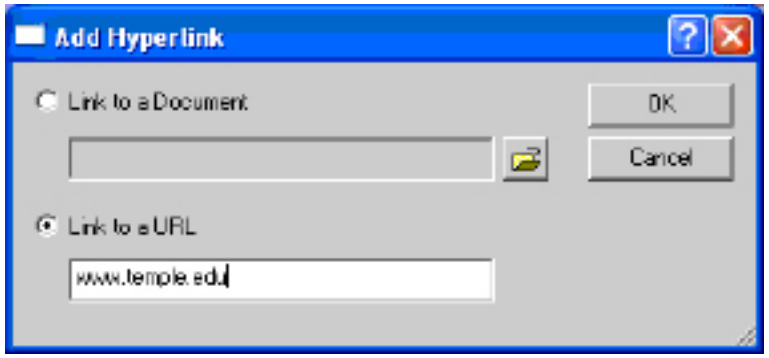


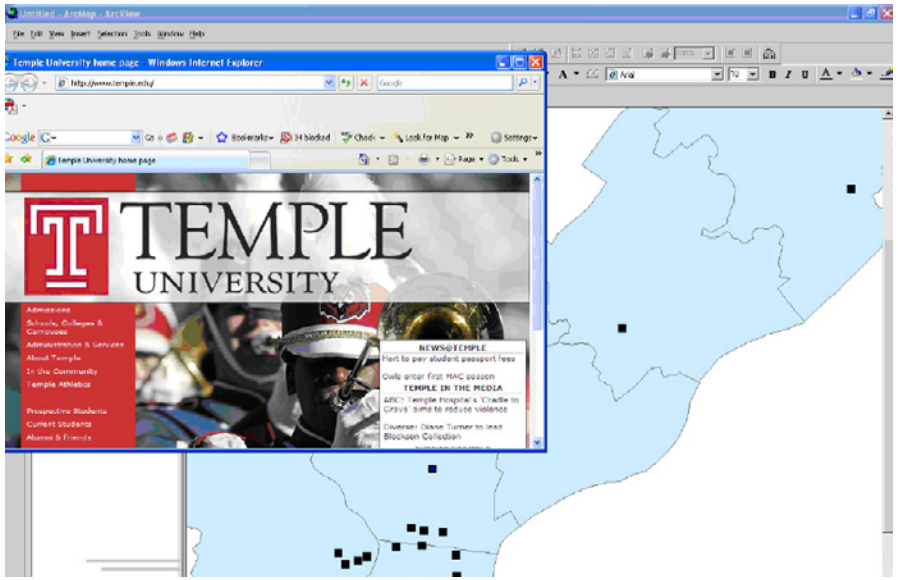
You can add multiple hyperlinks to the same map feature using this method. To remove hyperlinks, from the "Identify Results" box, right click on the text on the right and go to "Manage hyperlinks." If nothing happens when you click on the hyperlink, you probably need to set or reset the default program for opening the image. Find the image file you were trying to link to using My Computer or Windows Explorer, right click on it, and go to "Properties."



Check the program listed next to “Open with.” If none is listed, click on “Change” and pick a program (an image program or an internet browser, for example). Click “OK” and “OK.” To make sure the new program can open your image file, double click on the image file. If the software program opens and displays your image, this should also work for your hyperlink.

You can link to a website instead of an image. Click on the map feature you wish to link with the identify tool and right click on the text in the box on the left and go to “Add Hyperlink.”



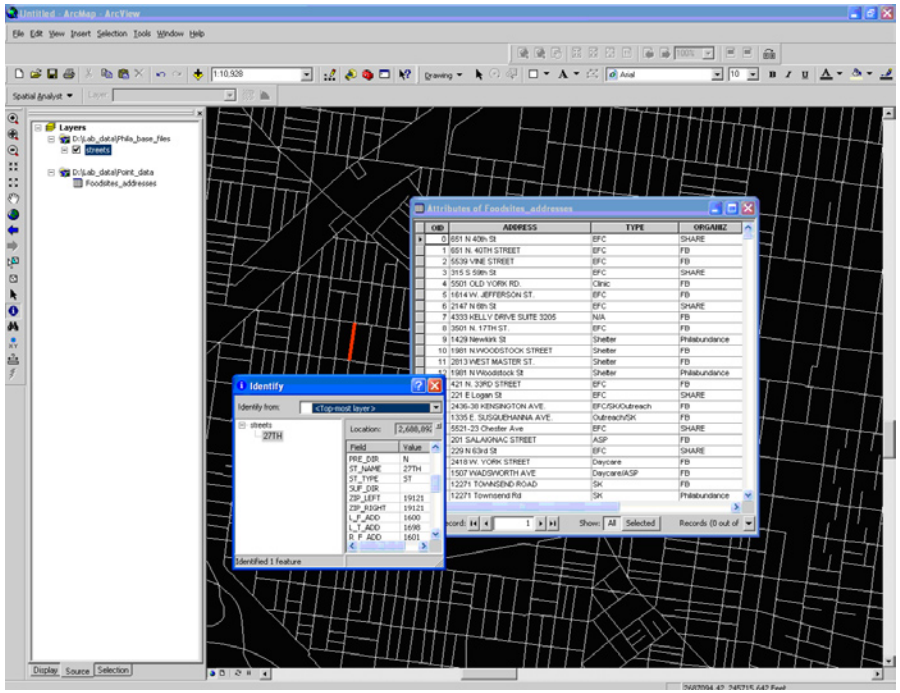


Adding Hyperlinks through Attribute Tables

If you have more than a few hyperlinks for a map layer, it might be easier to add them using the attribute table. Create a new text field called “Hyperlinks.” Start an edit session (from the Edit toolbar, go to “Start editing”). Type the full name of the image file, including the path (for example, c:/esri/maps/image.tif) in the appropriate record. Now you need to make the hyperlink(s) active. In ArcMap, double click on your shapefile name in the table of contents and, from the Layer Properties dialogue, make the “Display” tab active. Put a check mark in the Hyperlinks box and, from the dropdown menu, choose the field that contains your hyperlinks. Now you should be able to bring up the hyperlink using the lightning bolt button.

Geocoding

Geocoding refers to the process of transforming street addresses into map features. In order to geocode, you need to have a table with addresses and a shapefile for streets that matches the geographic extent of your addresses. Through the geocoding process, ArcMap will create a new point shapefile by matching each street name and number in your table to a place along a line segment in your streets shapefile that represents a certain range of house numbers. The image here shows how each section of a street centerline file has a known street name (ST_NAME) and address range (L_F_ADD and R_F_ADD). ArcView uses this information to locate the addresses in your table (called Foodsite_addresses here).



Preparing Tabular Data

In order to geocode, you need a table (.dbf, .xls, or comma-delimited .txt) that has a field with street addresses. If the parts of the street address—house number, street direction, street name, and designation/ type—are in separate fields, you will need to collapse these into a single field. Having a separate field with the zip code can also be helpful (keep this separate). Intersections can be used (Lehigh Avenue & N Broad Street) but house ranges (123-127 N Broad Street) and PO boxes will not, so make sure you change these to addresses with a single house number before you try to geocode.

Creating an Address Locator

In addition to a table with addresses, you also need a shapefile that includes information about all of the streets in your area. A street centerline file is made up of line segments that represent certain ranges of house numbers. The line segments also contain information about which side has even and odd house numbers. Street centerline files are available for each county in the United States through the US Census. You can download these for free from the following site:

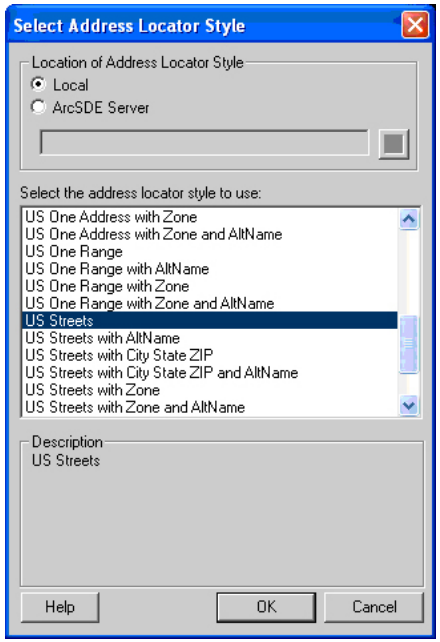
http://arcdata.esri.com/data/tiger2000/tiger_download.cfm

The street centerline file will be listed as "Line Features—Roads." If you use these files, you will only be able to geocode addresses for one county at a time. ESRI also sells a product called ArcGIS StreetMap that allows you to geocode addresses for the entire country.

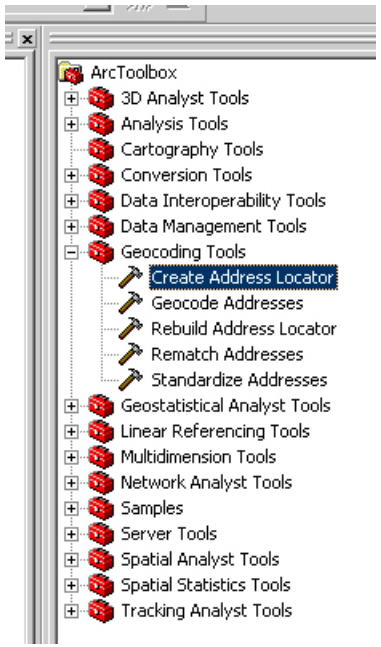
In order to be able to use the county street centerline file for geocoding, you need to create an address locator from it. This is essentially a registration process in which you help ArcView to recognize the fields in the street centerline file so that it can prepare it for geocoding. From ArcToolbox, choose

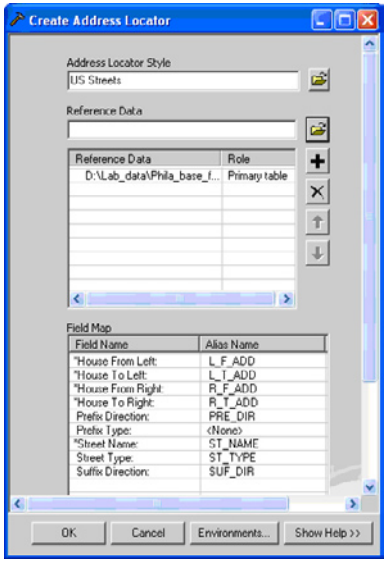
“Create Address Locator” (under “Geocoding Tools”).

First, you need to identify the address style from the drop-down. “US Streets” is the most basic and only requires that you have complete street addresses, including house number, direction, street name, and designation (Rd, St, Ave, etc.). Look through the other styles to see which matches the data you have if your data has different or additional information. For example, if you have zip codes in addition to street addresses you can use “US Streets with Zone.” The more fields that you have to help you geocode, the more accurate your mapping will be, but the trade-off for this greater accuracy is often a lower match rate.



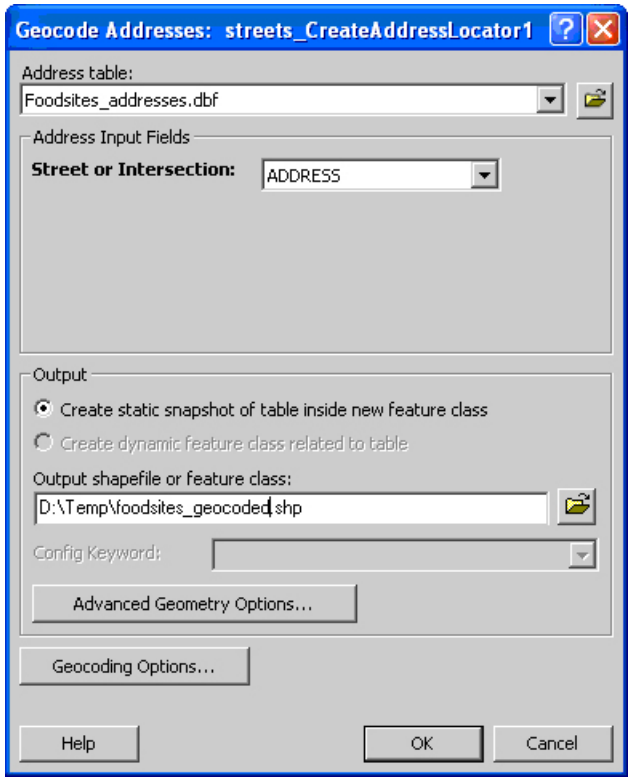
The “Reference Data” refers to your street centerline file. Click in the white space under “Role” and select “Primary table” from the dropdown menu. At this point, the Field Names and Alias names in the space below should fill in. If they do not, click on the empty space under “Alias” and show ArcView the name of the appropriate field. Click “OK” to finish.



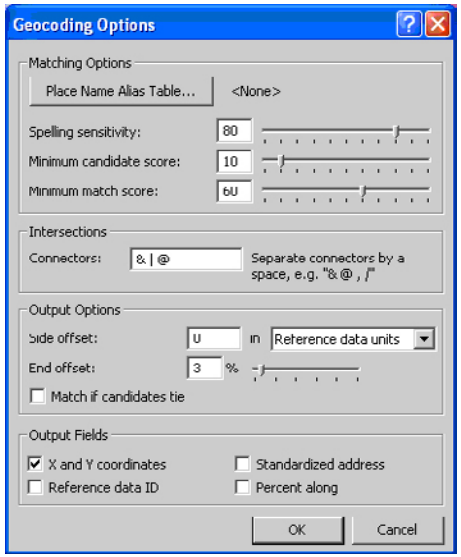


Geocoding Addresses

You can geocode addresses through ArcToolbox, but it is easier to go to the Tools menu, select “Geocoding” and “Geocoding Addresses.” In the “Add Address Locator” screen, click on “Add” and navigate to where you saved your address locator (this will likely be in the same folder where your street centerline file is located). Click “Add,” then click “OK.” On the next screen, you need to identify the table with your addresses, the field that contains the street address, and a name and location for the new point shapefile that will be created.

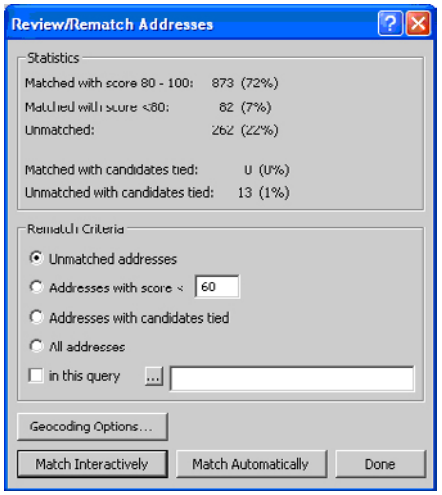


The “Geocoding Options” allow you to indicate the level of sensitivity for the matching process. Essentially, ArcView needs to match the house numbers and street names in your tabular data with information in the streets shapefile. If the spelling of the street name is slightly different or an appropriate range of house numbers cannot be located, ArcView will assign the match a less than perfect score (100 is a perfect match). ArcView can geocode based on street intersections in addition to specific house numbers. In the “Intersections” section you can identify symbols (or “AND”) used in your tabular data to indicate intersections. The “Side Offset” option allows you to place points slightly away from the middle of the street centerline file. While ArcView will know what side of the street your address falls on, your points will appear to fall directly on the centerline unless you specify an offset. 15-20 feet is adequate. Under “Output Fields,” if you check “X and Y coordinates,” ArcView will add X and Y fields to the point shapefile with your addresses.

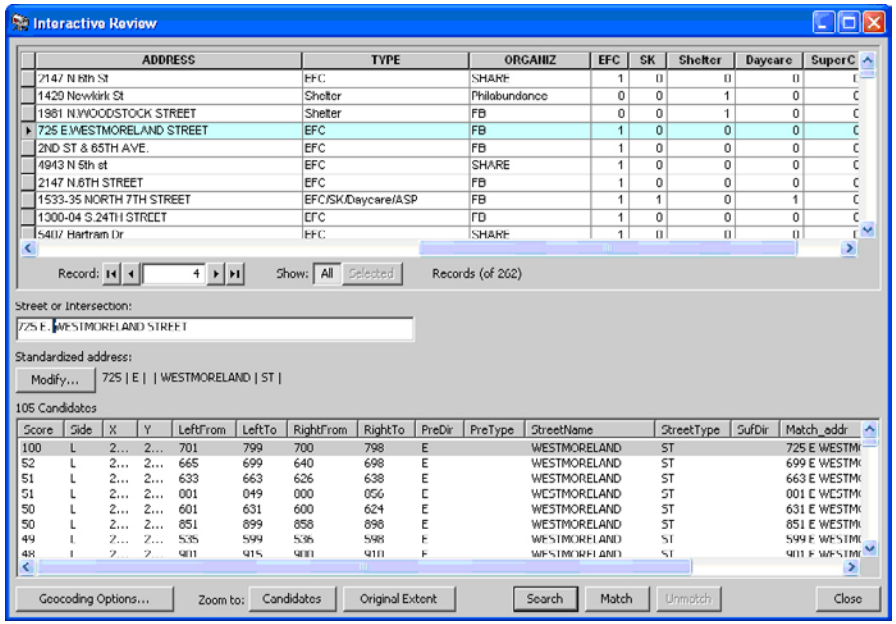


Once you click “OK,” a new address locator should be listed under “Address Locators” in the Catalog. Once you have created an address locator, you don’t need to do it again (unless you go to a new computer).

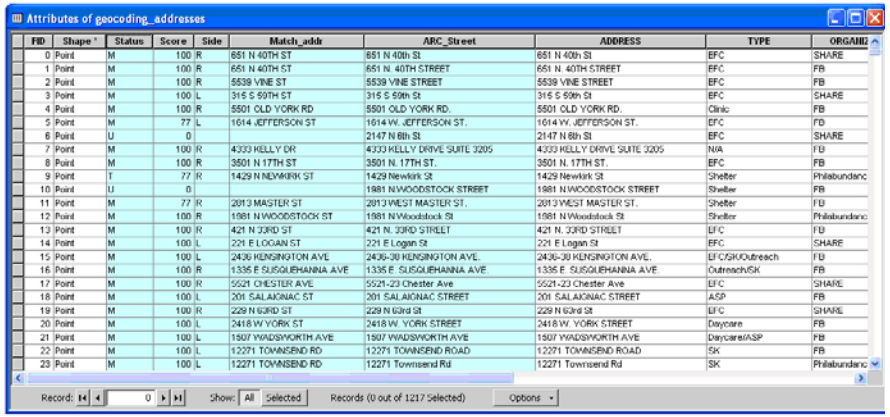
Click “OK” to exit the “Geocoding Options” and then “OK” again to start the automatic geocoding process. After a few seconds (longer if you have thousands of records), ArcView will give you a report showing how many matches were made.



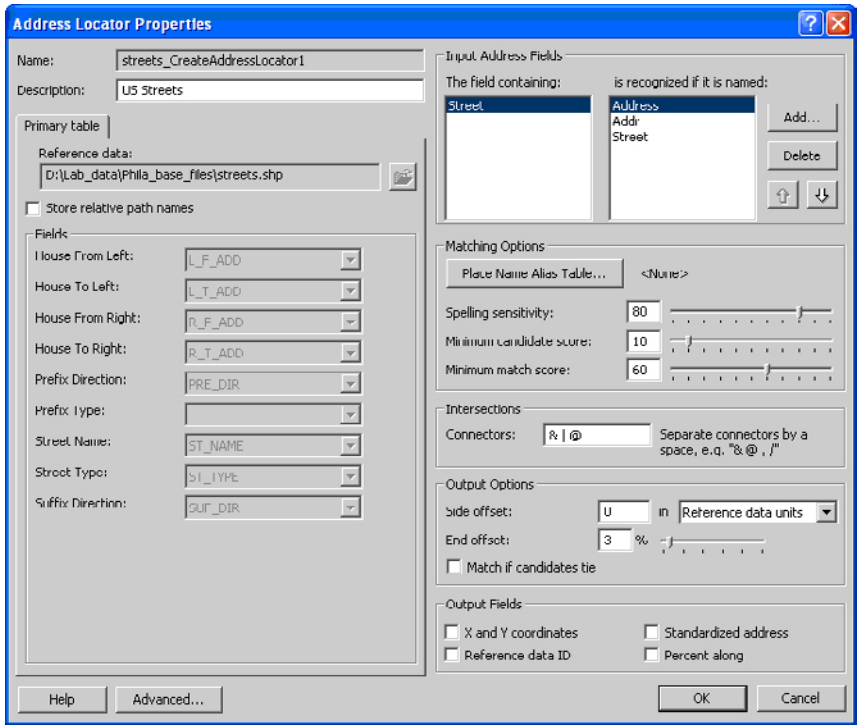
Take a look at the records that did not match by clicking on “Match Interactively” while the radio button under “Rematch Criteria” is next to “Unmatched addresses.” You may be able to see errors in your addresses that you can correct by going through them one at a time. The problem may be that you have a series of addresses (210-220 South 34th Street), are missing a space (725 E.Westmoreland Street) or a mis-spelled street name. You can correct the address by clicking on the “Modify” button or simply making the change in the “Street or intersection” box. Click “Enter” to see if new candidates appear below. Click on the best candidate, then click on the “Match” button.



Click on the “close” button when you have corrected all the addresses that you are able, then click “Done.” You should see a new point shapefile in your table of contents. If you open the attribute table associated with the new shapefile that the geocoding process created, you will see that the geocoding process added several fields to your original address table. The “Status” field indicates whether the record was matched (M) or left unmatched (U). The “Score” field indicates how closely the record matched the street centerline file. The “Side” field indicates on which side of the street the address was matched. The “Arc_Street” field is the address used in the match. This will be the same as the original address unless you edited it during the “Interactive Review.”

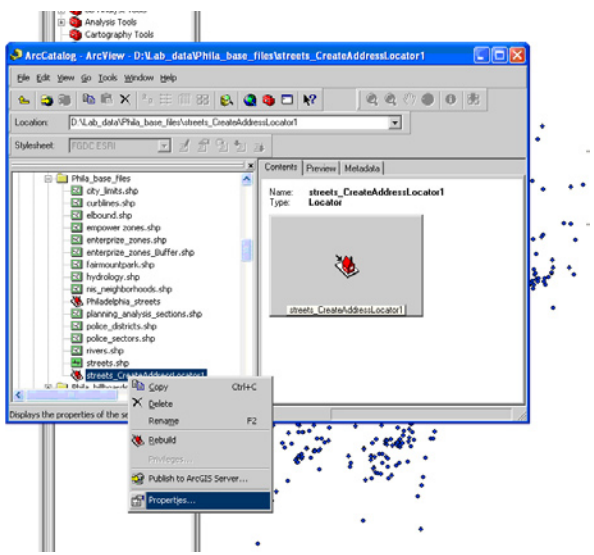


Here you have access to the "Matching Options" that were available when you geocoded your addresses. You may wish to do this if you had a low match rate and need to adjust the spelling sensitivity or want to match candidates that tie.



Modifying your Address Locator

You can modify the properties of your address locator after you have in ArcCatalog. Right click on the address locator and go to "properties."



Rematching Addresses

You can resume the "Interactive Review" even after you've clicked "done" and stopped geocoding. You may need to look up additional information before you can correct some addresses (such as missing "N" or "S" for street names). This From the tools menu, go to Geocoding, Review/Rematch Addresses and choose from the recently geocoded files. You will need to start an edit session in order to proceed. This is not a problem as long as you remember to go to the Edit toolbar and "stop editing" when you are finished.

Determining an acceptable match rate

Aim for a match rate of at least 90 or 95 percent. Be sure to write down the match rate so that you can report it later. Often you will receive a list of addresses that contains some PO Box numbers or missing data that will prevent you from matching all your records. Other times your addresses will look fine but simply won't match the street centerline file. The most important thing to determine is if the error (the unmatched records) is random or systematic. If you have done all that you can to gather complete and accurate addresses, random error is acceptable and probably unavoidable. Systematic error is not. Be sure to check for patterns in your unmatched records (either by interactively reviewing unmatched records or, after finishing geocoding, open the attribute table and sort by "status" to review all the "U," unmatched records). In Philadelphia, look for problems with Roosevelt Boulevard and numbered streets (particularly 2nd – 9th Street). There is no guarantee that the matched records will be mapped in the right place. Do a spot check with the "Identify" tool to make sure that records mapped somewhere that makes sense to you.

Finding an individual address

If you have only an address or two to map, you can take a shortcut. From the File menu, choose "Find" and click on the "Address" tab. Next, choose an address locator in the drop down menu. If you have not already created an address locator, you will need to do so. Next, type in the address in the "Street or Intersection" box and click "Find." ArcView will display the possible matches below, with their score. Right click on one of the addresses for mapping options. You might choose to "Flash Candidate Location(s)" to make sure it's mapping in the right area or "Add as Graphic(s)" if you want a marker at the location. Keep in mind that this is only a graphic; it can easily be deleted or moved. You can change the size and color of the graphic, but you cannot turn it on and off like map layer, and it has no attributes associated with it.

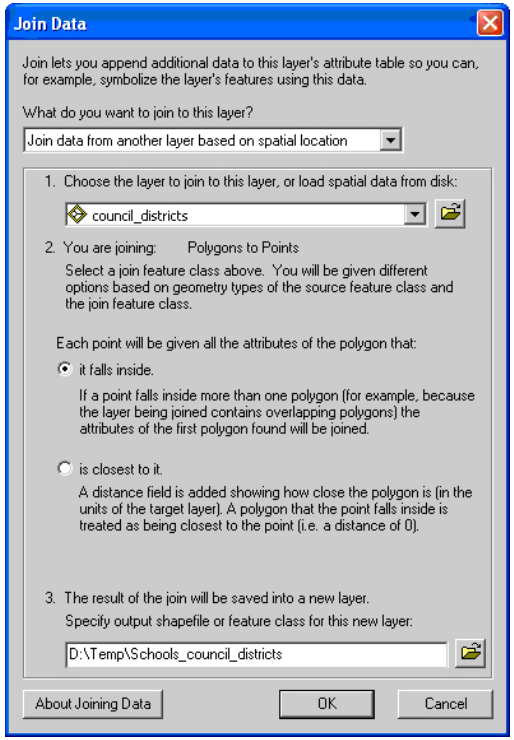
Spatial Joins

Tabular joins use a common unique identifier to attach an attribute table to a shapefile. Spatial joins use common geography to append fields from one layer, or information about a layer, to another layer. This allows you to assign the characteristics of an area—such as a census tract or city council district—to individual houses, individuals, or events as well as to aggregate points by areas.

Assigning Area Characteristics to Points

Using a spatial join, you can determine into what area a point falls. For example, you might need to determine in what council district each public school falls in.

You must have a point theme and a polygon theme in ArcMap in order to do this. Right click on the point theme, go to "Joins and Relates…," and choose "Join." In the first dropdown menu, indicate that you want to join data to that layer based on spatial location. In the next dropdown menu, choose your polygon layer. Next, choose the first radio button so that each point is given all the attributes of the polygon it falls inside. If you have points outside your polygon (for example, if you have a census tract map of Philadelphia with points representing addresses in the city and just outside it), choose the second radio button. Specify the name and location of the new point shapefile that will be created and click "OK."



The resulting point shapefile will have as many new columns as your polygon shapefile. This may include only the polygon identifier (such as the census tract number) or the identifier and attributes.

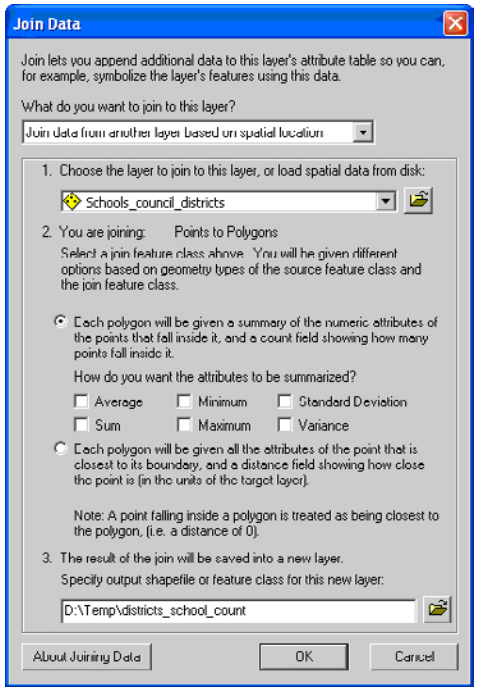
Attributes of Schools_council_districts

NAME	GR_STRUCT	PRINCIPAL	DIST_NUM
WASHINGTON	9-12	Samuel Karlin	10
SWENSON	9-12	Rueben Yarmus	10
RUSH	6-8	Mrs. Catherine Casselberry	10
BALDI	6-8	Mr. Richard Shohen	10
HANCOCK	K-5	Mrs. Rochelle Z. Agris	10
CROSSAN	K-5	Mrs. Susan E. Waterford	10
FOX CHASE	K-5	Mrs. Ellen L. Cooper	10
HOLME	K-5	Mrs. Carolyn P. Garvin	10
LABRUM	6-8	Dr. William Garberina	10
SHALLCROSS	5-12	Mr. William McMonagle (Administrator)	10
COMLY	K-5	Ms. Margaret Carnvale	10
FITZPATRICK	K-5	Cheryl Glaser	10
FRANK	K-5	Mrs. Barbara O. Shohen	10
DECATUR	K-5	Mr. Charles Connor	10
GREENBERG	K-8	Mrs. Marcia A. Green	10
LOESCHE	K-5	Dr. Michael Kolakowski	10
GRATZ	9-12	Hildebrand Pelzer	8
GILLESPIE	6-8	Romesa Scott	8
CLEVELAND	K-5	Mr. Joseph J. Bahm	8
KENDERTON	K-8	Mrs. Sylvia Rider	8
PIERCE ELEM	K-5	Mr. Shively D. Willingham, III	8
CENTRAL	9-12	Dr. Sheldon Pavel	8
GERMANTOWN	9-12	Gloria Pelzer	8
GIRLS	9-12	Dr. Geraldine Myles	8

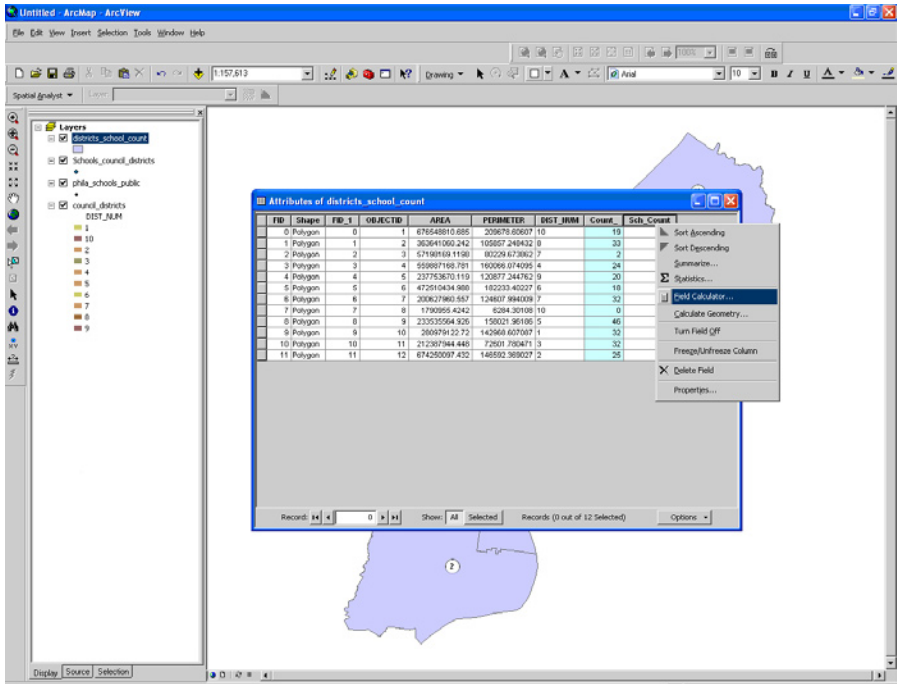
Record: 0 Show: All Selected Records (0 out of 265 Selected) Opti

Aggregating Points by Polygons

Using a spatial join, you can also determine how many points fall in each polygon. For example, you might want to know how many schools fall in each council district. You must have a point theme and a polygon theme in ArcMap in order to do this. Right click on the polygon theme, go to "Joins and Relates…," and choose "Join." In the first dropdown menu, indicate that you want to join data to that layer based on spatial location. In the next dropdown menu, choose your point layer. Next, the radio button should be set for the second from the top option, "Each polygon will be given a summary of the numeric attributes of the points that fall inside it, and a count field showing how many points fall inside it." If your points do not all fall within your polygons (for example, you have a map of city council districts and points representing addresses in the city and just outside it), choose the second radio button, instead. You can then decide if you want to summarize the attributes of your points by their areas in the boxes below (for example, if your schools attribute table included a column with the total number of children enrolled, you could summarize that data so that you know how many children are enrolled in schools in each council district. Choose "Sum" in a situation like this). Finally, specify the name and location of the new area shapefile that will be created. Click "OK."



If you did not check any of the boxes to summarize the attributes of the points, your new shapefile will have only one new field called "count." This will indicate how many points fall into each polygon. You will probably want to change the name to something that you will remember (by creating a new field called "SchoolCount," for example, and calculating it as equal to "Count"). Now you can use this count value as the basis of a thematic map.



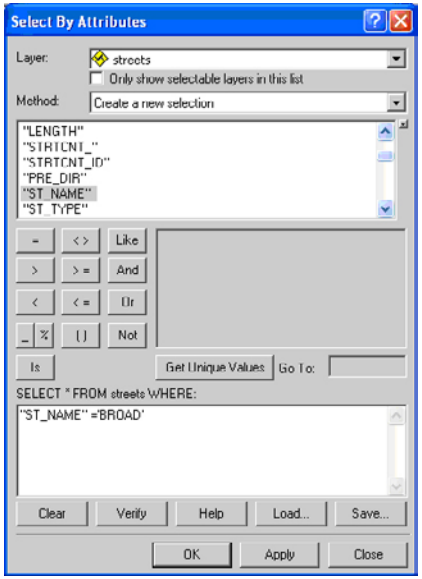
You can also use the spatial join function to calculate the distance between features in two different labels. Depending upon the type of file you start with (right click on), the spatial join dialog box will give you different options.

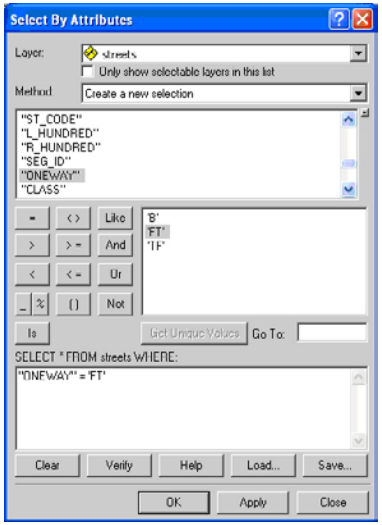
Querying by Attribute

With GIS, you can identify a subset of map features based on their attributes or their location. You may use queries as an intermediary step, as part of getting to know your data, to create new values, or to answer your research questions.

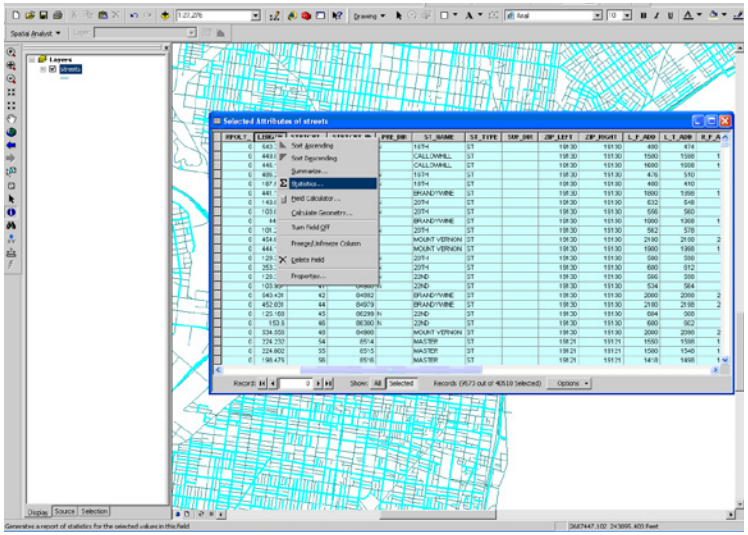
Select by Attribute

To start a query, from the Selection menu go to "Select by Attributes." our first choice is what layer in your map you wish to query (attribute queries are limited to a single layer). In the Method drop down menu, you need to decide whether you are building on a previous query or starting fresh. From here, the query dialog is similar to the Field Calculator. Build an expression using the field names and functions, connecting statements with "AND" or "OR" as necessary. The values associated with each field will be displayed in the text box at the far right. You can use these or type in your own. If you want help working through these steps, click on the Query Wizard button. Click "Verify" to make sure ArcMap likes your expression. You can import (Load) and save expressions using the buttons OR using Ctrl + C and Ctrl + V with a word processing file. Note that if the values you input are text, rather than numbers, you need to put single quotes around them (for example, 'BROAD'). When you click "Apply," the map features that satisfy your query will be highlighted with a bright blue outline.

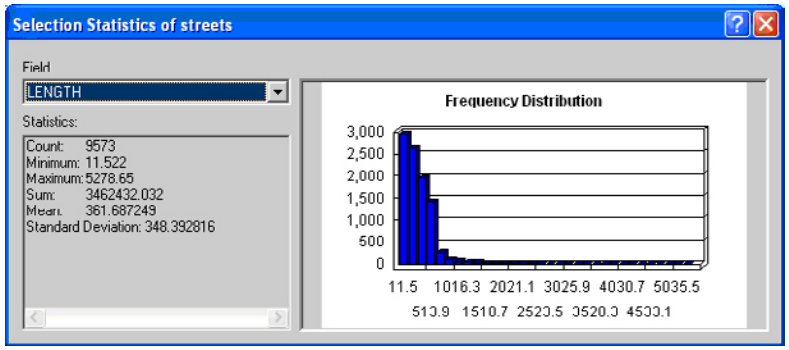




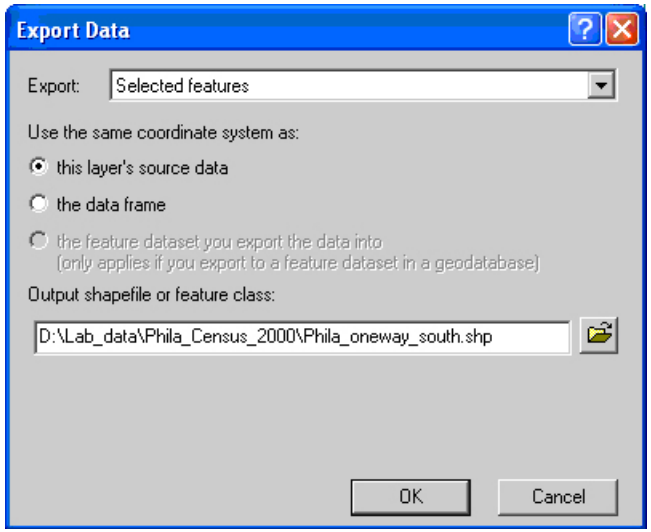
The query shown to the left identifies all one-way streets that run south through Philadelphia.



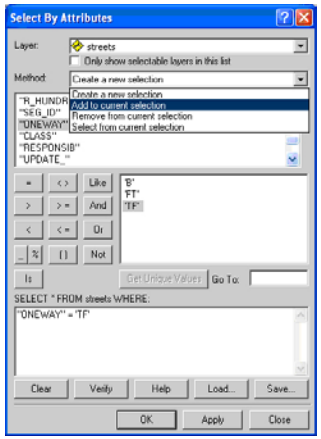
To review the selected records, right click on the map layer and go to “Open Attribute Table.” Click on the Select button at the bottom to view only the selected records. You can calculate values on an existing or new field for only the selected records. You can also look at summary statistics for only the selected records by right clicking on a column name and going to “Statistics.” By looking at the statistics for the length field on the selected southbound one-way streets, we can see that there are 3,462,432 feet (655.7 miles) of southbound one-way streets in Philadelphia.



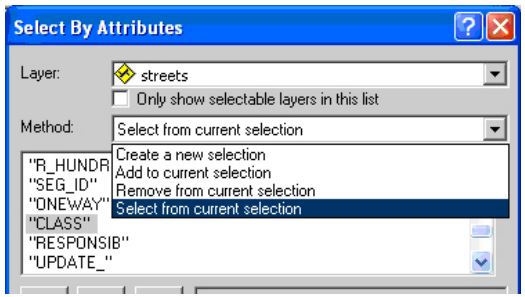
To see all of the selected records, from the Selection menu, go to “Zoom to Selected Records.” You can create a new shapefile that only includes your selected map features by right clicking on its name in the Table of Contents, going to “Data” and “Export Data.” Choose the radio button regarding coordinate systems (you’ll probably want the default). Make sure you have “Selected Records” chosen in the Export drop down menu. To un-select all records, from the Selection menu choose “Clear Selected Features.”



You can perform an additional query (adding, removing, or selecting from this selected group) or close the query dialog. The query shown here will add the northbound one-way streets to the already highlighted southbound one-way streets.



You could also select the subset of south-bound one-way streets that are class 1 (highways) roads.

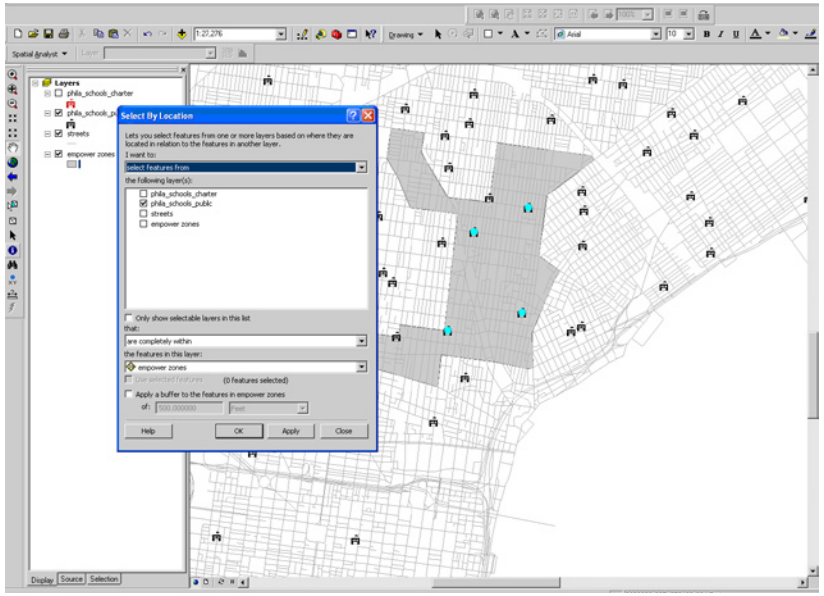


Querying by Location

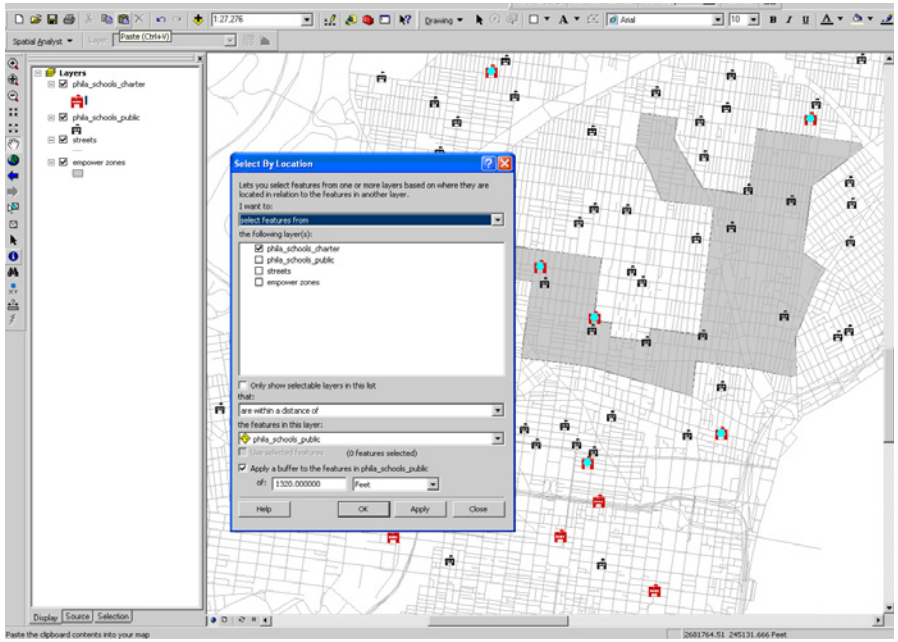
The ability to query based on the location of map features is something unique to GIS, and combining attribute and location queries really takes advantage of GIS functionality.

Select by Location

To select features in a map layer based on their location, from the Selection menu go to "Select by Location." Your first choice involves the nature of the selection. Are you starting from scratch or querying a subset of map features already selected? In the next box, put a check mark next to the map layer(s) whose features you wish to select. The drop down menu then provides various relationships between the features in that layer and a subsequent layer (identified in the next drop down menu).

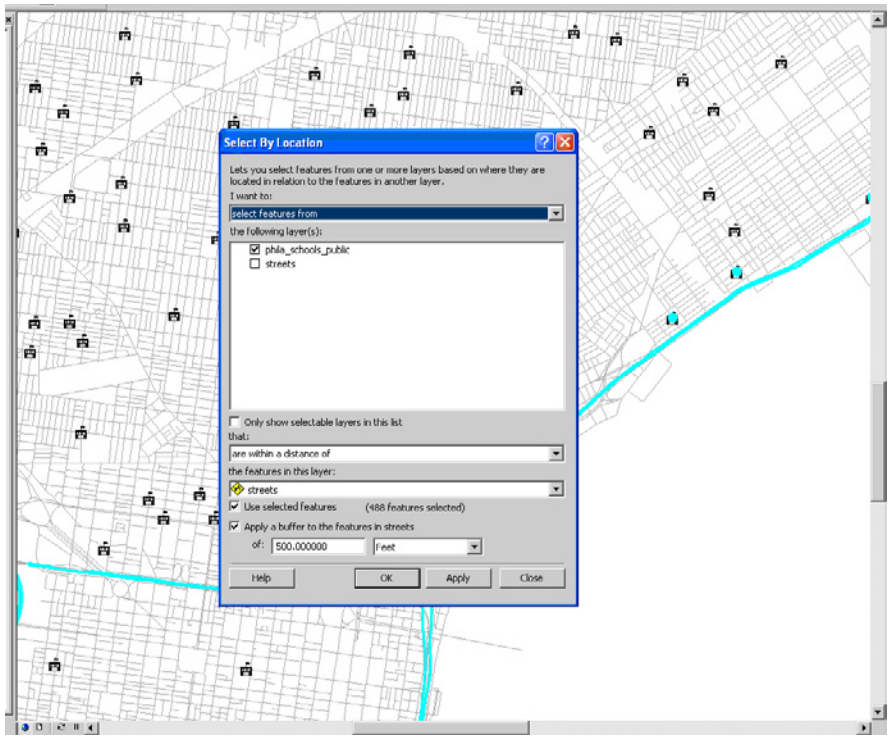


For distance-based queries, you will be able to select your units as long as the map units have been specified in the Data Frame properties. This query shows which charter schools are within ¼ mile (1320 feet) of public schools.



Combining Attribute and Location Queries

The "Select by Attribute" and "Select by Location" dialogs do not allow you to mix the type of query. But by performing one type of query first and then conducting a subsequent query on the selected records, you can perform attribute and location queries on the same map layer. For example, you may be interested in which schools are located within 500 feet of class 1 (highways) streets. Using the "Select by Attribute" dialog, identify all the code 1 streets first, then select the schools "within a distance" of 500 feet of the selected streets.

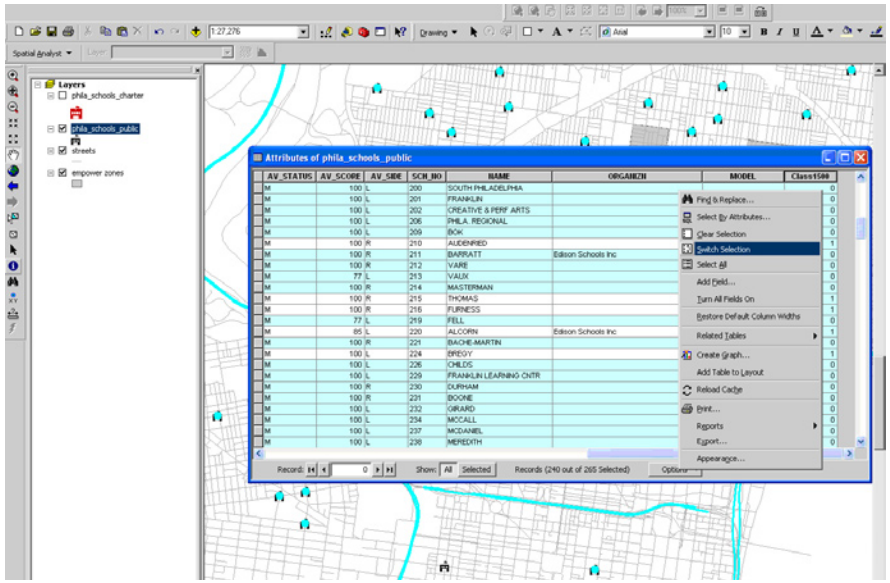


As the resulting map shows, several of the public schools in Northeast Philadelphia are within 500 feet of I-95.

Often, it will not matter which query you do first. Just be sure that the selection method you choose for the second query allows you to add, remove, or select from the records selected from the first query. You may need to try the query a couple of times to get it right. Double-check your results to make sure they make sense because it is easy to make a small mistake in building your query that can leave you with a completely wrong answer.

Using Query Results

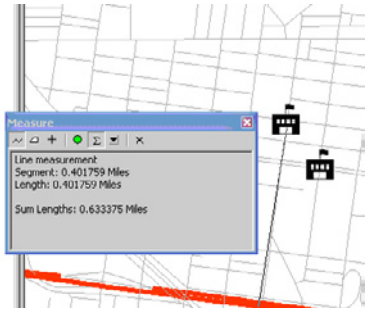
The turquoise highlight feature is meant to help you visualize relationships, but it is not meant for final maps. Once you have identified a subset of records, create a new variable and symbolize it properly using the symbology tab. For example, if you want to create a map showing the schools that are located within 500 feet of highways, complete the query and then use the query results to create a dummy variable indicating which schools meet the query definition. Do this by opening the attribute table for the schools. Create a new variable called “Class1500” (for 500 feet within class 1 street) that is formatted as an integer. Right click on the new column, then go to “Field Calculator.” Set Class1500 = 1. Only the highlighted records will be assigned this value. Assign the other records = 0 by going to “switch selection” from the “option” button on the bottom of the table.

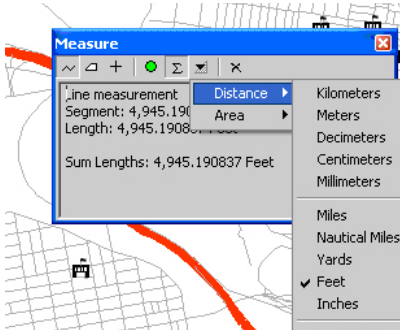


Measuring Distances

Using the Measure Tool

The measure tool allows you to draw a line, or a series of connected lines, to roughly measure the Euclidean (as the crow flies) distance between points. Click on it and then click on your map at the starting point. Move your cursor to your end point, or next point, repeating until you are done. Double click to finish.

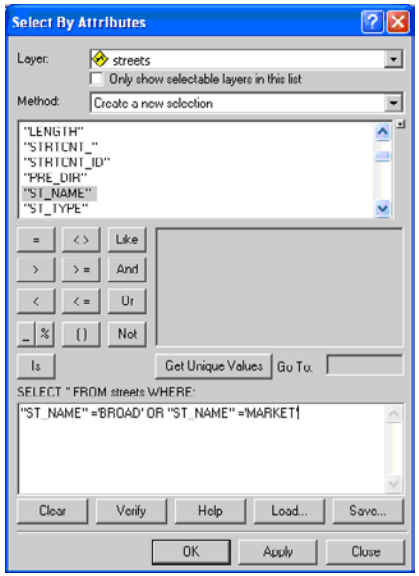


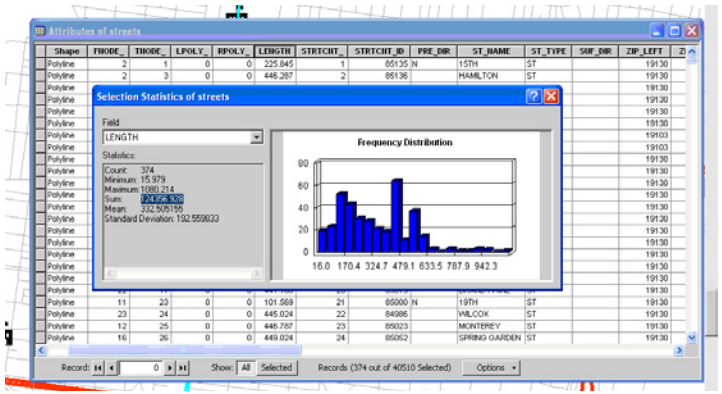


The measure tool will use the map units particular to that map layers projection or the display units you specified in the Data Frame Properties. You can change this from the Data Frame Properties (right click on the name of the Data Frame, go to Properties, and the General tab) or in the Measure pop-up box. The black triangle pointing down includes various distance units to choose from.

Measuring with Attribute Data

If you need more accurate measures of distance than you can get using the measure tool, you can use the values in perimeter (polygons) and length (line) fields of the shapefile attribute tables. Select the features of interest, then right click on the perimeter or length field and go to "Summary." The "sum" field will indicate the total distance. For example, if you need to know the total length of Broad and Market Streets, go to "Select by Attributes" and select all line segments in the street centerline file called "BROAD" or "MARKET." Then open the attribute table associated with the street centerline file, right click on the "length" column heading, and go to "Summary." The "sum" should indicate how long Broad and Market Streets are.



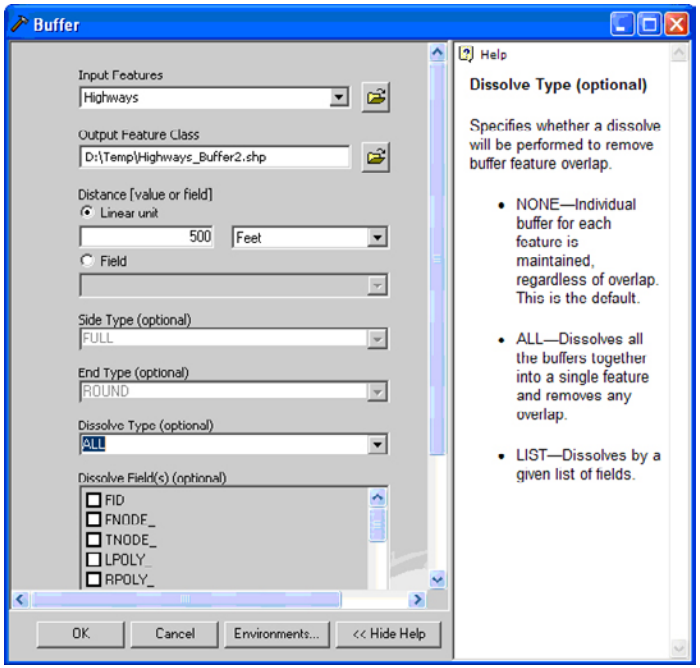


Measuring Distance with Networks

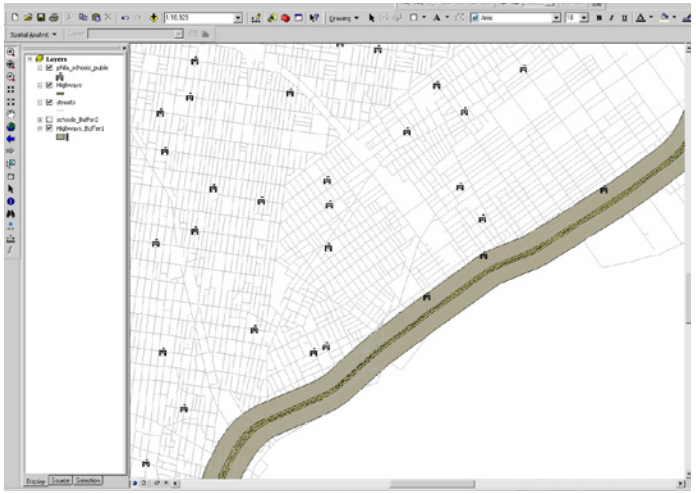
Both of these methods described above allow you to calculate Euclidean distance—as the crow flies. This is a rather crude measure that fails to take into consider that people can't fly and must navigate one-way streets, traffic conjestion, and other barriers. Using ArcView's Network Analyst, it is possible to factor in travel times and traffic patterns, among other considerations.

Buffers

Buffers allow you to visualize zones around map features. If you are interested in seeing which schools fall within 500 feet of class 1 (highways), you can create a 500 foot buffer around class 1 streets. For analysis purposes, queries by location may be more helpful because they will allow you to actually select the schools within 500 feet of class 1 roads. But you may want to create buffers, as well, so that you can visualize this relationship.



You can create buffers using the Buffer tool in ArcToolbox (under Analysis Tools). Select the map layer you wish to buffer using the first dropdown menu. Note that ArcView will only buffer highlighted features if any of them are highlighted. Specify a name and location for the new buffer shapefile, then specify the distance and distance units. You may want to choose "all" from the "dissolve" dropdown so that the buffer around multiple map features, such as street segments, will be one continuous polygon.



Multiple Ring Buffers

If you want to show several different distances at the same time, choose the "Multiple Ring Buffers" Tool in ArcToolbox (under Analysis Tools). Choose the layer you wish to buffer and specify a name and location for the new file. Type in each distance, one at a time, and click the + key so that the distance appears in the list below.

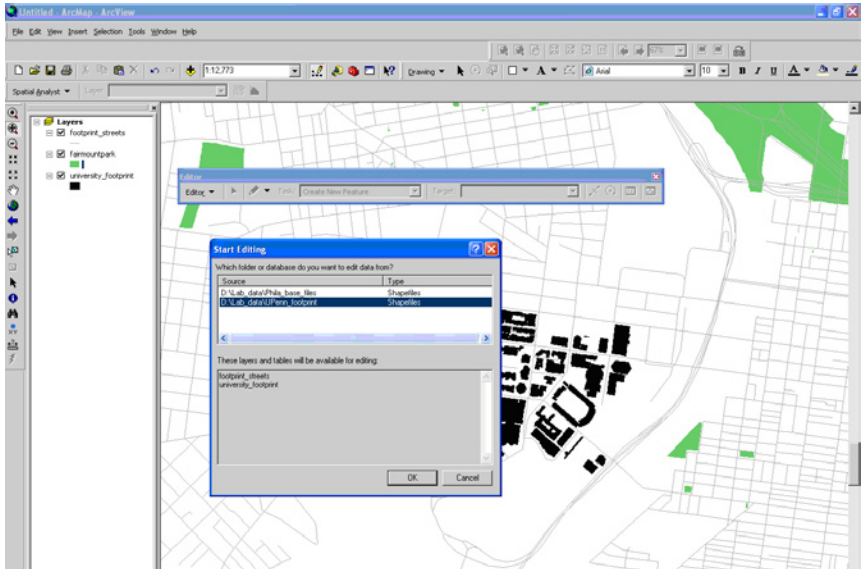
Use the symbology options in Map Layer Properties to represent the different rings with different colors.

Editing Shapefiles

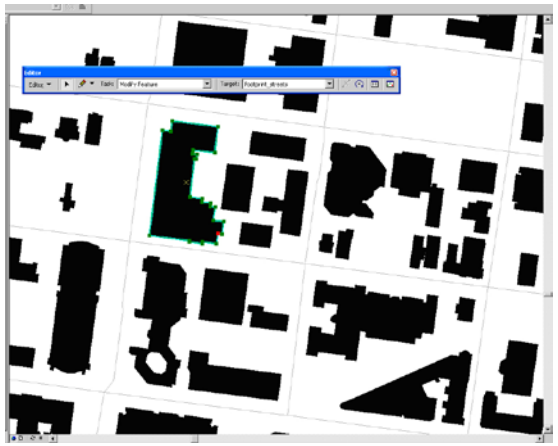
Editing shapefiles is tricky—and a bit dangerous—territory. If possible, use the geoprocessing tools such as clip, union, intersect, and dissolve to make changes to your shapefiles rather than using the editing tools described below. The directions provided here are very minimal. If you need to do much editing of shapefiles, you should seek out additional resources (such as the ESRI Virtual Campus course on digitizing).

Deleting and Modifying Features

In order to make changes to a shapefile, you must start an edit session. From the Editor toolbar, choose "start editing." If you have multiple shapefiles in your map document that are from different subdirectories on your computer, you will need to specify which directory will be part of the edit session (you can only edit the files in a single folder at one time).



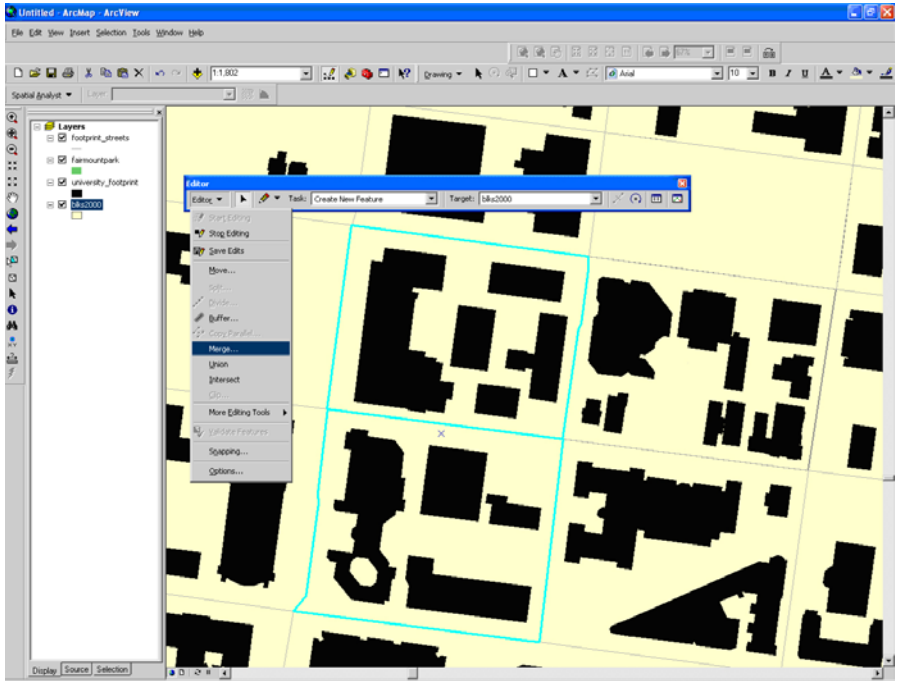
From the Target drop down menu in the Editor toolbar, indicate which map layer you wish to edit. To edit an existing feature (point, line, or polygon), click on the edit tool and click on the feature you wish to edit (it should become highlighted). By clicking and holding down the mouse button, you can move your map feature to a new location. To modify a line or polygon feature, double click on it. Notice that the vertices become visible and the Task menu automatically brings up "Modify a Feature." You can reshape your feature by putting your cursor over a vertex, clicking, and dragging it. Click outside of the map feature to complete. (ArcView will show the last created vertex in red). You can add a vertex to a feature by right clicking on a green line and going to "insert vertex" (a new vertex will be created where you right click). Most of the boundaries between polygons are shared boundaries. In order to move the boundary for both polygons (rather than creating an awkward gap), you need to use the shared edit tool. Click on the shared edit tool and double click anywhere on the shared boundary. The shared boundary will be shown in green and the vertices along the shared boundary will become visible. Move a vertex, then click outside the map feature to complete.



To save edits, from the Editor menu on the Editor toolbar, choose "Stop Editing" and say "yes" to saving edits. Notice that you do not have a "save as" option. You may want to make a backup of your original data before editing.

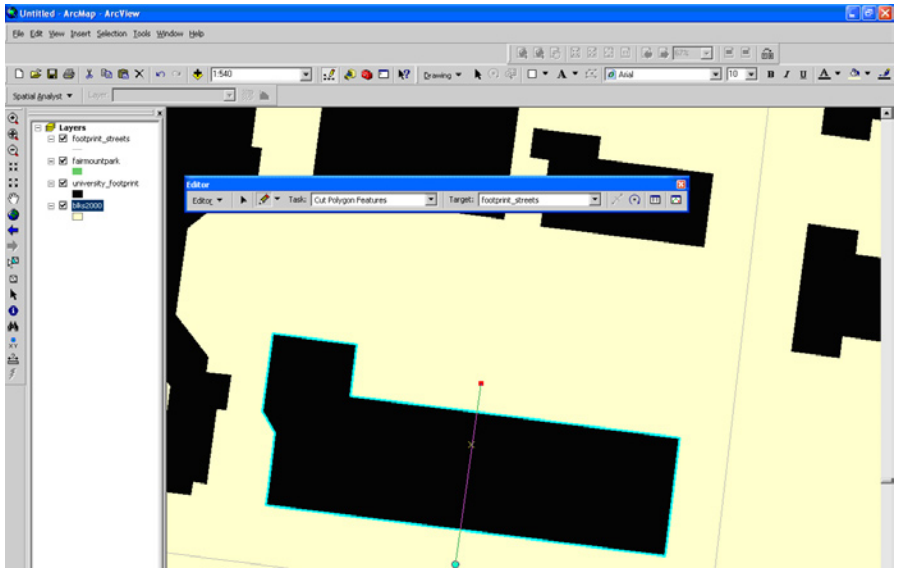
Merging Features

In order to dissolve the boundaries between two or more polygon features, you must start an edit session. Using the edit tool and the shift key, click on the features you wish to merge (they should become highlighted), then from the Editor menu on the Editor toolbar select “Merge.” You can also select map features based on their attributes by opening the attribute table and selecting the corresponding records. To save edits, from the Editor menu on the Editor toolbar, choose “Stop Editing” and say “yes” to saving edits.



Splitting Features

Splitting polygon features involves creating a new line within an existing polygon. Start an edit session and choose “Cut Polygon Features” from the Task drop down menu. Using the edit tool, select the polygon you wish to split. Click on the sketch tool and then draw a line through your polygon (the line does NOT have to be straight), double clicking to complete. To save edits, from the Editor menu on the Editor toolbar, choose “Stop Editing” and say “yes” to saving edits.



Updating Area, Length, and Perimeter

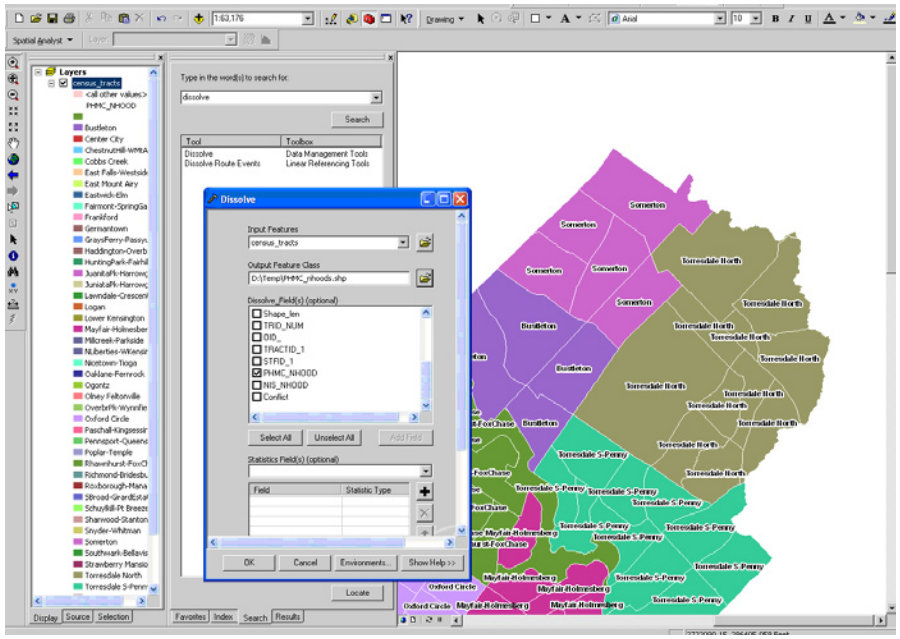
Keep in mind also that editing shapefiles can change attribute values that you may need to update. Follow the directions in the section of this guide entitled “Calculating Area.”

Transforming Shapefiles

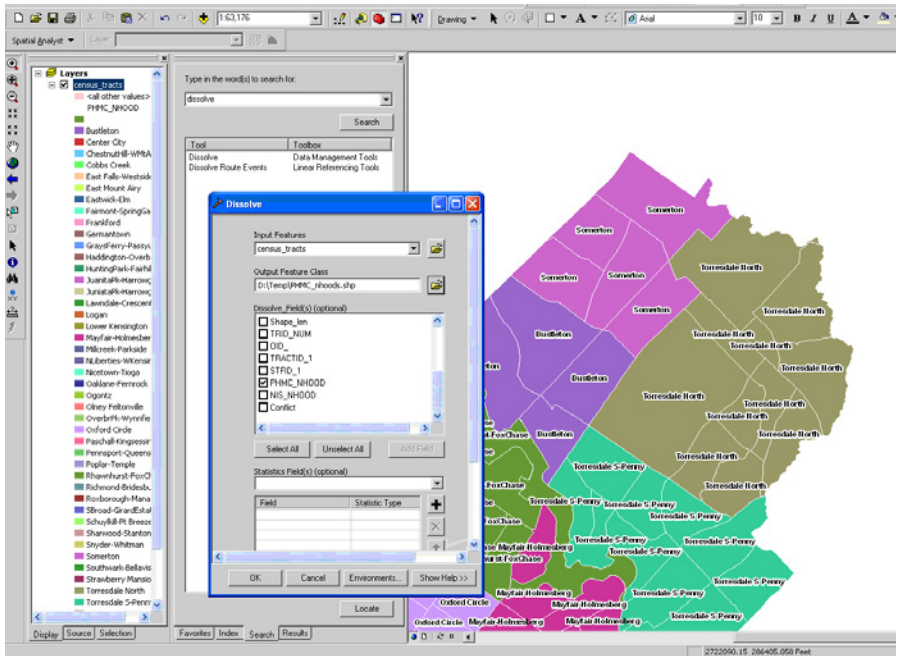
There are a number of different functions you can perform on map layers, either based on location or attribute value, that result in new map layers. Several of them fall under the description of "overlay analysis." You must define the projection for map layers before using any of these functions. If you have selected a subset of features within a map layer, the functions will only be performed on the selected features.

Dissolve

The dissolve operation allows you to collapse the boundaries between polygons if they share the same value on a particular attribute. For example, you could create a neighborhood map layer by assigning each census tract to a neighborhood and then dissolving the boundaries. From ArcToolbox, you can find "Dissolve" under "Data Management Tools" and "Generalization." On the next screen, you need to identify the map layer whose features you wish to dissolve under "input features." If the layer is already added to ArcMap, you can use the dropdown menu. Otherwise you will need to click on the folder icon to locate the may layer. ArcMap will give the new shapefile that will be created a default name (adding "_Dissolve" to the input layer name). If you want to rename this or change the location, click on the folder to the right of "input feature class." Next, choose the column in from that layer's attribute table that contains the information you wish to use for the dissolve. This must be an attribute for which multiple map features (polygons) have the exact same value. The values can be numbers or text, although keep in mind that nominal and categorical variables will work better than ratio variables. If polygons have the same value but are not contiguous, they will still be dissolved into a "multipart feature."



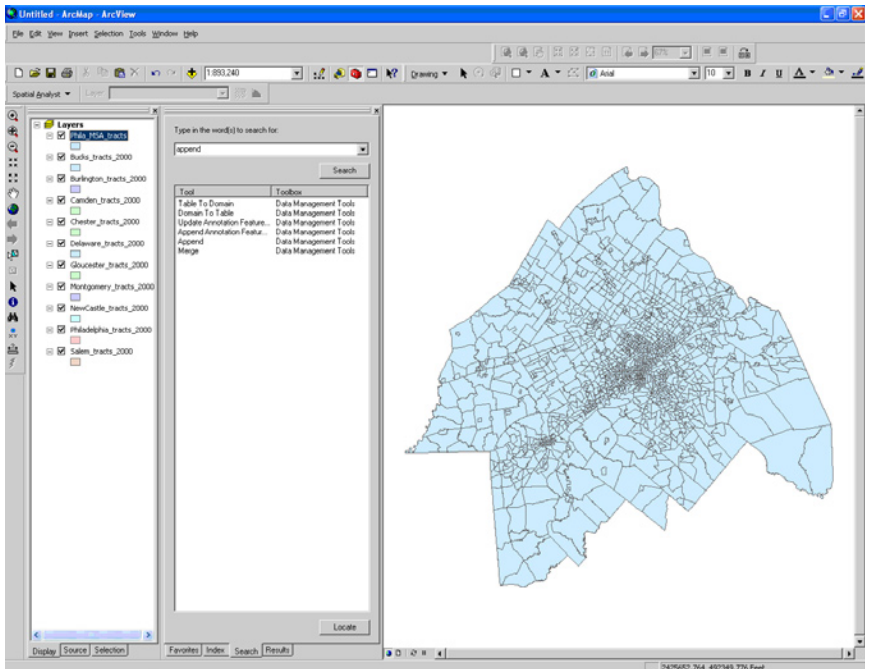
ArcView will create a new shapefile that combines all of the map features (census tracts) into a single polygon (neighborhood).



Append

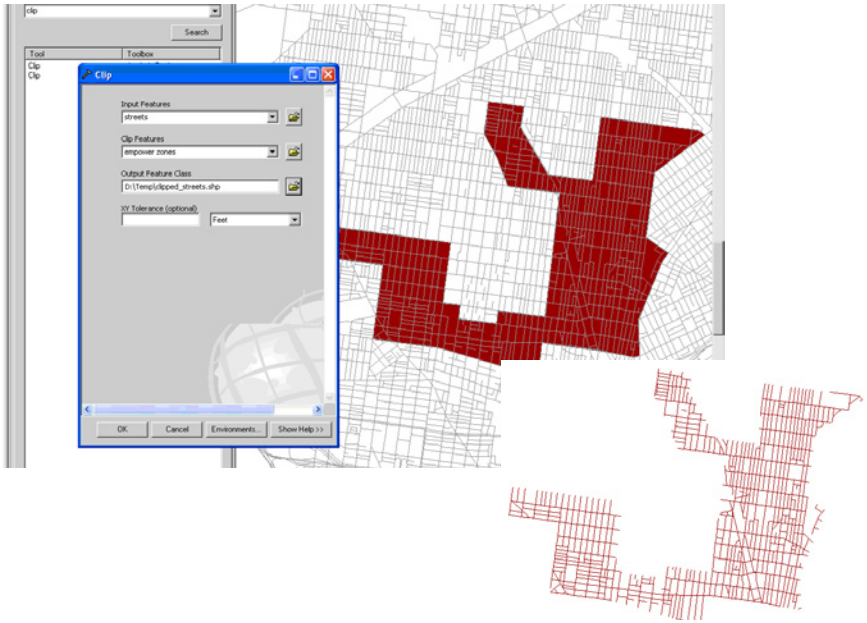
Appending allows you to incorporate two or more non-overlapping layers into a single map layer without changing their map features. You can append point, line, and polygon layers. Appending can save you time when it comes to symbolizing features and lead to more consistent symbology. For example, you can merge census tract files from several counties so that when you display the percent of homeowners, you don't have to repeat the process of classifying your data for each county.

From ArcToolbox, you can find "Append" under "Data Management Tools" and "General." Under "input features," list all the map layers you wish to merge. You can use the dropdown menu if you have added the map layers to ArcMap, but you will need to add them one at a time. A new layer will not automatically be created, so you will need to specify an EXISTING layer in "output feature." This will overwrite the existing layer, so be sure to make a backup copy if necessary. If the columns in the attribute tables of all the input features are identical, you can select "TEST" under "Scheme Type." Otherwise, you must choose "NO_TEST." The resulting shapefile will contain all of the map features in the appended layers. If the column names were the same for all of the layers (as they could be for census tract files from different counties), there will be values for each record in each column. Keep in mind that these merged shapefiles can grow very large, particularly if you merge street centerline files.



Clip

Clipping allows you to turn one shapefile into a cookie-cutter in order to cut out part of a larger shapefile. For example, you might need to create a map layer of streets for the area within a single police district but your street centerline file covers the entire city. Using a street file that is clipped by the police district boundaries will allow you to work with a smaller and more manageable file that looks neater. From ArcToolbox, you can find "clip" under "Analysis Tools" and "Extract." On the next screen, you need to identify an input feature (the layer to be clipped) and the clip features (cookie cutter). The default name for the new shapefile will be the input feature name plus "_Clip." If you want to change this or the location of the new file, click on the folder to the right. You can leave "Cluster Tolerance' at 0. Changing it will allow slightly mismatched map layers to be considered "coincident."



Intersect

Intersect allows you to fuse two overlapping layers together to create a new shapefile that includes the attributes of both layers for the area in which the layers overlap. In effect, this combines the union (described below) and clip operations. You can intersect two polygon layers or a line and polygon layer. From ArcToolbox, you can find the "Intersect" function under "Analysis Tools" and "Overlay." On the next screen, select the input features. The default name for the new shapefile will be the first input feature name plus "_Intersect." If you want to change this or the location of the new file, click on the folder to the right. If you intersect a line and polygon layers, the resulting shapefile will contain "polylines" that act like lines. If you intersect polygon layers, the resulting shapefile will contain polygons. Length, perimeter, and area values will be inaccurate after you perform an intersection, so if you need these be sure to recalculate them. Other attribute values maybe deceptive, as well. In the example at right, census tracts were intersected with police districts. The result was many sliver polygons resulting from slight differences in their digital boundaries, not real differences in their actual boundaries. Note that three polygons have been given the same total population based on the census tract data, two of which are sliver polygons. Adjusting the cluster tolerance can help you avoid sliver polygons.

Union

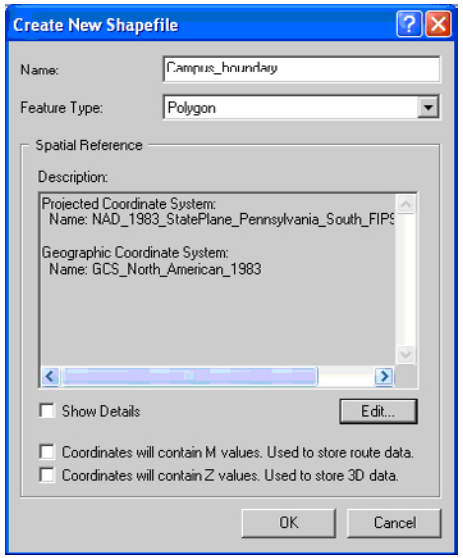
Union is similar to intersection in that it fuses the boundaries of two layers together, but rather than clipping the resulting shapefile to include only the area covered by both, it creates a new shapefile that covers the combined extent of the layers. From ArcToolbox, you can find the “Union” function under “Analysis Tools” and “Overlay.” Select the input features. The default name for the new shapefile will be the first input feature name plus “_Union.” If you want to change this or the location of the new file, click on the folder to the right. As with shapefiles created through intersections, the shapefiles created by a union will most likely have some attribute values that no longer make sense. Be sure to recalculate length, perimeter, and area if you need these variables.

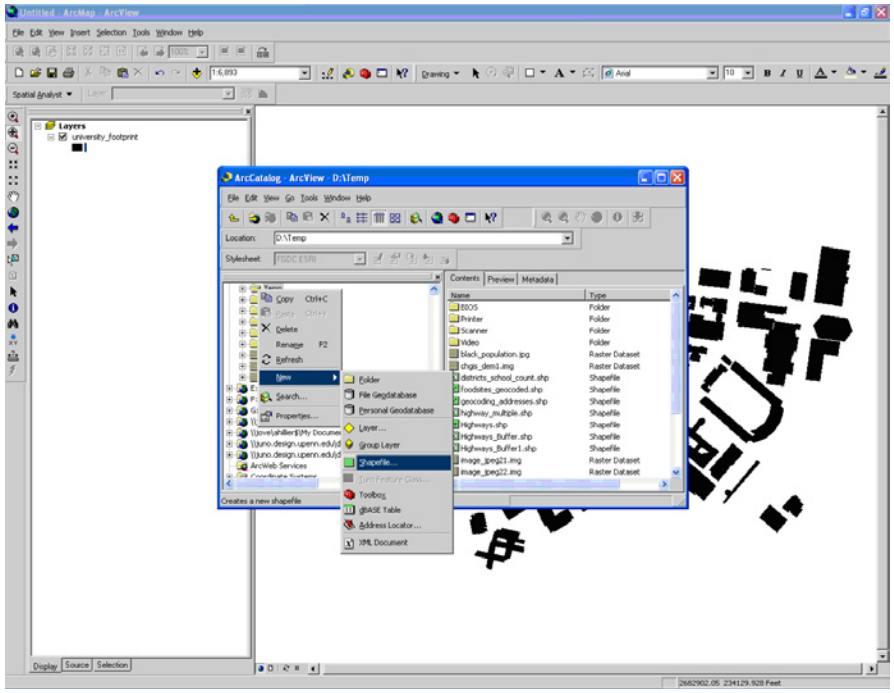
8 | Digitizing

Most of the time you will use shapefiles that someone else created. Using existing shapefiles saves time and generally results in more accurate map layers. But if you need a line or polygon file that doesn't exist—such as a boundary for your study area—you will need to create it yourself. Digitizing is the process of drawing or tracing map features to create a new geographic file. Before on-screen digitizing was available, this process involved tracing a paper map on a digitizing tablet and then assigning real world coordinates to certain parts (like georectifying). In some cases, professionals will still use this approach. But ArcView 9.2 has on-screen digitizing tools that allow you to create new shapefiles without additional hardware or software.

Creating New Shapefiles

When you open ArcMap, you are in "Data View" and use the Tools toolbar to navigate your map. When you switch to the Layout View, you have access to a different range of tools and use the Layout toolbar to navigate. To switch to "Layout View," click on the icon at the bottom of your map display that looks like a piece of paper (next to the globe icon) or, from the View menu, go to Layout View.

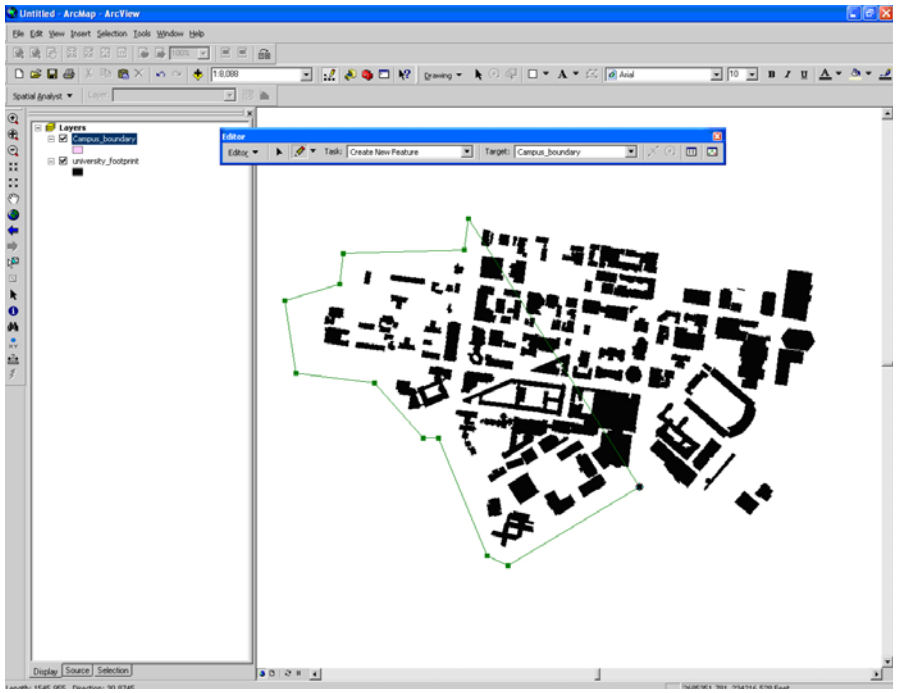




Next, open ArcMap and add your new shapefile, along with other map layers that may help you draw your new features. Start an edit session: from the Editor menu in the Editor toolbar, choose "Start Edit Session," and indicate which directory contains the shapefile (shell) you just created. Be sure that your new shapefile is listed as the Target and that "Create New Features" is selected from the Task menu. Next, you need to choose a drawing tool. You have five choices: The Create New Feature tool allows you to draw points, lines, or polygons. The Arc tool allows you to create lines that are curved (rather than just a bunch of short line segments that look like a curve). The Distance-Distance tool will place a point at one of the locations where two circles intersect. The Intersection tool places a point where two lines would

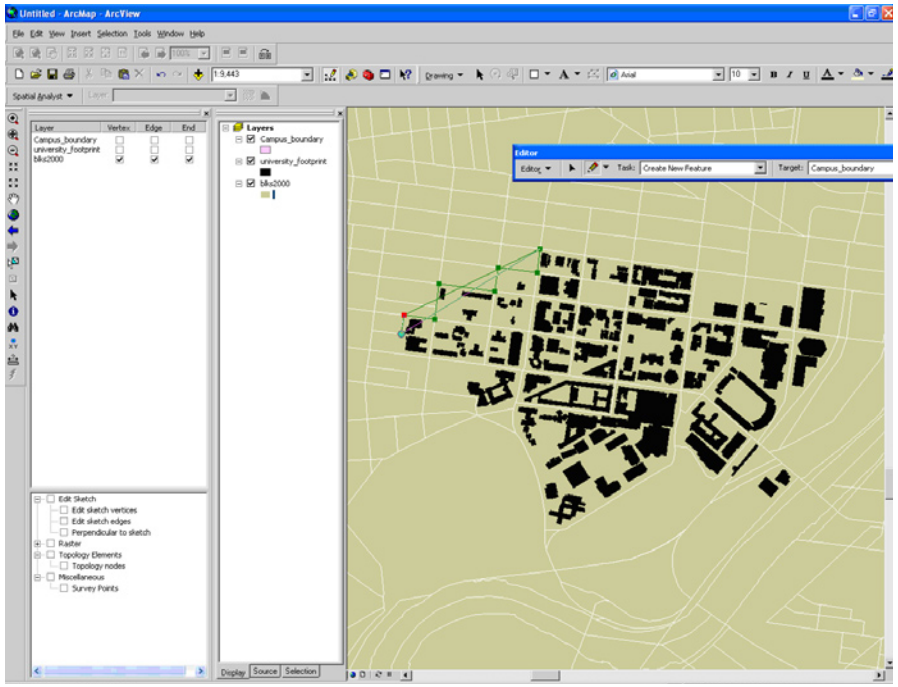
cross if they continued far enough. The Trace tool creates features that follow existing map features.

The Create New Features tool is the most basic and allows you to draw new map features. Click to create a new vertex and double click to finish. In the example at left, a new polygon feature was drawn that follows four streets. Use the delete tool to start over. Use the undo tool to remove the last vertex. To save your new feature, from the Editor menu choose "Stop Editing" and save edits.



Snapping to an Existing Feature

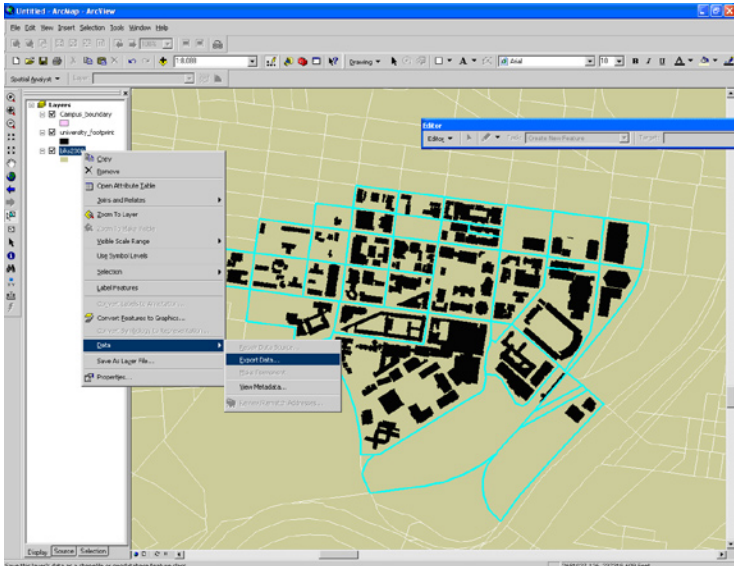
It is nearly impossible to draw features that match an existing layer just by looking at it. The result is map layers that look sloppy and can negatively impact the result of your analyses. You can avoid this problem by "snapping" your new lines to an existing shapefile. From the Editor menu of the Editor toolbar, go to Start Editing and indicate which directory contains the shapefile (shell) to which you want to add map features. From the Editor menu, choose "Snapping." In the top of the dialog box, you can identify the layer(s) to which you want to snap your new features. Try drawing your new features using different combinations of layers and vertices and/or edges. If you use a street centerline file as your guide, vertices will work well. Now when you start to draw your new features using the Create New Features tool, your cursor will be pulled toward the vertices of the shapefile you are trying to trace.
To create the most accurate line, move your cursor slowly over the existing shapefile, clicking at each vertex to create a new vertex in your shapefile. You can change the snapping "tolerance"—the distance from the existing shapefile you can be and still snap to it—from the Editor menu, "Options," and the "General" tab. The map units reflect the units you identified in the Data Frame properties (General tab).



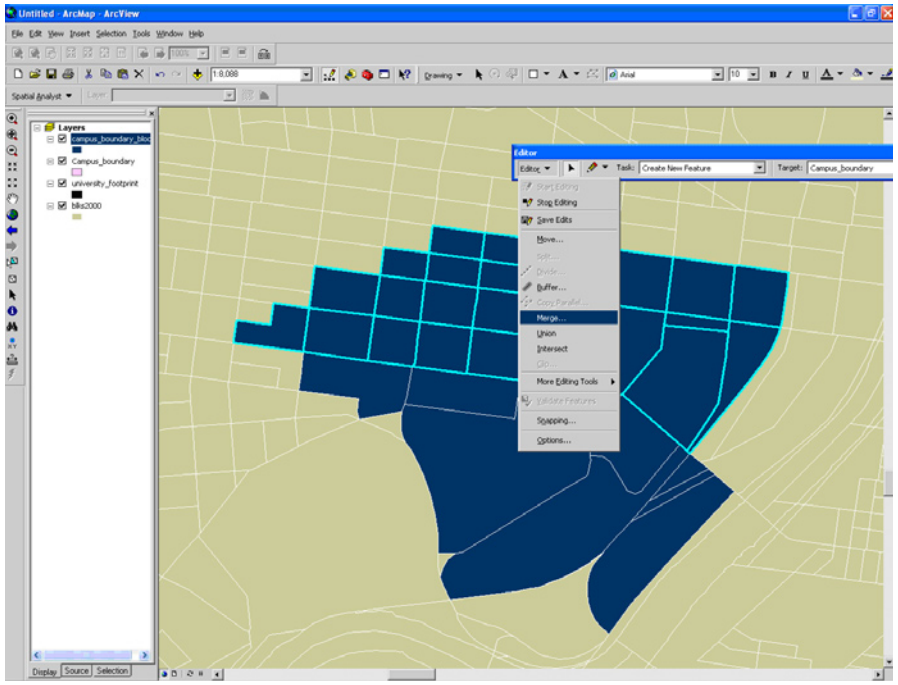
Using the snapping tool, you should be able to create new features that line up with existing shapefiles, even when you zoom in close. If you are not happy with your results, click on the map feature with the Edit tool and hit Delete (you can do this even after saving edits to the shapefile, as long as you start an Edit Session).

Digitizing using the Merge Tool

The tools in ArcMap for dissolving boundaries between features provide another approach to digitizing. This may give you less control over the shape of new map features, but it provides an easier way of creating new shapefiles that line up with existing shapefiles. In order to create shapefiles using the dissolve tools, you need to have a shapefile that can serve as building blocks for your new file. For example, you may want to create a map of health districts. If the districts are based on census tracts, you can use a shapefile of census tracts to build your new district file. A census block file may prove the most helpful. To start, add a census block layer to ArcMap. Select the blocks within the area of interest, create a new shapefile based on these selected blocks (right click on it, go to “Data” and “Export Data”), and add it to your map.



Using the Select Features tool, highlight the blocks that cover just the area you want your new map layer to cover. You can select multiple features by holding down the shift key. You can also draw a box around the area containing the individual features (this is faster). To dissolve the boundaries between the blocks, start an edit session, then from the Editor menu choose “merge.” Stop editing and save edits to finish.

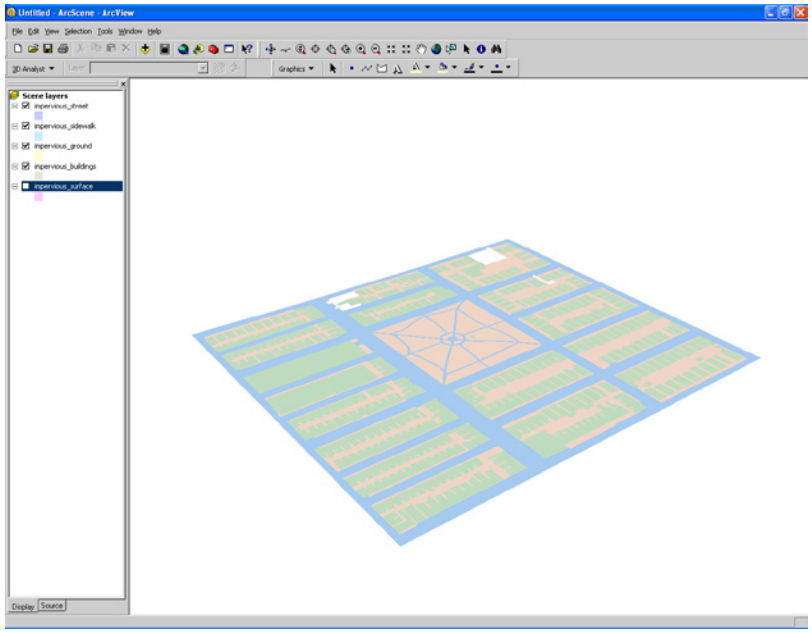


If your new shapefile only needs to include this single map feature, you can right click on the block shapefile (with the new feature still selected), go to Data and Export Data. Be sure that the Export drop down menu indicates that only selected features will be included. Alternatively, you may need to repeat the process of dissolving boundaries so that all census blocks become part of a new map feature.

9 | Working With 3D

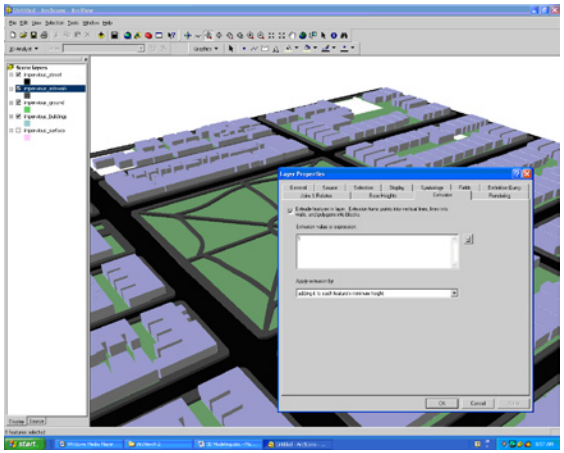
3D Models of Vector Data

3D modeling happens in ArcScene rather than ArcMap. ArcScene is a separate application (.exe file) that you can launch from the Start Menu (Programs, ArcGIS, then ArcScene). Once open, it looks similar to ArcMap with a table of contents in the left, where the names of your map layers will appear, and a big space to the right where your map layers will draw. You add map layers into ArcScene just like ArcMap, with the "Add Data" button or from the File menu, "Add Data." Don't worry if your map layers look funny when you first add them. Vector polygons layers will draw as solid fill colors without any outlines. Points and lines will look more similar to the way they draw in ArcMap. It is possible to make points and lines 3D, but polygons work better. Most of the buttons on the tools toolbar for navigating your map layers are the same in ArcScene as ArcMap, but a few are new.

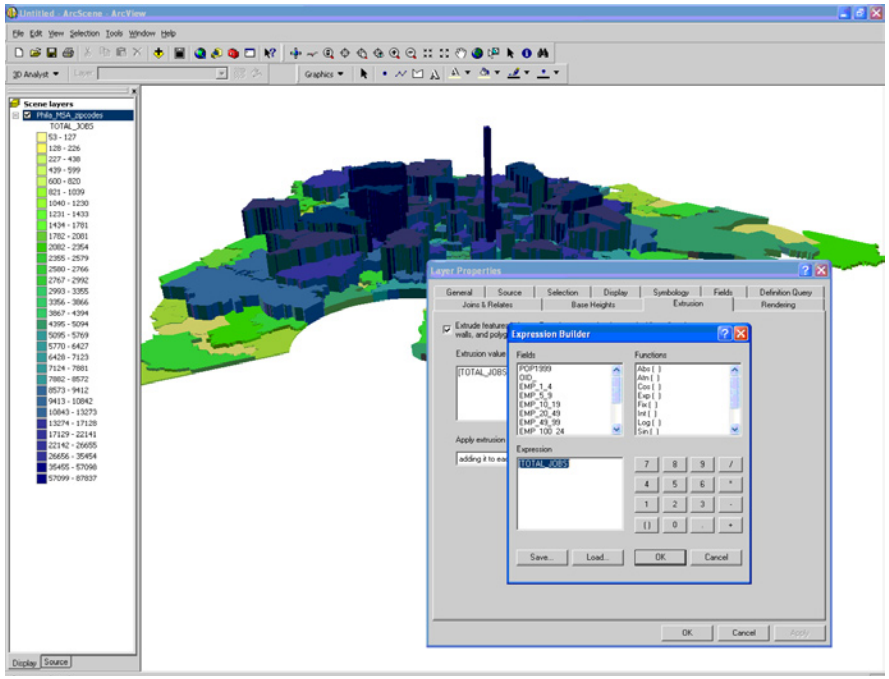


The navigate button is the most useful. When you hold down the right mouse button, you can spin and twist your map layers, looking above or below them and from any angle. If you click the left mouse button, you will be able to zoom in and out continuously. If you hold both buttons down, you can pan your map layers (move them around without zoom in or out or tilting them). The zoom in/out button allows you to zoom in and out continuously (like the continuous zoom tool in ArcMap). It is even easier in ArcScene to loose track of where you are than it is in ArcMap. Click on the full extent button (globe) to bring your map layers back. The fly tool allows you to swoop in and around your model (caution: this may cause motion sickness). Hit "Esc" to stop.

In order to make your polygons 3D, double click on the map layer. Most of the tabs under "Layer Properties" are the same as ArcMap, but some are new. Click on the "Extrusion" tab. Here you can enter a constant value under "Extrusion Value or Expression" in order to make the entire layer the same height. This makes sense in some situations, such as when extruding streets and sidewalks in an impervious surface layer.

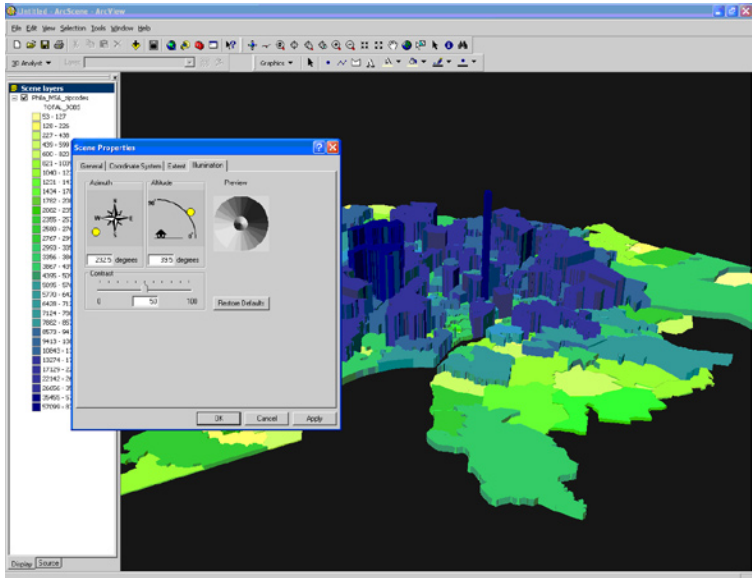


More often, you will want to extrude the polygons based on an attribute. For example, if you have a height variable, you can extrude the polygons to reflect this. Click on the little calculator to the right of the “Extrusion value or expression” box and use the “Expression Builder” to create a formula for the height of the building. You may need to adjust the formula later to make your relative heights work, but don’t worry too much at this point. Click “OK” and then click “OK” again. Now your buildings should be different heights. You can use attributes other than height or elevation as the basis of the extrusion. For example, you can extrude neighborhoods based on the amount of crime. In order to see the differences in the height more clearly, use the options under the Symbology tab (use this just the way you do in ArcMap) to make different heights different colors (graduated color map based on height variable). You can use different variables for the basis of your extrusion and symbology, especially when you are extruding based on height or elevation. For example, you can use the extrusion option to make buildings different heights and then use the symbology options to use different colors to show which properties are vacant.



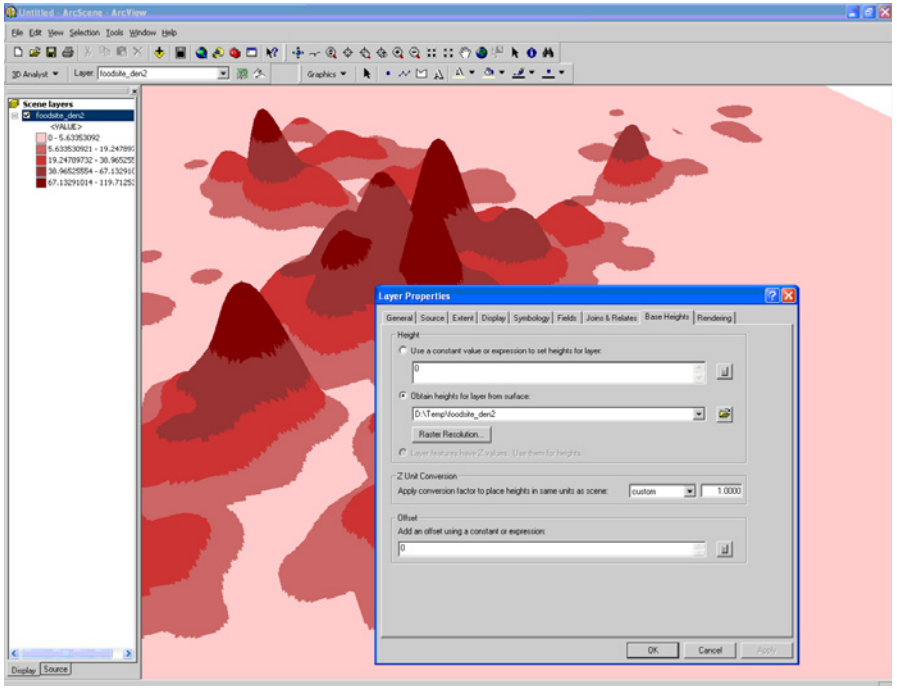
Scene Properties

To access scene properties, double click on the word “Scene Properties” at the top of your table of contents or go to the View menu and “Scene Properties.” From the General tab, you can change the background color (black looks pretty cool). You can also change the vertical exaggeration. This is especially helpful when your layers look too flat or way too tall after extrusion. Click on “calculate extent” for ArcScene’s suggestion for how much you should exaggerate the vertical extent. If you put a check mark in the “Enable Animated Rotation” box, you can make your 3D scene spin around continuously. Rotate your scene with the navigate button, then let go of the mouse button while the scene is still moving. Imagine that your scene is sitting on top of a lazy susan and you are just giving it a push in the right direction. Hit “Esc” to stop the animation. From the Illumination tab, you can change the height and direction of the sun to adjust the lighting in your 3D scene.

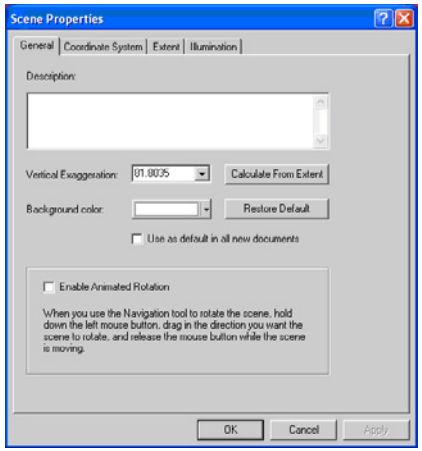


3D Models for Raster Data

Raster data makes for great 3D models in ArcScene. Add your raster layer to ArcScene just as you do vector layers. If you are asked about building pyramids, say “yes.” Don’t worry if your map layer looks funny when you add it. From the “Layer Properties” click on the “Base Heights” tab. Click the radio button next to “obtain heights for layer from surface.” This means that the values stored in your raster layer will be used as the basis for the layer’s height. Then from the “Symbology” tab, switch to a classified map and symbolize your map using one of the color ramps. You may want to exclude all 0 raster values (click on classify, then exclusion and type in “0”) and add extra classes so that the color ramp shows more gradual differences in value.

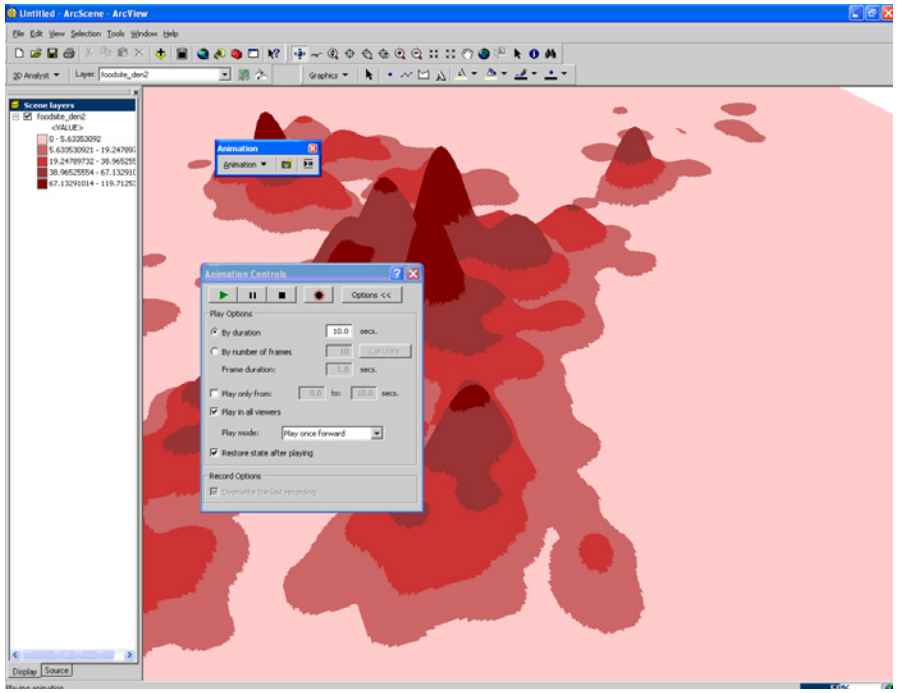


You may need to exaggerate the differences in your values to create a 3D model. From Scene properties, go to the “general” tab and click on “Calculate from Extent” next to “Vertical Exaggeration.” If you do, you may wish to report this exaggeration factor when you create maps out of ArcScene.



Animating 3D Scenes

To animate your 3D scene, you need the Animation Toolbar to be visible (“View” menu to toolbars, then “Animation”). The animation will be based on a series of snapshots of your 3D scene. Use the navigate tool to create the first perspective. Click on the camera button once (or use “Ctrl” + “A”). Use the navigate tool to choose your next perspective, then click on the camera. When you have created all your images, open the animation tools (using the button at the far right of animation toolbar). Click on the play button to view your animation. You can adjust the length (from options button) and speed (from Animation menu, Animation Manager) of your animation.



Saving 3D Scenes

You can save your 3D scene in the same way you save a map document in ArcMap. Instead of an .mxd file, you will create an .sxd file. Since these behave in the same way as .mxd files, you need to remember to keep the .sxd file with the shapefiles or raster layers upon which the 3D scene is built. To export an image from ArcScene as a 2D image, go to the “File menu” and “Export scene” and “2D.” You can also save an animation as a video file.

10 | Troubleshooting

I can't save my files...

Are you saving to a write-able drive (you can't save to a cd)? If so, change the location where you are trying to save the file. Have you run out of room on your drive? Try deleting some old files (if you are deleting map layers, be sure to do this in ArcCatalog).

My scale bar isn't right...

Are the units "unknown"? You need to define the projection for one or more of your map layers. Do the units show up but not make sense? For example, does it show that Center City Philadelphia is 0.5 miles tall or 30 miles wide? Your projection was probably defined incorrectly. Start over with your original map layer and work through the projection steps again.

My map looks skewed...

Did you export the map in import it into MS Word, PowerPoint or other file? You may have skewed it here, while resizing. Export the map again. Resize only from the corners, not the sides (resizing from the sides squishes the map). Are your data projected? Check the coordinates in the bottom right of your map in the map view. If you see longitude/latitude coordinates, that's the problem. Be sure to define, then project the data.

I can't join my attribute table...

Are you starting with the shapefile? Be sure to right click on the shapefile you are joining your data to, then choose "join."
Have you identified an identical join field in both tables? Open both tables up. Sort them both ascending to descending to make sure they are the same. Count the number of digits. Make sure both are formatted as string (left justified) or number (right justified).

I can't open the attribute table on my shapefile after the join...

Right click, data, export, save under new name, add back in. Might work.
Spaces in names of variables?
Long name? On harddrive, change name of file, try again.

I can't add/open my table to ArcView...

Is it open anywhere else (like in Excel)? If so, close and re-try. Are there spaces in the names of any of your variables? If so, correct this in Excel, re-save, and try again.

I can't see my table in the table of contents...

At the bottom of the table of contents, click on the source tab.

I can't move my layers up and down in the table of contents...

At the bottom of the table of contents, click on the display tab.

I made a change, but I don't see it on the screen...

Refresh the graphics (arrows in a circle next to map view and layout view buttons).

I get an error message when I calculate values...

Are you dividing by zero? Sort the column with your denominator to look for zeros. Highlight every row with a zero, switch the selection so that all non-zero rows as highlighted, then try your calculation again.

I just get 0 and 1 when I'm trying to calculate a percent...

You probably formatted your column as a short integer rather than double. Delete the column (right click on column name, delete) and create a new variable formatted as double, then try your calculation again.

Still stuck?

Close ArcView, re-start and try again. Try a new computer somewhere else (different lab). Ask for help. Don't worry, pretty much everyone does at some point (or at least they should).