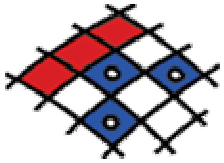
Using
ArcView 9
An introduction



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Making Maps

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Introduction to ArcGIS

ArcGIS is a scalable system of GIS software produced by Environmental Systems Research Institute (ESRI). This system contains three different products: ArcView, ArcEditor, and ArcInfo.

ArcView
ArcView is the desktop version meant for a general (non-professional) audience. It is the most popular desktop GIS software program, but it is not the only one. With the jump from ArcView 3.2 to ArcView 8.x, ESRI brought ArcView into its ArcMap 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. ArcView 9 adds some functionality to ArcView 8, but the two versions work in a very similar way.

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.

ArcSDE is ESRI's database service, allowing you to manage geographic information in several different types of databases (IBM DB2, Informix, Microsoft SQL Server, and Oracle) while **ArcIMS** adds internet map services.

Introduction to ArcView 9

ArcView 9 includes two separate applications: ArcCatalog, and ArcMap. Although they are designed to work together, they run under separate executable files (.exe) so they each have their own icons.


arccatalog


ArcMap

ArcCatalog works sort of like Windows Explorer. It is a place to browse and manage your data. You can also create and edit metadata in ArcCatalog.

ArcMap is where you actually create maps. This is where you will spend most of your time.

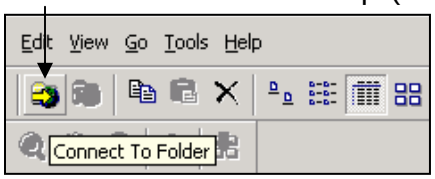
ArcToolbox was a separate application in ArcView 8. For ArcView 9, it has been integrated directly into ArcCatalog and ArcMap.

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. Using ArcCatalog will help you to develop good GIS habits, so it's worth the effort.

Connecting to Folder

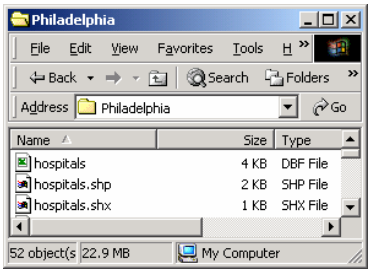
When you launch ArcCatalog (from the Start menu, go to ArcGIS, then ArcCatalog, or add a shortcut to your desktop), a list of all the folders and sub-folders on your computer will be displayed on the left in the catalog tree. "Connect to folder" allows you to make a direct connection to the place on your computer where your GIS data are stored. This is not necessary but will save time. You will use these same shortcuts in ArcMap (and you can connect to folder from ArcMap, as well).

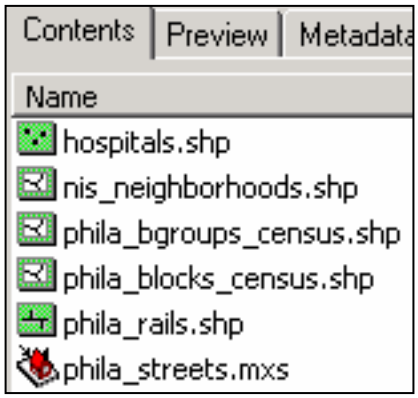


From the file menu, go to "Connect Folder…" or click on the "Connect To Folder" button (yellow arrow against a globe). Navigate until you find the folder with your data and click "OK." Your folder should now be listed under "Catalog" next to a  icon.

Seeing File Types

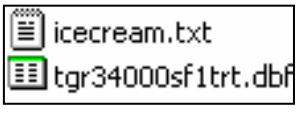
When the contents tab is active in the window on the right (catalog display), ArcView will indicate the type of file using icons. Shapefiles, the format for geographic files in ArcView, are made up of three or more separate files. If you viewed them outside of ArcCatalog (in Windows Explorer or through My Computer), you would see all of the files listed with extensions such as .dbf, .shp, .shx (see example at right).



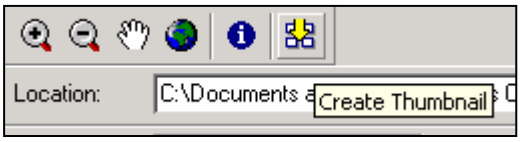


In ArcCatalog these various files will appear as a single shapefile. ArcCatalog also indicates what kind of shapefile: point, line, polygon, or geocoding service. In the example on the left, the file "hospitals.shp" is made up of points, "nis_neighborhoods.shp" is made up of polygons, and "phila_rails.shp" is made up of lines. "phila_streets.mxs" is a geocoding service. This means that it has been indexed so that you can use it to geocode addresses. By copying and pasting shapefiles using ArcCatalog, you insure that you will keep all of the components of a shapefile together.

Tables that contain no spatial information can also be displayed in ArcCatalog. The icon changes depending upon the type of table. Images can also be displayed.



Creating Thumbnails

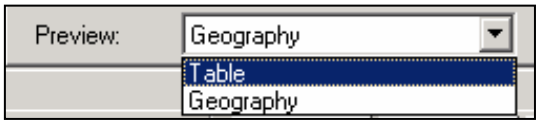


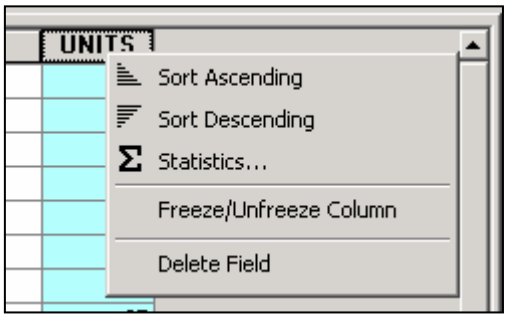
For some files, including maps and layers created in ArcMap, ArcCatalog will display a thumbnail image of your data when the "contents" tab is active.
To create thumbnails for shapefiles and images (you cannot create thumbnails for tables), click the "preview" tab, highlight the shapefile name, and click 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 what your geographic data looks like mapped. You need to view your data in ArcMap in order to make changes to the way it displays, but this preview in ArcCatalog allows you to look quickly at your data. 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.

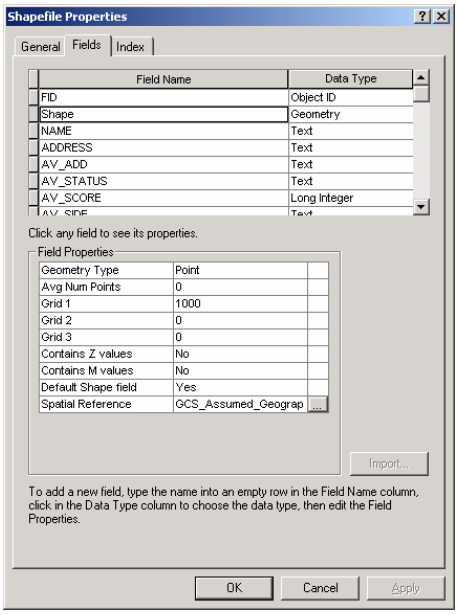




Click on the "options" button to add a new field or export the table. Right clicking on a column heading allows you to access a number of other functions such as sort, freeze/unfreeze column, delete field, and statistics (the statistics option is only available for numeric fields). You can also access these functions in ArcMap.

Checking Properties

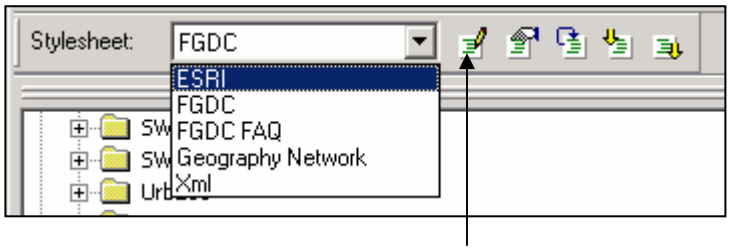
Double click on the file name to bring up the shapefile or table properties (or by highlighting the file name and choosing "properties" from the File menu). With the fields tab active, you can identify the data type for each of the columns in your table. When you click on a column name, the length of the field will appear below. The column called "shape" will appear for your shapefiles. When you click on the field name "shape," several new field properties appear at the bottom. From the "spatial reference" field, you can see what datum and projection have been defined (if any). You can change or add to this information by clicking on the "..." From the index tab, you can create attribute or spatial indexes in order to increase the speed of searching, querying, and drawing data.

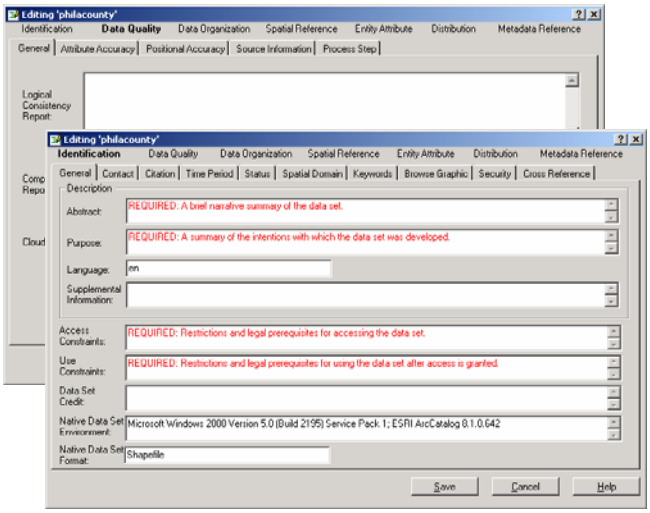


Updating Metadata

ArcCatalog also allows you to update and store metadata. Click on the "metadata" tab to access this functionality. Sometimes you will receive data that contains metadata, but generally this is something you will have to add after acquiring or building a dataset. 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 geocode addresses and work with maps and layers, although these are functions that can also be done through ArcMap.

Introduction to ArcMap

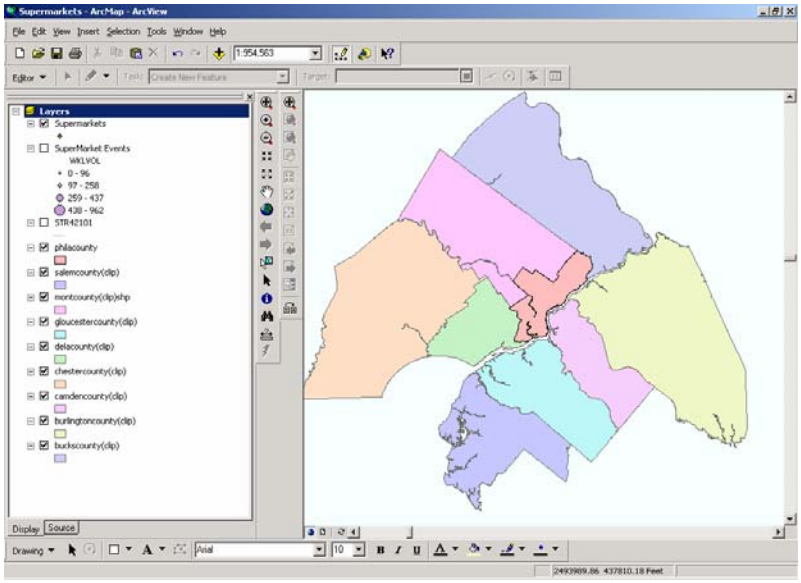
ArcMap is where you create maps and access most of the ArcGIS functionality. You can access some of the same functions through ArcCatalog and will need to decide for yourself which approach you find works best for you.

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, ArcGIS, and ArcMap or double-click on a desktop icon (if you created one). 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.

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 that lists your map layers is the table of contents; the window that shows your map is the map display. You can close the table of contents by clicking on the "x" and resize it by holding your cursor over the right edge until your cursor changes to a two-headed arrow. 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.

Adding Tools and Toolbars

To add or remove a toolbar, left click anywhere outside of the table of contents, map display, or toolbar (somewhere gray) or, from the view menu, go to "toolbars." Anything with a check mark next to it will be displayed. You can also add new buttons to your toolbars from the "customize" option. One especially helpful button allows you to zoom continuously. Choose the commands tab, scroll down to "pan/zoom," then right 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.

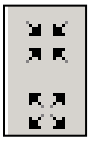
Working with the Table of Contents

The table of contents has two tabs (at the bottom): display and source. When the display tab is active, the table of contents will only list data that can be drawn as a map layer. When the source tab is active, the table of contents will also show tables along with the path indicating where the data are stored. Turn on and off a layer by checking and unchecking 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.

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. Click on it, 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). This is not a standard tool, so you will need to add it. See instructions on previous page for customizing toolbar.

Using the other (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 work like the zoom tools when you click them rather than draw a box. Each time you click, you will zoom in or out a fixed amount.

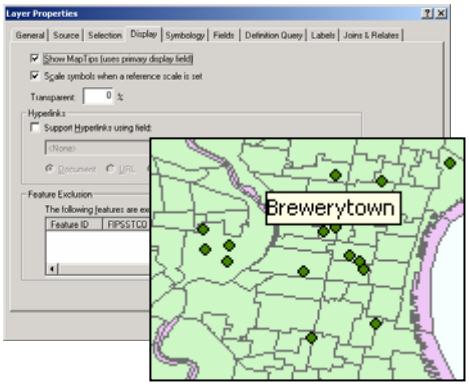
The pan tool works like the continuous zoom tool when you right click on it. Think of the pan tool as a sticky hand. Left click on your map display, hold the mouse button down, and shift your map. Your extent (amount zoomed in or out) stays the same while your map moves.

The full extent button will zoom in or out so that all of your active (checked) map layers can be viewed. 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 using one of the zoom tools. 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 map layers are all map features that have attributes stored in a table. You can access this information in several different ways. Using the identify 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.

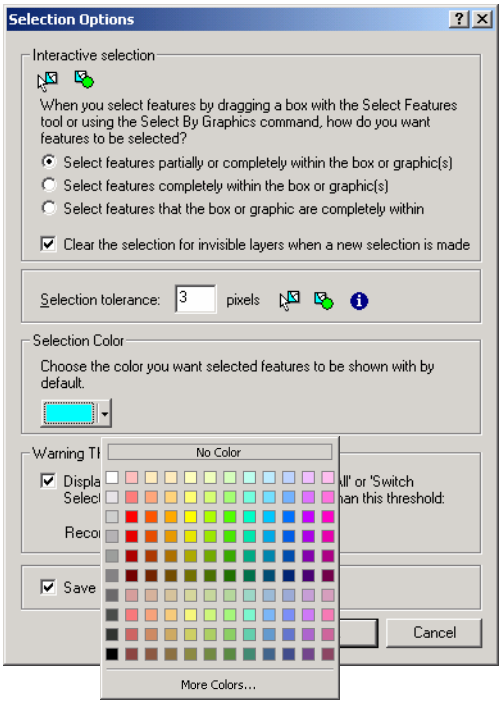


Showing Map Tips

Map tips are small text boxes that appear when you hold the cursor over a map feature. You can determine which value in your attribute table is used in the map tips. 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 "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.

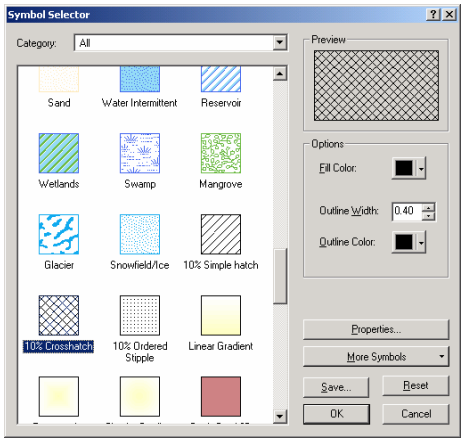
Selecting Features

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) of interest 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. You can change the selection color from "options..." in the selection menu. It is also possible to use different 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.



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." Remove the check mark next to one of the categories of symbols if you find that it is not helpful (to reduce the amount of scrolling necessary to find appropriate symbols).



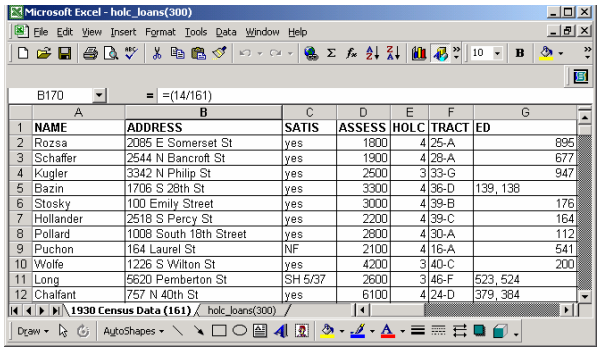
You can change the color, size, and angle using the options on the right of the window. The “reset” button will undo any changes you have made to the symbol since opening the symbol selector window. For lines, the options are similar. For polygons, you have choices about the fill pattern, fill color, 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.

Managing & Saving Files

ArcGIS can integrate many different types of data into maps. The most common forms are tabular data and geographic data, but you may also use various images. Through ArcMap, you can create additional types of files, including map documents (.mxd) and map layers (.lyr). Naming and storing these files in a consistent manner will make your work with ArcGIS much easier.

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, such as census data. ArcMap can only work with comma-delimited text (.txt) and dbase (.dbf) files, so frequently you will need to convert your tables to one of these formats before adding it to ArcMap.



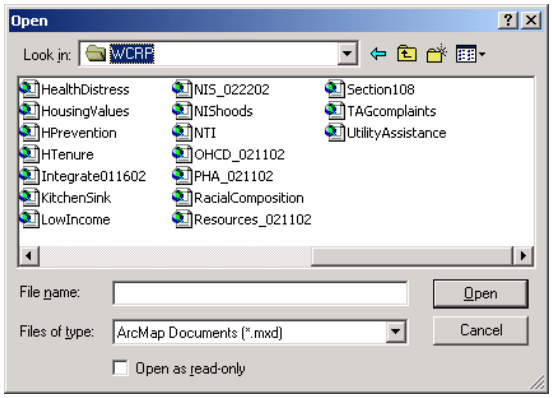
	A	B	C	D	E	F	G
1	NAME	ADDRESS	SATIS	ASSESS	HOLC	TRACT	ED
2	Rozsa	2085 E Somerset St	yes	1800	4	25-A	895
3	Schaffer	2544 N Bancroft St	yes	1900	4	28-A	677
4	Kugler	3342 N Philip St	yes	2500	3	33-G	947
5	Bazin	1706 S 28th St	yes	3300	4	36-D	139, 138
6	Stosky	100 Emily Street	yes	3000	4	39-B	176
7	Hollander	2518 S Percy St	yes	2200	4	39-C	164
8	Pollard	1008 South 18th Street	yes	2800	4	30-A	112
9	Puchon	164 Laurel St	NF	2100	4	16-A	541
10	Wolfe	1226 S Wilton St	yes	4200	3	40-C	200
11	Long	5620 Pemberton St	SH 5/37	2600	3	46-F	523, 524
12	Chalfant	757 N 40th St	yes	6100	4	24-D	379, 384

Geographic data

Geographic data are unique to GIS programs because they allow you to create maps by locating them in real world coordinates. Shapefiles are the standard format for geographic data in ArcView, but you can also use tables that contain X and Y coordinates (for point data) or convert geographic files in other formats into shapefiles. Shapefiles are made up of three or more separate files that all need to be located in the same directory in order for ArcMap to recognize them as parts of a shapefile. (Note: shapefiles are used for vector GIS data. Raster GIS data are stored in files that are more similar to images).

Images

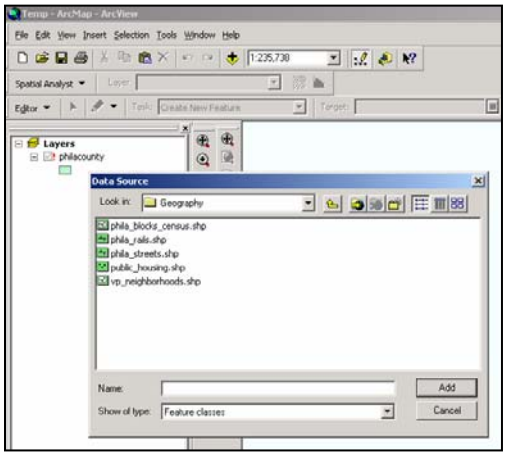
ArcGIS allows you to import and export many different types of images. The images you import may be scanned paper maps, aerial photos, or other pictures or photos that you “hot link” to your map features. ArcMap can import a wide range of file types. You can also export finished maps in ArcMap in a number of formats: EMP, BMP, EPS, TIFF, PDF, JPEG, CGM, JPEG, PCX, and PNG.



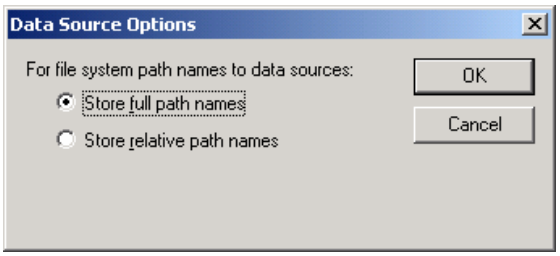
Map Documents

If you save all of your work in ArcMap (by going to the file menu, “save” or “save as”), you will create a map document (.mxd). This file will save all of the work you have done, including the data you have added and the changes you have made to layer properties, symbology, and the layout. This .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 without running into problems. It also means that map documents are 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, but this can be time-consuming (and frustrating) and is best avoided.



Using Relative Paths

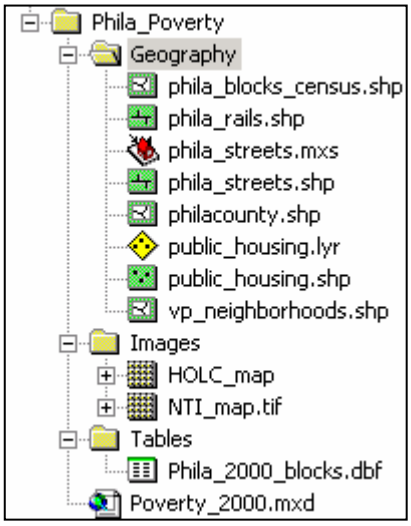
One way to minimize problems when you move files that are part of an ArcMap document is to use relative paths. If you specify that you want to use relative paths, ArcView will be able to find the pieces of your ArcMap document if you move it or its components. From the file menu, go to "map properties" and click the button "Data Source Options." Choose the radio button "Store relative path names."

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

Giving your files clear and consistent names will make working with ArcMap much easier. You need to develop your own naming convention that makes sense to you. ArcGIS can work with file names that are more than 8 characters, but really long names can be difficult to view. ArcGIS can also work with files that have spaces in their name, but this will create problems if you work with the Spatial Analyst extension. Your file names should help you distinguish the content and version of your data.



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 in that directory. Create subdirectories for tabular data that are not associated with geographic files, geographic data, and images. Keep map layers in the subdirectory for geographic data.

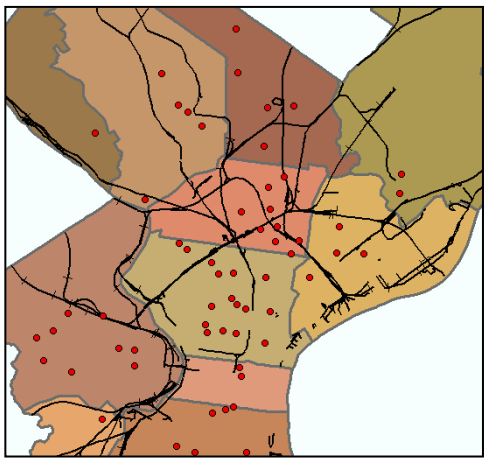
Geodatabases

With ArcGIS, ESRI has introduced a new geographic data model called a geodatabase. Geodatabases allow for topologically integrated features, similar to coverages used in ArcInfo, and define rules for the behavior of different types of objects. This provides a much more sophisticated approach to storing and managing data than using directories and subdirectories and works particularly well for sharing data.

Shapefiles & Vector Data

Vector GIS

Vector is the most common model for GIS data used in the social sciences. It uses 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.

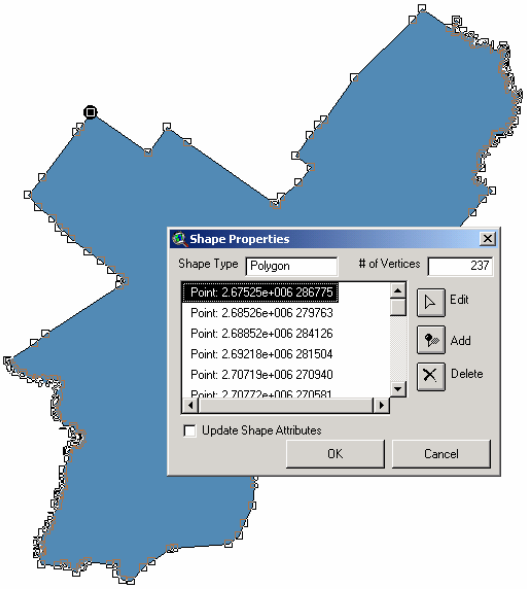


Shapefiles

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. 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. 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.

.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 shapefiles 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.



Adding Shapefiles to ArcMap

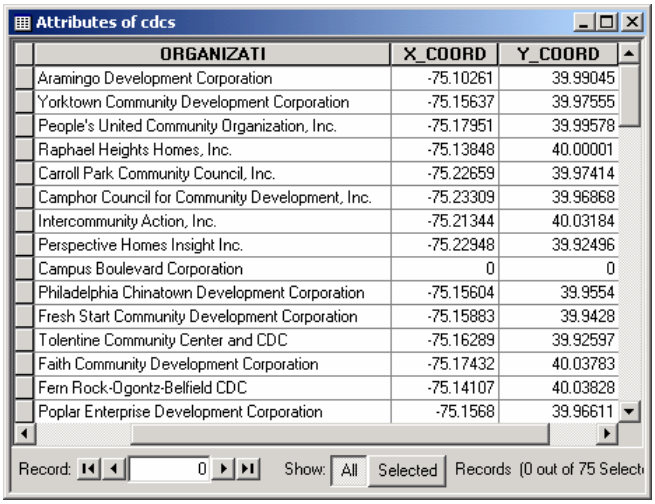
You can add shapefiles to ArcMap in several ways. From ArcCatalog, you can click and drag shapefiles right into ArcMap (click on the file name in ArcCatalog and hold down, dragging to either the table of contents or map window and letting go). You can also add shapefiles from ArcMap using the "add data" button  or from file menu go to "add data."

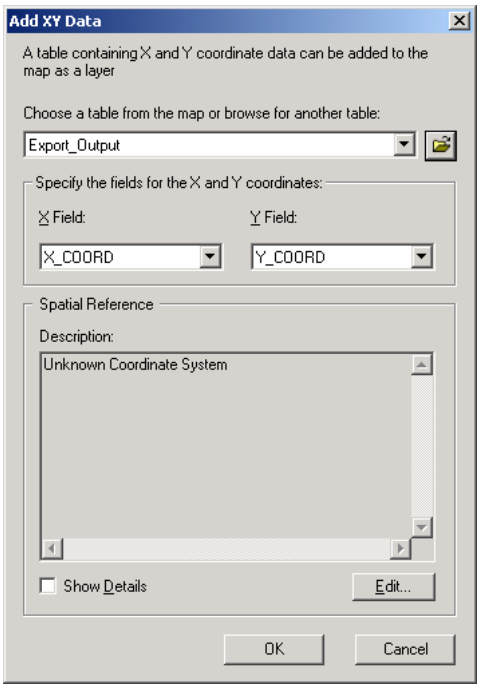
Topology

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.

Adding XY Data

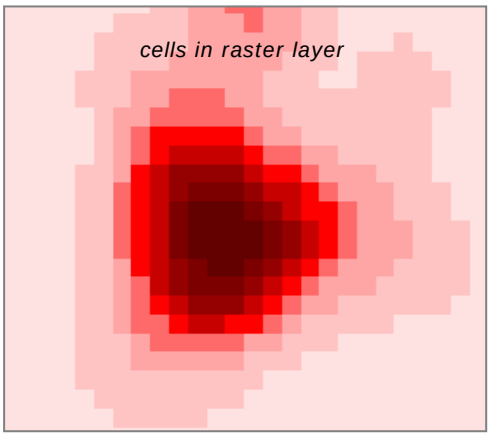
Sometimes you will need to map a table that just has X and Y coordinates identifying specific locations but no shapefile associated with it. This might occur because a GPS (global positioning system) unit was used to collect the data or because that is the way a private vendor has chosen to distribute the data. A table with X and Y coordinates is much easier to distribute than a shapefile, because it is smaller, does not involve multiple files, and is not ArcView-specific.





In order to map the data in ArcView, the X and Y values will need to be included as separate columns in a dBASE or delimited text file. You can add the table to ArcMap just as you would a shapefile (with the “add data” button), but you do not need to add it to ArcMap in order to map it. From the tools menu, choose “Add XY Data” and browse to the table with the XY data. ArcMap will probably find the appropriate fields in your table; otherwise, use the dropdown menus to indicate the fields containing the X and Y values and click “ok.” As with shapefiles, tables with XY data that you acquire may be projected. If XY coordinates are in the form shown in the table above, they are unprojected.

Raster Data



Raster GIS

Raster data use grids made up of regular cells to represent spatially continuous data. Each cell is assigned real world coordinates and an attribute value (such as precipitation level or elevation). 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.

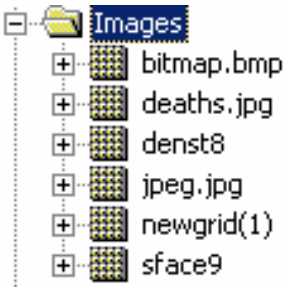
In order to work with raster data in ArcView, you need the Spatial Analyst extension. When raster layers have the same size cells, their values can be added, subtracted, multiplied, divided and queried using map algebra (a system developed by Dana Tomlin).

pixels in scanned image

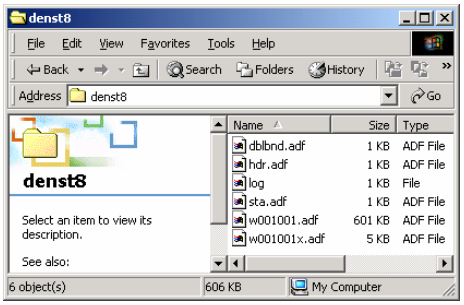
Raster GIS layers are essentially images made up of individual pixels, just like scanned paper maps and aerial photographs. You can add raster data to ArcMap just as you do vector data, using the “add data” button menu option when the Spatial Analyst extension is available and is turned on. If the raster data have no spatial information (for example, a scanned map that has not been georeferenced), ArcMap will not be able to display it with other map layers.

ArcMap saves raster layers in its GRID format. ArcCatalog recognizes GRIDs and other image formats (including BMP, JPEG, TIFF) as raster layers. Images with no extension (such as “denst8” show below, left) are GRIDs. If you view a GRID outside of ArcCatalog, it will consist of six or so files within a directory (see below, right).

Raster Data in ArcCatalog



Raster Data in My Computer



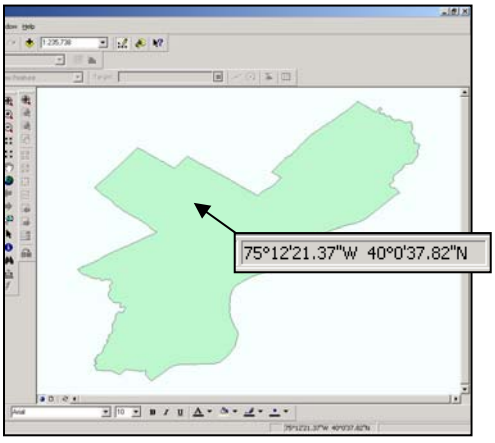
Working with Projections

Projections manage the distortion that is inevitable when a (mostly) spherical 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 since 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. The tools for working with projections in ArcView 9.0 are more advanced than in ArcView 3.x, particularly in their ability to re-project layers with different projection systems "on the fly." They look different from the projection tools in ArcView 8.3, although they essentially do the same thing.

Recognizing the Coordinate System

Map layers can be drawn according to a geographic coordinate system 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. Often you will not 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. You can look at the information in this 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."

If there is no projection information, you can map the data 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.

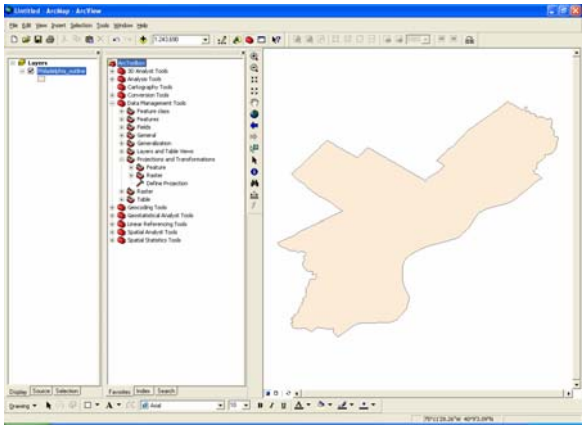


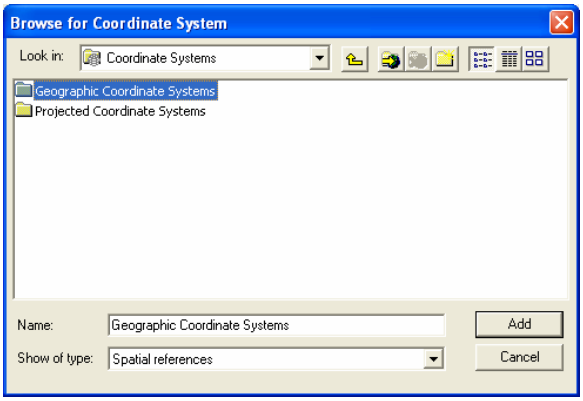
Working with "Unprojected" Layers

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 uprojected; 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."

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, then 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.”





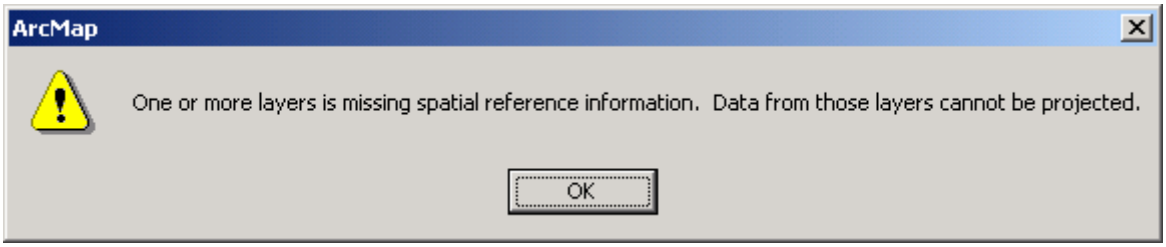
In order to project the map layer, click on the “Project” wizard. If you are projecting a shapefile, use the “Project” wizard listed under “Features.” If you are projecting a raster image, use the “project” wizard listed under “raster.” As with the “define” wizard, you will be asked to specify the map 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. 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.

Working with Projected Map Layers

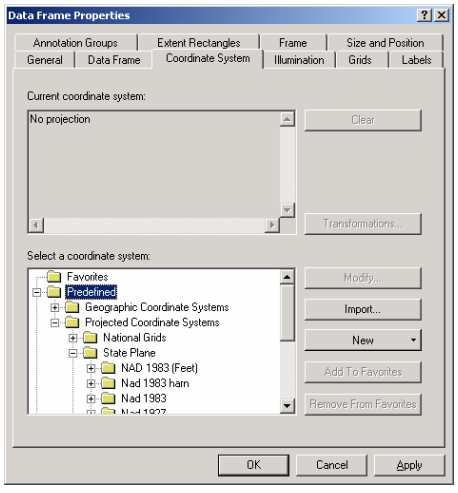
Sometimes the map layers you receive will already be projected but won’t carry a .proj file so you don’t know the projection. If you download the data, be sure to read any metadata files that may contain information about the project. If someone

has sent you the map layers, ask them about the projection. If these approaches fail, try mapping the data. You may recognize that the data are projected 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).

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. If you are not able to figure out the problem, you may want to show your shapefiles to someone with more GIS experience. 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. Stay calm and don’t be ashamed to ask for help. You may also have luck returning to your original files (be sure to keep a copy of the originals before messing with the projection).

Georectifying Images

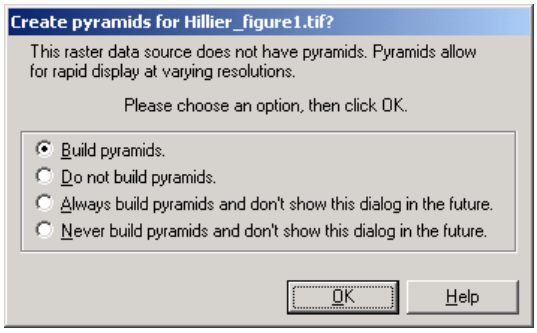
Georeferencing allows you to convert a paper map into a GIS map layer. Essentially, the process assigns X and Y coordinates to points on your digital map image, shifting, rotating, and scaling your map so that you can view it as a map layer along with your shapefiles.

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.

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."



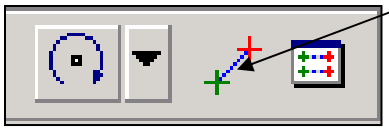
Don't worry if you get a warning message that your image lacks projection information. The name of your image should now appear in the table of contents and draw in the map view window. At this point, your image is in "pixel space" since there is no coordinate information.

Add reference layers (shapefiles)

Choose an existing shapefile that contains spatial information that will help you georeference your paper map (choose more than one, if necessary). You need a shapefile that covers the same extent as your paper map and that contains several points that you can identify visually on your paper map. In the table of contents, put your reference layer(s) on top of your map image and highlight the reference shapefile. Right click and choose "zoom to layer." From the view menu, choose toolbars → 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.

Add control points

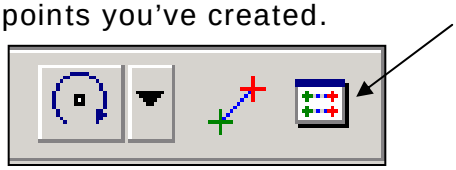
Click the "add control points" button.



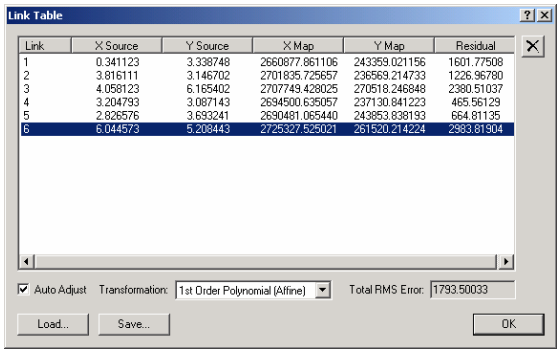
Create your first control point on your image by clicking once on a point you can also identify on your shapefile. Then click on the shapefile in the corresponding spot. Double click to create a control point. You may find it easier to use the magnifier window (from the window menu, choose "magnifier"). Create additional control points. After doing this two or three times, your paper map should shift significantly to line up with the shapefile. Continue to add control points as long as doing so improves the alignment.

View Links

Click on the “view links” button to view the coordinates of each of the control points you’ve created.



The “residuals” column indicates the amount of error. You may improve the alignment of your image by deleting the point(s) with the greatest error.



If you have six or more control points, you can perform a second order If you have six or more control points, you can perform a second order transformation; if you have twelve or more control points, you can perform a third order transformation.

Rectify Image

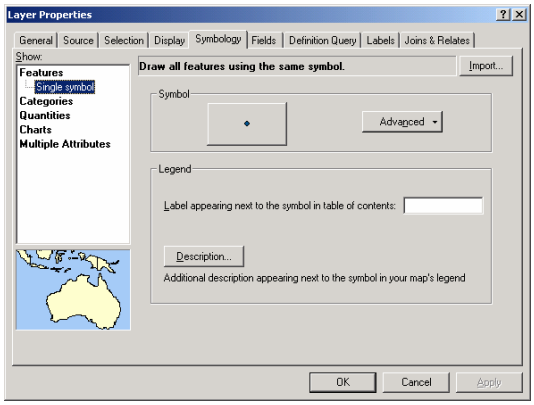
In order to permanently save the transformation, choose “rectify” from the georeferencing menu. ArcMap will create a new image (rather than changing your original data). Check the ArcMap Desktop Help if you want information about choosing a resampling type.

You don’t have to rectify your image. If you want to revert to your original (un-georeferenced) image, from the georeferencing menu, choose “reset transformation.”

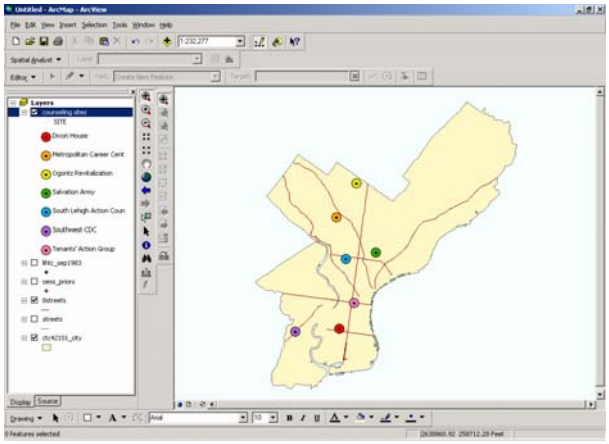
Displaying Point Data

ArcMap offers a wide range of colors and symbols for representing your point data. 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.

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.



Unique Value

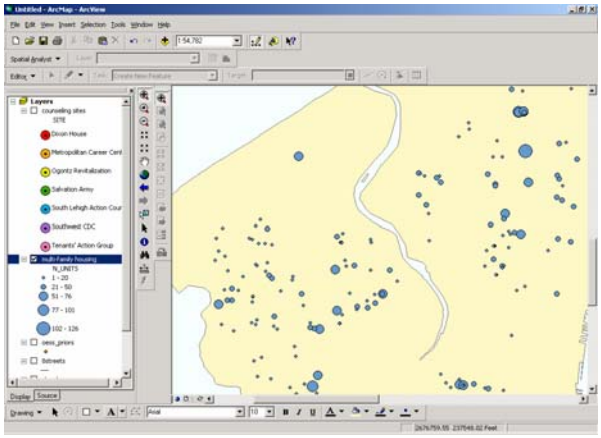
Unique value allows you to use a different symbol for each of the points in a shapefile. This can work well for small files (10 or fewer points) but can quickly be overwhelming for larger files. From the symbology tab, click on "categories" (under "Show:"), and "unique values." Using the "Value:" dropdown menu, select the field with the values you wish to use to represent your points, and 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).

Graduated Symbol

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. he 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).

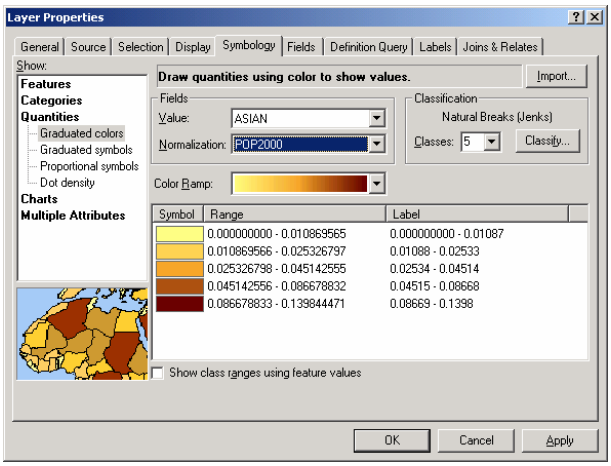


For more on symbology, see *Getting to Know ArcMap*, Chapter 5, “Symbolizing features and rasters,” pp. 83-114.

Displaying Area (Polygon) Data

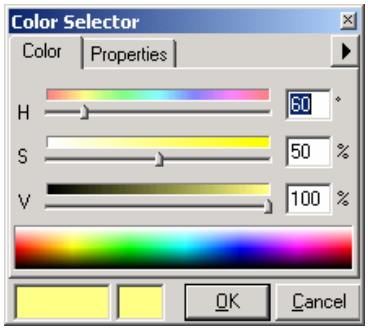
The symbols in ArcMap can be used for any type of data—points, lines, or polygons. The following symbology schemes work particularly well with area (polygon) data.

Graduated Color



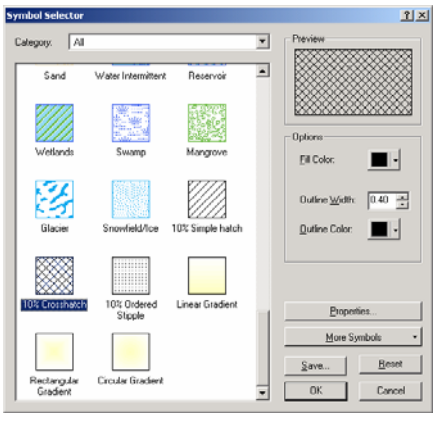
You can use different colors—or different shades of the same color—to represent different values to create choropleth maps. From "Layer Properties," click on the Symbology tab. On the left side of the screen, click on "Quantities" and "Graduated Color." Choose the field with the values you wish to use.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

You can normalize a value in order to transform it into a rate using the "Normalization" dropdown menu. 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. Choropleth maps are best used to represent rates rather than raw counts since raw counts can look deceptively large for large polygons (alternatively, you can create new fields in your attribute table corresponding to rates).

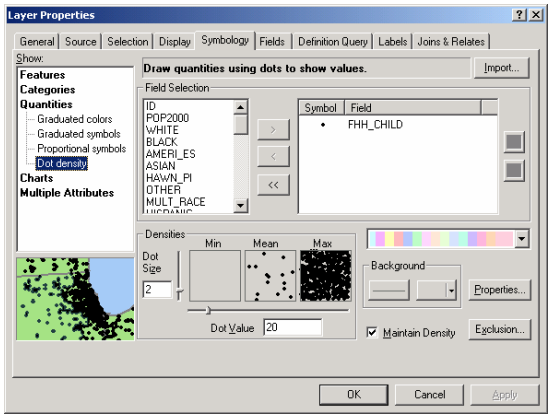


Graduated color works best when you use the same shade of a single color, with lighter shades representing lower values and darker shades representing higher values. But keep in mind that it may be impossible to distinguish between more than four or five shades of the same color, depending upon the quality 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).

Fill Patterns



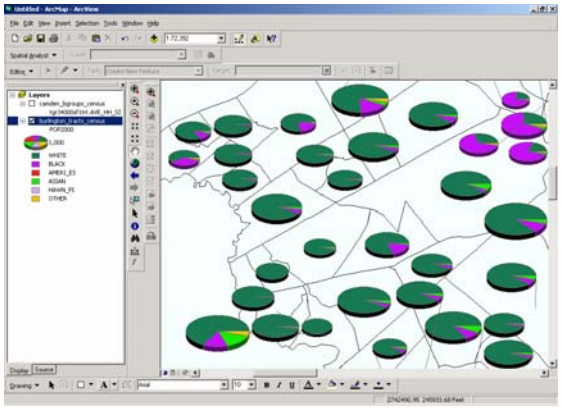
You can use different patterns in addition to, or instead of, using different colors to represent different values. Patterns are particularly helpful when you are restricted to printing maps in black and white. Choose "Graduated Colors" from the Symbology tab and select the field with the values you 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.



Dot Density

Dot density maps use randomly placed dots within polygons to represent different values. They provide an alternative to using choropleth maps to represent raw counts, although it is important to remember (and communicate to anyone reading your map) that the points do not represent precise locations, as they do in a point layer. To create a dot density map, open the Layer Properties and make the Symbology tab active. Click on “Quantities” and “dot density.”

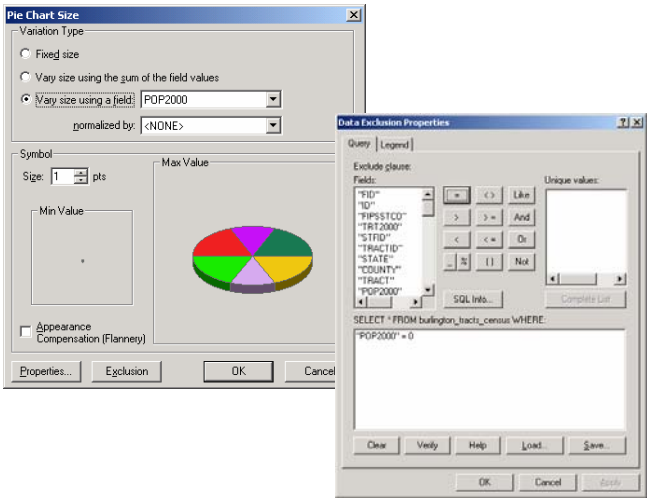
From “Field Selection,” choose the field you wish to use as the basis for the map. Counts (such as the total number of households on public assistance) are appropriate for dot density maps, but averages, medians, and rates are not. Choose your dot size, or keep the default (which is advisable, at least 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.

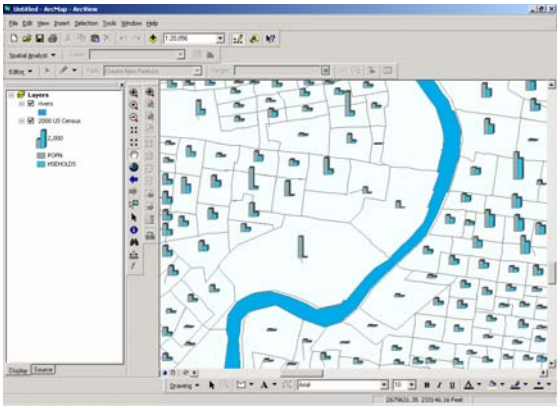
To create pie charts, click on “Charts” and “Pie” from the Symbology tab. Holding down the shift key, select the fields that you want to include. Make sure that together, they add up to 100 percent (you may need to create and calculate a new “other” field in your attribute table before using charts). 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).

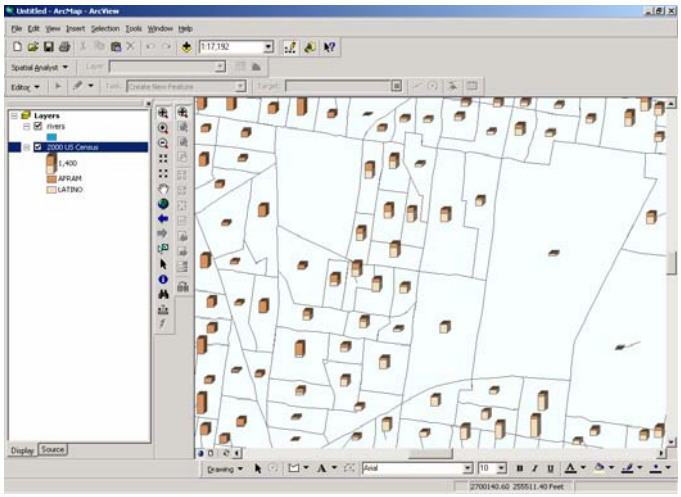


Click on the Size button if you want to have different size pie charts depending upon the total (such as total population). If you choose to "Vary size using a field," you may need to exclude records with a zero value. To do this, click on the Exclusion button and, using the appropriate field name, create 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.

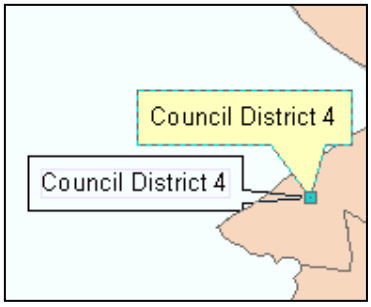
Labeling Features

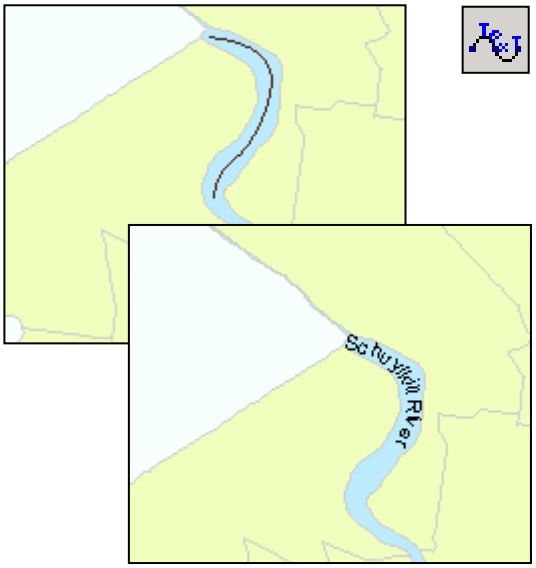
Labeling features in ArcView can be frustrating and tedious, but labeling features well is important to making your maps readable, so it's worth the effort to learn.

Using Text Boxes to Label Features

You can place text on a map in order to label map features. This 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 four buttons. 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.





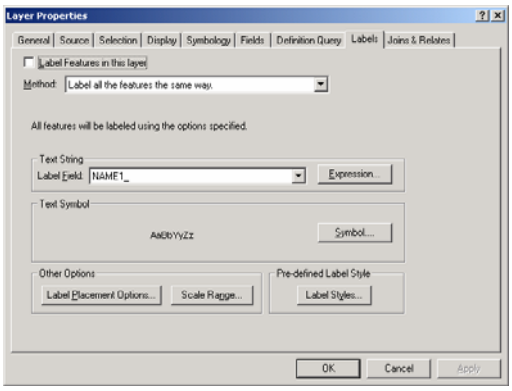
A third option is the spline text tool. This allows you to write text along a curved line. This works well for labeling rivers and curvy roads. Click on the spline tool, then click on the starting point for your label. Continue to click along the curve (you don't need to make many clicks) and double 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

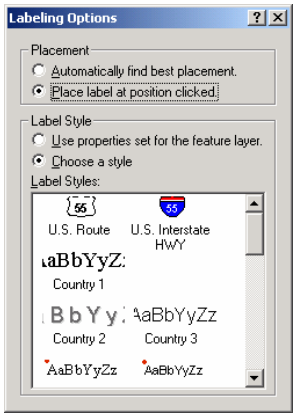
Using the label tools in ArcMap, rather than the text tools, allows you to use the values in a layer's attribute table for your labels (in other words, you don't have to type the label out as you do with the text tools). By manually placing labels, you also avoid having your labels act as a group, which means 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. 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. 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.

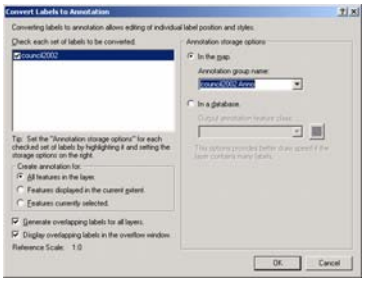
Auto Labeling

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.”

Converting Labels to Annotation

One solution to the problem that dynamic labels present for fine-tuning is to convert them to annotation, so that they function as individual text boxes as they do with manually placed labels. To do this, right click on your map layer after labeling it and go to “Convert Labels to Annotation.”

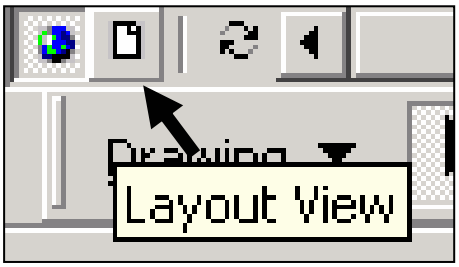


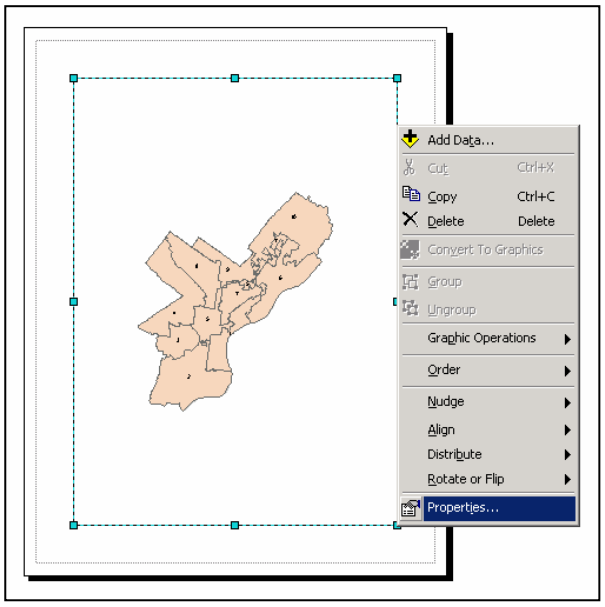
Designing Map Layouts

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 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

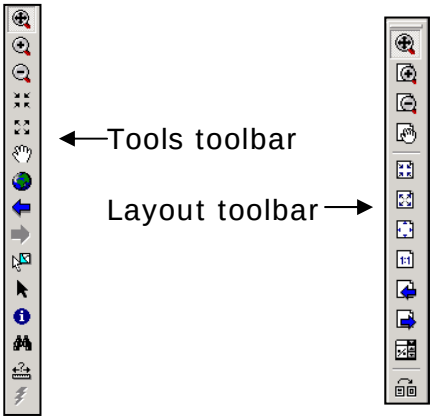
When you open ArcMap, you are in "Data View" and use the Tools toolbar to navigate your map. When you switch to the Layout View, you have access to a different range of tools and use the Layout toolbar to navigate. To switch to "Layout View," click on the icon at the bottom of your map display that looks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

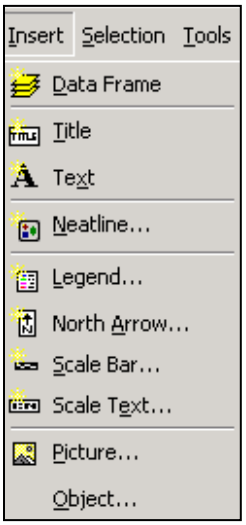




In Layout View, you get a much better idea of how your map will look when it's printed. ArcMap will automatically place a border ("neat line") around your map. You can change this by right clicking on it (so the line is turquoise and perforated) and going to "Properties." Click on the "Frame" tab. From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

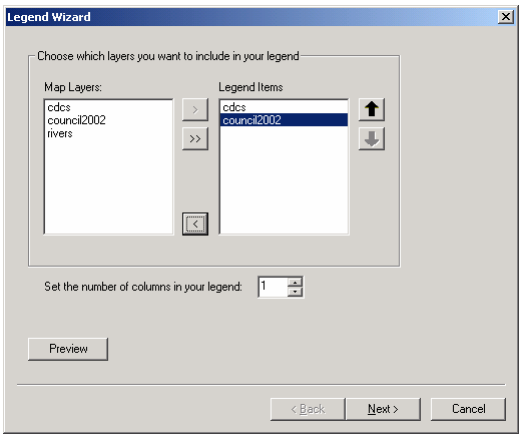
Adding a Title

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.

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).

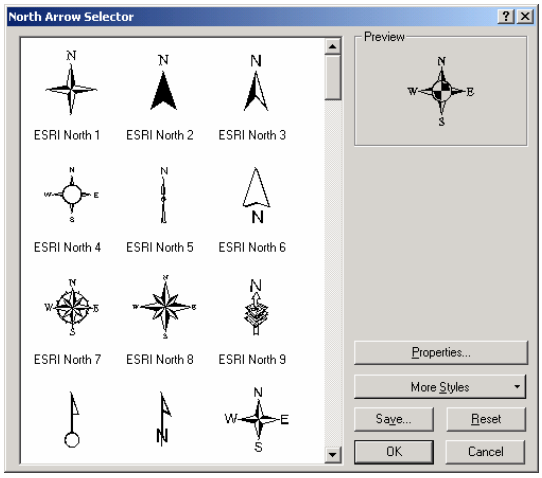


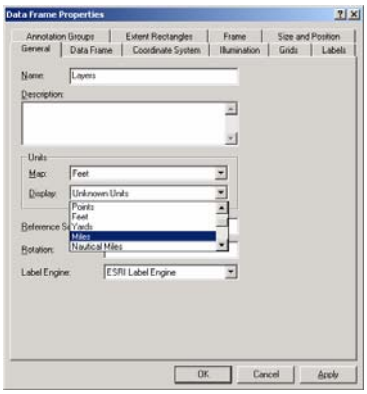
If you want more than one column in your legend, make the adjustment here. To see what your legend will look like (before working your way through the rest of the screens), click the "Preview" button. If you are satisfied with it, you can click the Finish button and skip the other steps. Otherwise, click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

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.





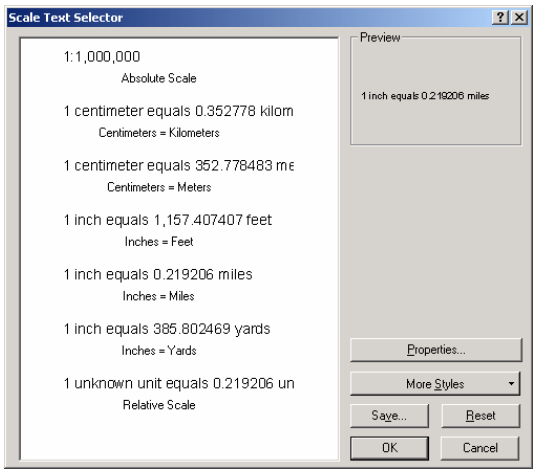
Adding a Scale Bar

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 as well as the font size (by clicking the Symbol button or from the format tab).

Adding Scale Text

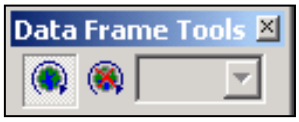
You may wish to include a text description of the map scale, particularly if this is important to your audience and you deliberately chose a scale (as opposed to maximizing the size of your map based on the size of your page). To add scale text, from the Insert menu go to "Scale Text." Double click on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

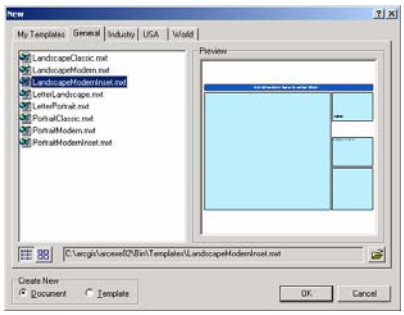
Click on the "Rotate Data Frame" button, then click and hold down on your map, moving your map to change the rotation. To restore the original orientation, click on the "Clear Rotation" button.



Using Map Templates

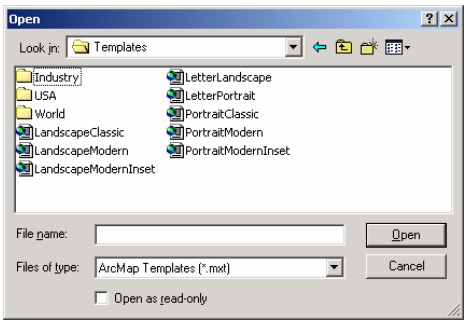
Using map templates can save you time and lead to greater consistency in your printed maps. You can use ArcMap's custom templates or design your own.

Opening map templates



If you are going to use a map template, you need to decide this before you start adding data to your map document. When you open ArcMap, choose to start using ArcMap by clicking on the template radio button in the dialog box. The templates listed in the General and Industry tabs provide empty layouts while those in USA and World tabs also include map layers.

Choose a template by double clicking on its name or clicking once and hitting "OK." Don't worry if the template includes colors or elements that you don't want. It only provides a starting place and you will have the opportunity to customize it.

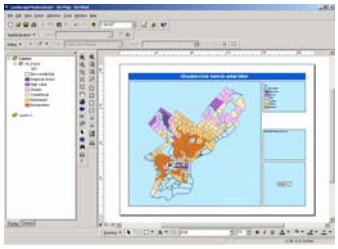


If you have turned off the opening dialog box (by putting a check in the "Do not show this dialog again" box when you opened ArcMap previously), go to the File menu and "Open." From the "File or type" dropdown menu, choose ArcMap Templates (*.mxt). Navigate to ArcGIS's template folder (probably c:\ArcGIS\arcexe82\Bin\Templates) and choose a template. You can't preview the templates if you access them this way.

Using map templates

If you selected a map template that contains no data, you must add one or more data layers to your map document. Once you do, the legend and other elements of your layout will be automatically created based on the template design. Make changes to the data frame (which contains your map), legend, scale bar, and north arrow from the Properties dialog boxes (right click on any of these and go to Properties). You can also move the elements around (click and hold down) as needed. Notice that when you use map templates, ArcMap opens in Layout View. You can still switch back and forth to Data View using the  buttons.

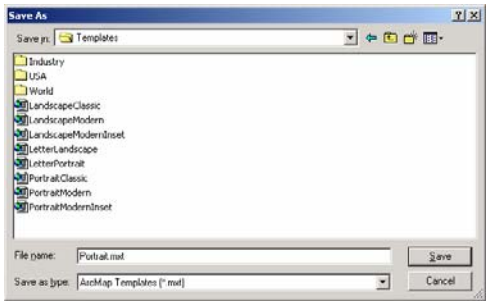
Using inset map templates



For the map templates that include insets, you'll need to add at least two layers. When you open one of these templates, you'll see Layers 1 and Layers 2 listed in your table of contents. By having two

separate groups of layers, you can have two maps in your layout.
This might be two different maps or the same map at different extents. Right click on “Layers” and go to “Add Data” to select the map layer for the main map in your layout. Then right click on “Layer 2” and, from “Add Data,” find the map layer for the inset map.

Creating your own template



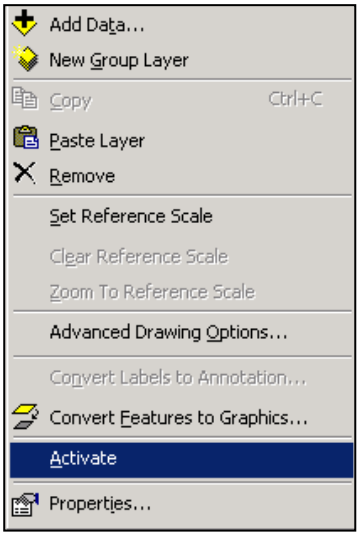
You can create your own map template by modifying an existing custom template or starting from scratch. Once you have created a layout that you would like to reuse, go to the File menu and “Save As.” From the “Save as type” dropdown, choose “ArcMap Template (*.mxt).” If you are not in the ArcGIS Template folder, navigate to it (c:\ArcGIS\arcexe82\Bin\Templates). Give your template a name and hit “Save.” Your new template will appear under the “General” tab when you choose to start using ArcMap with a template (You must save your template in the Templates folder in your profiles location in order for it to appear under the “My Templates” tab. If you create a new subdirectory in the Bin/Templates folder, your templates will appear under a new tab with the name of your subdirectory).

Making Inset 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 or because you want to zoom into a small area for your main map and indicate on a smaller map what area that covers.

Adding Group Layers

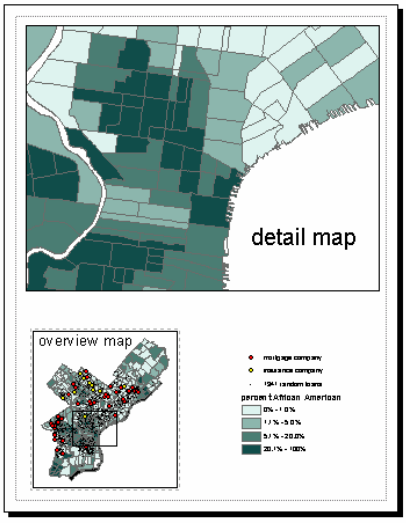
Most of the time you will only need one data frame in a map document. Working with data frames can make your map document complicated and prone to crash. But if you need to include more than one map in your layout (including the same map at a different extent), you'll need two or more data frames. When 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." To remove the original copy of the layer, right click on it and go to "Remove." The layers in only one data frame can be displayed 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."

Creating Extent Rectangle

If you want to have an overview map that shows on a larger map the outlines 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 Maps

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 down menu.

.EMF: If you are working with vector data and need to import a map into Power Point or MS Word, .emf works very well. The one drawback is that you must have ArcView installed on the computer where you open your .ppt or .doc or your map symbols may be corrupted. These files will probably get too large to work with if you have raster data.

.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.

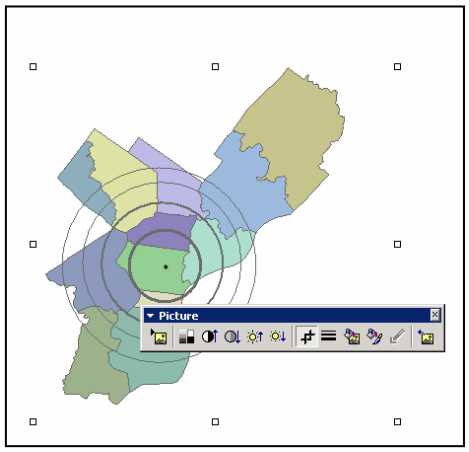
.JPG: The .jpg format will compromise the quality of your image, so be sure to click on the "options' button when you export and increase the resolution to at least 200 dpi. The .jpg format is good because it stores your map in a fairly small file and, unlike .emf, your map will not be compromised if you open it on a computer that does not have ArcView installed.

.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 (print screen, or alt + print screen) and crop the image, but this will not result in a presentation-quality map.

Inserting Maps into Power Point

Save your map as an .emf. 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.

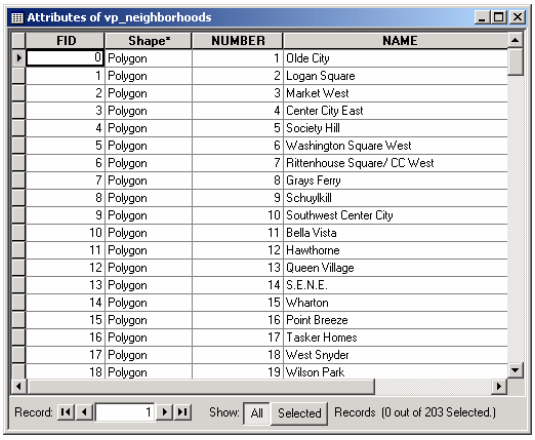
You may encounter problems exporting maps to PowerPoint if you try to show the PowerPoint presentation on another computer if it doesn't have ArcView loaded. Your markers (the dots and squares used to represent points on your map) may come up looking like # and other strange symbols. This is because your exported maps are relying on the ESRI typefaces to draw these markers correctly. If ArcView isn't loaded, those typefaces are not available and PowerPoint comes up with the closest approximation from other typefaces. There is no good way around this problem. If you use .pdf files or screen captures, you can avoid the problem but will sacrifice image quality and flexibility.

Inserting Maps into Microsoft Word

You will have greater control over the placement of your map if you import it to Power Point first, then copy it into Word. From Power Point, click on your map image and hit the copy button (or Ctrl + C). In MS Word, hit the paste button (or Ctrl + V). You can move your map around by clicking and dragging it or by using the arrows on the right side of your keyboard. Hold down the Control key while using the arrow keys to make small moves ("nudge"). You can crop your map in MS Word. From the View menu, go to Toolbars and "Picture."

Working with Tables

Attribute Tables for Shapefiles

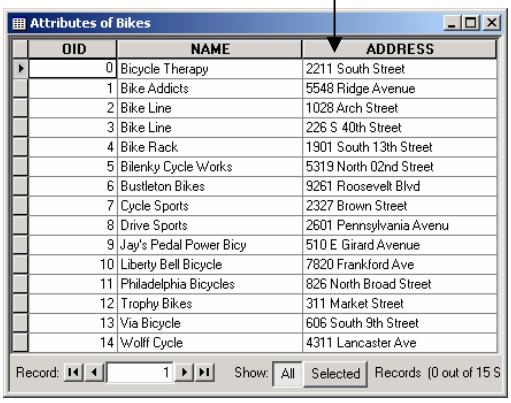


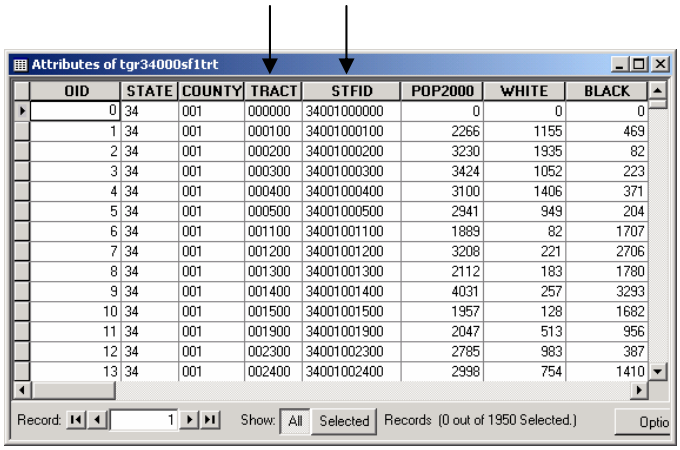
Every shapefile has an attribute table associated with it. You can open the table by right clicking on the shapefile name and going to "open attribute table." The table will have as many rows, or records, as it does map features. The total number of records will be shown at the bottom of your table. here can be any number of columns, or fields. Two are standard: FID, the feature ID, and Shape, which can be point, polyline, or polygon. The rest of the fields will vary. There should be a field 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).

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 dBase (.dbf) and comma-delimited text tables (.txt), but will allow editing for only .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.

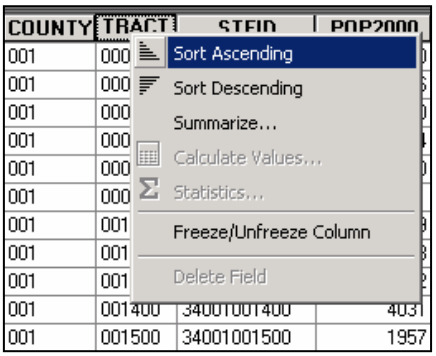




You can work with tables—sort values, freeze columns, generate summary statistics, select records, and export tables—without worrying about corrupting your data. You cannot change any of the data in your table unless you go to "start editing" from the editor toolbar… except to add new fields or delete existing fields.

Sorting Records

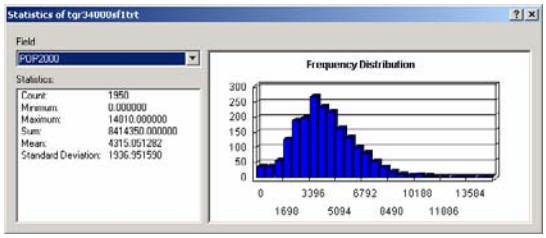
You can sort values in an attribute table by right clicking on the field name and going to "sort ascending" or "sort descending."



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."

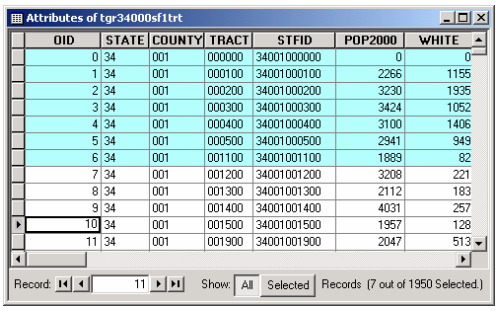
Summary Statistics



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 right 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."

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.

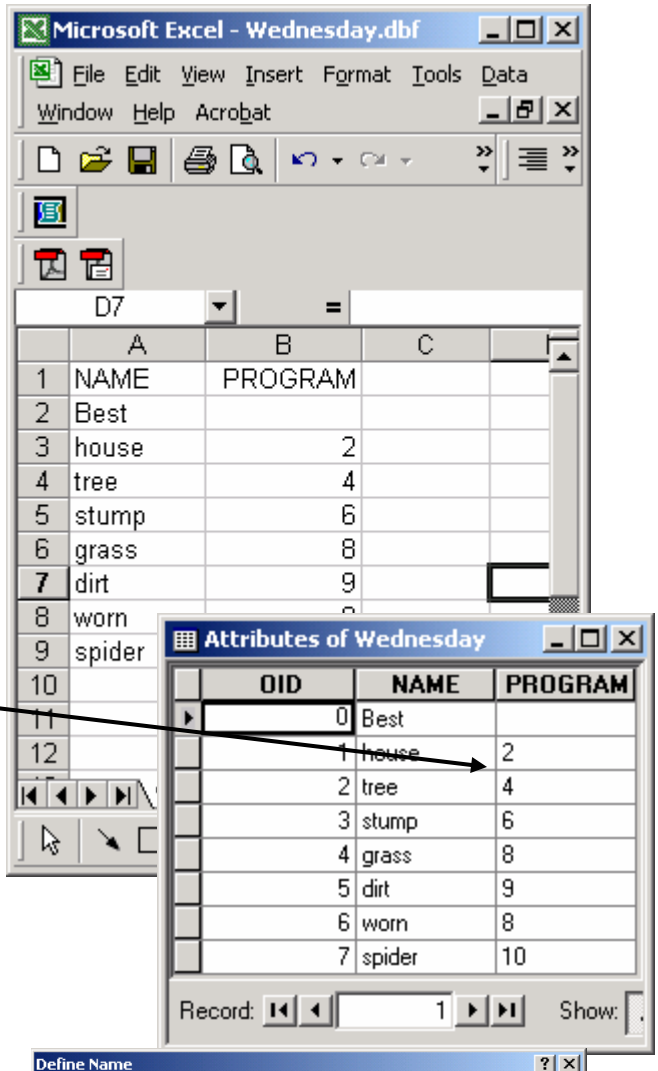
Converting Excel Worksheets to DBF Tables

Excel is not the only way to create new tables or to convert tables to .dbf format. You can also use SPSS, ACCESS, or other statistical and database packages. But in many cases, Excel will be the only software available for the job.

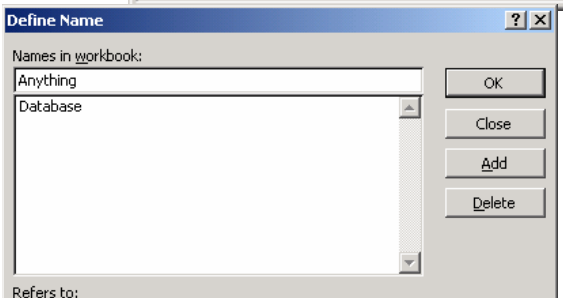
Excel can open a wide variety of formats, including delimited or fixed width text, Lotus, Quattro Pro, and web pages. If you are working with one of these other formats and need to make changes to your data in Excel, it is probably best to save the document as an Excel worksheet. In order to add or edit a table in ArcView, it must be in .dbf format. When you save an Excel document, you can choose another format using the "save as" options. But even if you choose .dbf at this stage, you may encounter problems. For example, your new .dbf file may not include all of the cells in your original file, or the columns may be formatted as strings rather than numbers. Here are some things you can do to increase the odds of preserving your data during the conversion.

1. Limit your column headings to 10 characters. Excel will let you have infinitely long column names, but ArcView will shrink them. It's better to come up with your own abbreviated names than to risk losing important information when ArcView shrinks the names.

2. Check your columns to be sure that they are formatted correctly as strings (left justified) or numbers (right justified). Also, look for rows at the very top that may be blank or contain data that are different from the following cells. For example, you may have a column named "programs" with values ranging from 2-10 for all of your cells, but the first cell is blank or has an "NR" for "not reported." This column will be formatted as a string when you convert to .dbf and open it in ArcView, because .dbf takes its cue from the first data cell in the column. To avoid this problem, you can re-sort the data so that the blank cell is not on top, or you can put in an appropriate numeric value (such as 0 or 999 for missing data). You can convert a string field to numeric in ArcView, but it's easier if you start with the right format.

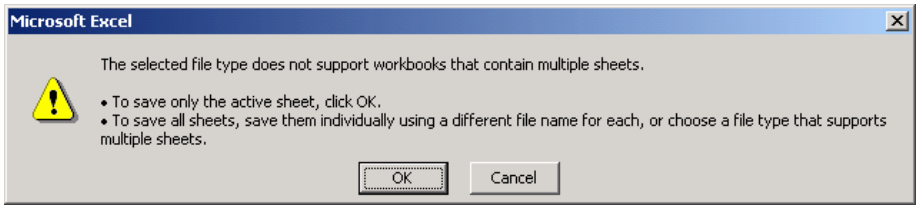


3. When you are ready to save your data, highlight all of the cells that contain values (including the column names). From the

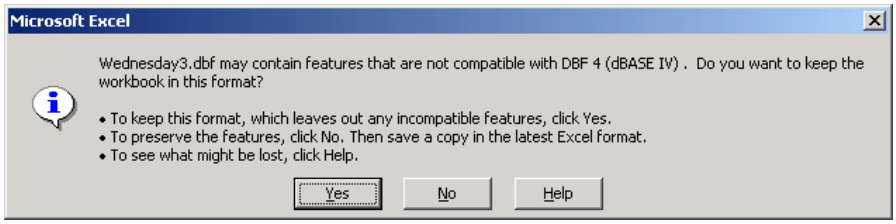


Insert menu, go to “Name” and “Define.” Type in a name (type anything; it doesn’t matter), click “Add” and “OK.” This increases the likelihood that all of your cells will be included in the new table.

Now you can save your document. First, save all changes in your Excel document. Then, from the File menu, choose “Save As” and select “DBF4” from the dropdown menu. First Excel will give you a warning that the .dbf format doesn’t support multiple worksheets and that only the data in the top (active) worksheet will be saved. Click “OK.”



Excel will then give you a second warning message, because .dbf is very different from .xls and some formatting may be lost. Just click “OK.”



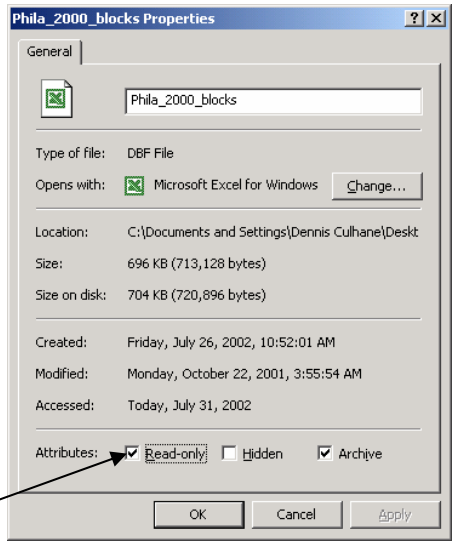
When you close Excel, Excel will prompt you again with these messages, as though it is still incredulous that you would choose any format other than Microsoft’s. Humor the software and go through these two steps again. As soon as you add your table to ArcView, look it over to make sure that all of the data came through and are in the right format.

Calculating Values in Tables

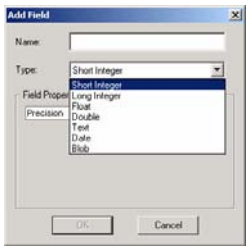
You may find it easier to edit your attribute tables outside of ArcView, but ArcView has fairly sophisticated tools for calculating values. In ArcView, you can edit values in an existing field or create a new field and calculate new values. Keep in mind that you cannot change the format (text, integer,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



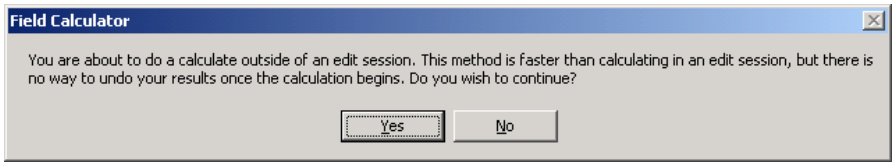
Short integer: numeric, no decimal place, up to 19 characters
Long integer: numeric, no decimal place, up to 19 characters
Float: numeric, with decimal place, (default is one place before decimal and 11 after)
Double: numeric, with decimal place (default is 7 places before the decimal and 11 after)
Text: numbers or letters, specify length (default = 50 characters)
Date: can include time and date
Blob: up to four characters; Boolean

Finally, determine 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.

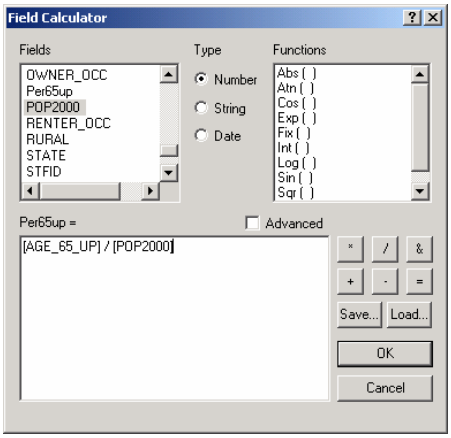
NOTE: You can also add a new field from ArcToolbox (under "Data Management Tools", then "Add Field").

Calculating Values Outside an Edit Session

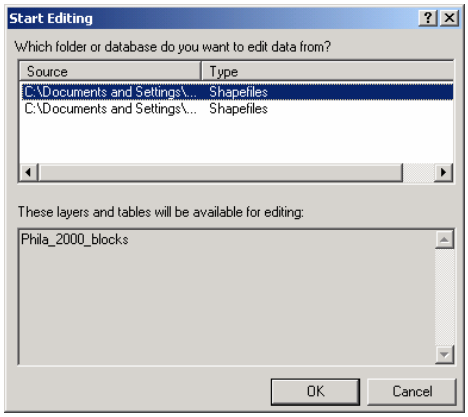
To calculate the value of your new field (or an old field), right click on its name and go to “Calculate Values.” ArcMap will ask you if you are sure that you want to calculate values outside an edit session, warning that you will not be able to undo your results. Say “yes.”



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”).

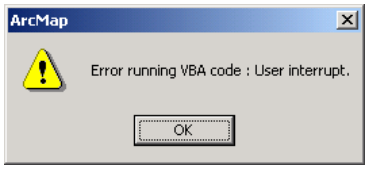


Calculating Values In an Edit Session



In order to make changes within an “edit session,” you need to 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. While this is the more careful way to proceed, it is also more tedious. If you do edit a table outside an edit session, it’s best to create new fields rather than to edit values in an existing field, since you cannot undo your work. With new fields, you can just delete a field and start over if you mess up.

Calculating Values on Selected Records



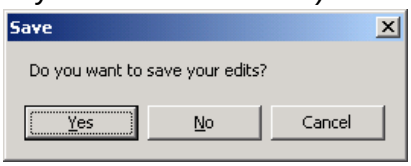
You can get an error while calculating values for many different reasons. ArcMap will not allow you to divide by zero, so if the denominator (total population in example above) is zero for any of your records, ArcMap will not calculate any of the values.

To get around this, 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. Holding down the control key, 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.

Editing Individual Values

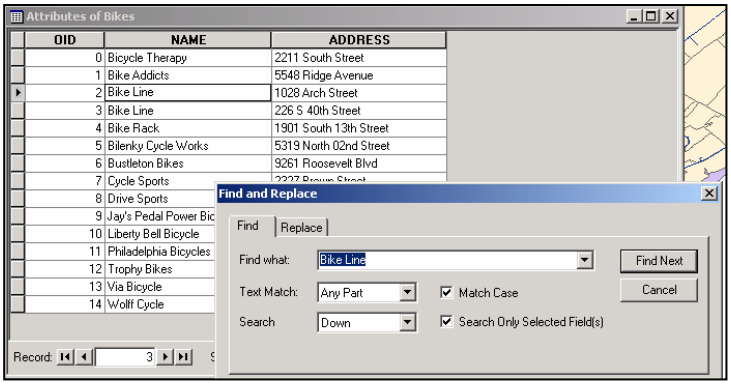
You many need to edit an individual value rather than re-calculate values for a whole field. To do this, start an edit session by going to “start editing” from the edit toolbar. You will need to specify the directory that your table is in before you can start editing (you can only edit files within one directory at the same time).

Open your table and, using the select elements tool  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”).

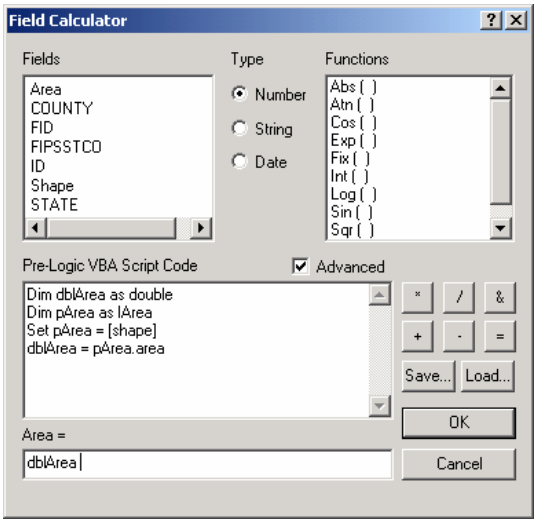


Calculating Area, Perimeter, and Length

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. Area can be especially helpful when you are trying to normalize values and create densities (calculating persons per square mile, for example).

To calculate area, you must 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,” choose “double” as the style, and click “ok.” Right click on your new field and go to “Calculate Values.” Check “Advanced” and type the following in the first text box:

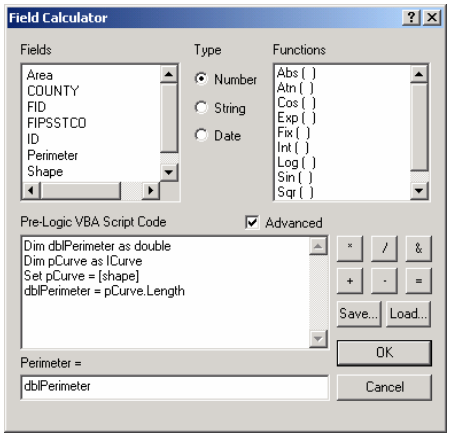



```
Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area
```

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 “make field calculations.” Depending on the version of ArcView you are running, the second entry that’s found will include this and other scripts.

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.



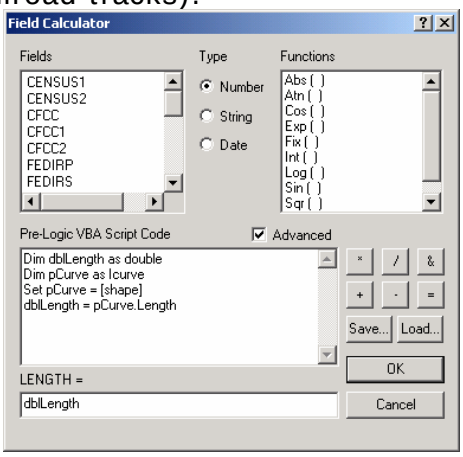
Open the attribute table, click on “Options” and go to “Add Field.” Create a field called “Perimeter,” choose “double” for the style, and click “OK.” Right click on the heading of your new column and go to “Calculate Values.” Check “Advanced” and type the following into the first text box:

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

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

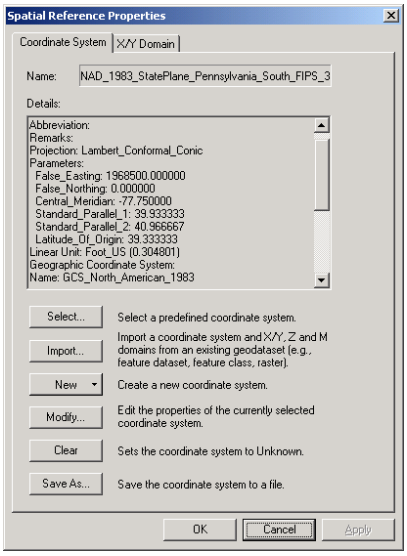
Calculating Length

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 "Calculate Values." 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."



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

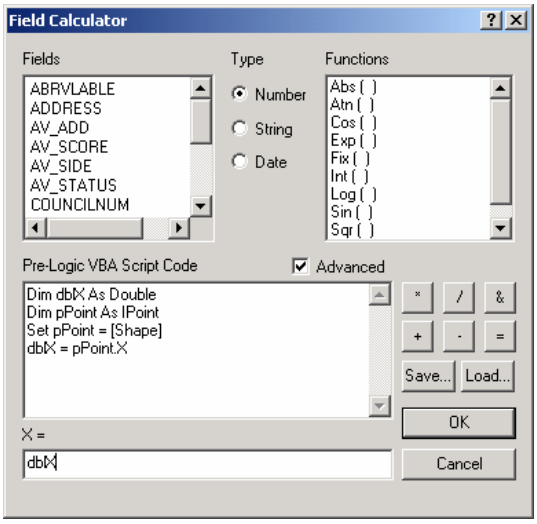
Adding XY Coordinates to a Point Layer

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. You do this by creating 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 "Calculate Values…" 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.



You can also create XY coordinates for a point file in ArcToolbox (under "Data Management Tools" go to "Features" to fine "Add XY Coordinates").

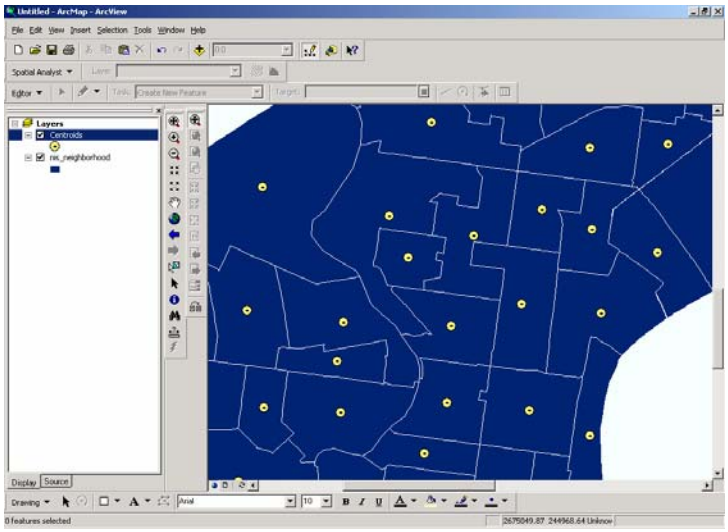
You can check the new XY coordinates by mapping them. With you table open, click on "Options," and go to "Export." Say "yes" and add the new table to your existing map, then close the table. From the tools menu, go to "Add XY Data" and select your table from the drop down menu (ArcMap will probably have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

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.



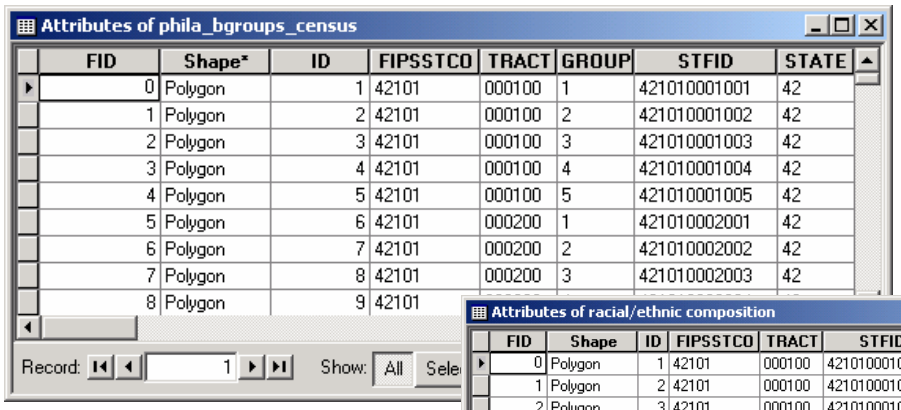
You can check the new XY coordinates by mapping them. With you table open, click on “Options,” and go to “Export.” Say “yes” and add the new table to your existing map, then close the table. From the tools menu, go to “Add XY Data” and select your table from the drop down menu (ArcMap will probably have 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.

Joining Tables

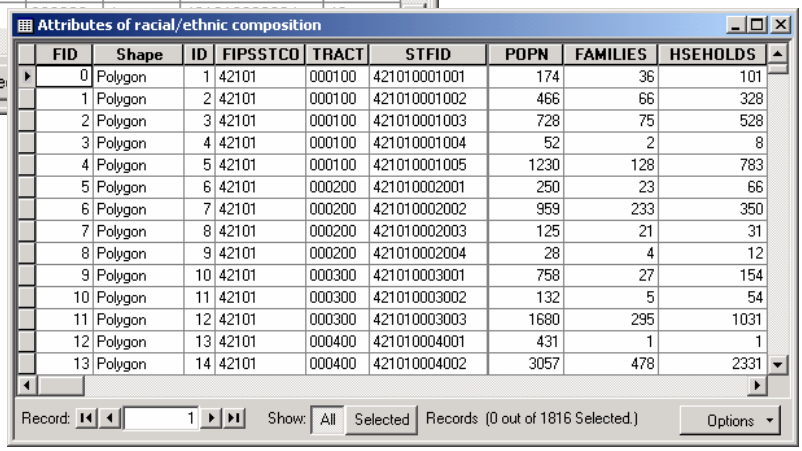
In GIS, you can link map features to their attributes, but only when your attributes are in the same file as your geographic data. Often you will have attributes stored in a separate table that you will need to join to a shapefile in order to display that data. This is especially common with census data, when you will often obtain census attribute data (SF1 or SF3) in files separate from the shapefiles for census tracts and blockgroups.

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.



At left, the attribute table of a census tract shapefile contains multiple fields that uniquely identify each record: TRT2000, STFID, and TRACTID.



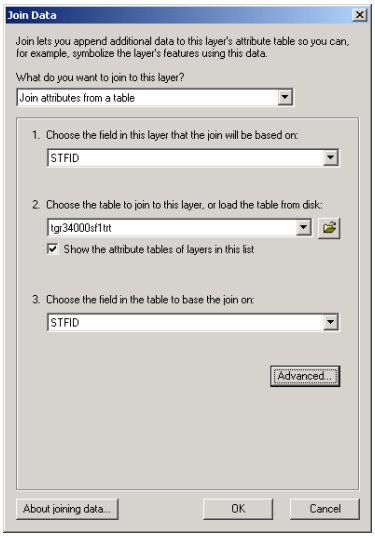
The table at right includes several attributes of census tracts but cannot be mapped until it is joined to a shapefile. There are two fields that uniquely identify records AND match fields in the census tract shapefile: TRACT and STFID.

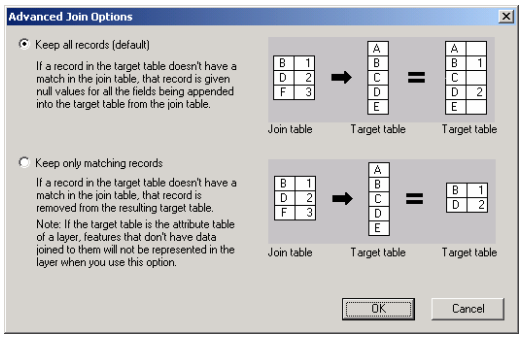
The field name doesn't have to be the same in the attribute table and the shapefile in order to join them; they just have to be formatted in the same way.

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.

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.



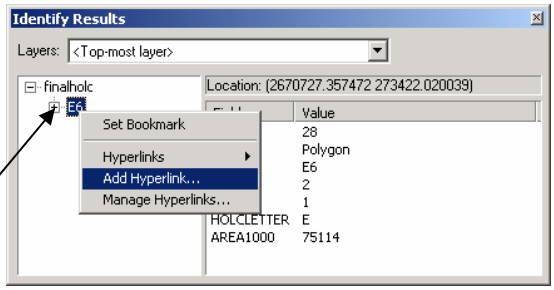


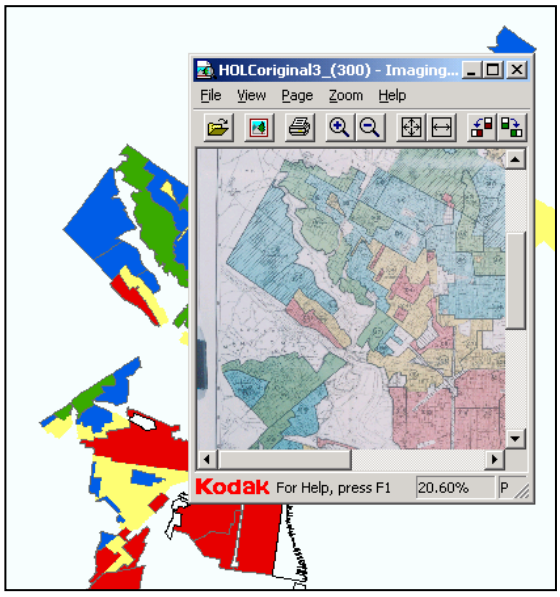
From "Advanced," you can indicate what you want ArcView to do if all of the map features in the shapefile don't have a match in the attribute table, or vice versa. The default is to keep all records, meaning that some map features might have no values for some fields. Individual records might not match 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. 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 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

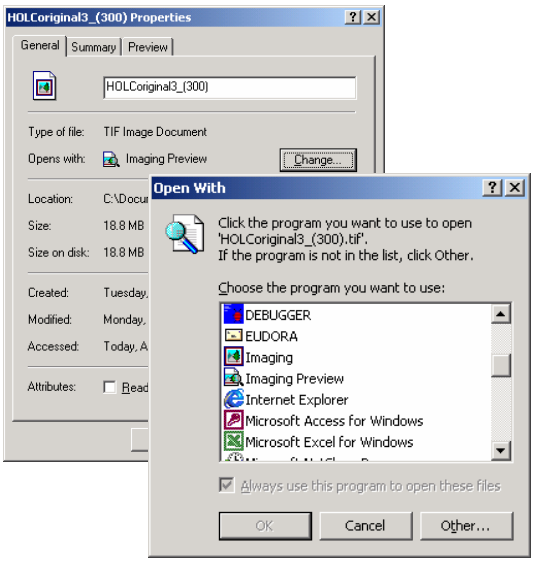
Hyperlinks allow you to click on a map feature and bring up a relevant image (or website) rather than just the attribute values stored in your attribute table. Click on the map feature you wish to link with the identify tool. Make sure that the "Identify Results" table brings up information relating 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. 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.



Adding Hyperlinks through Attribute Tables

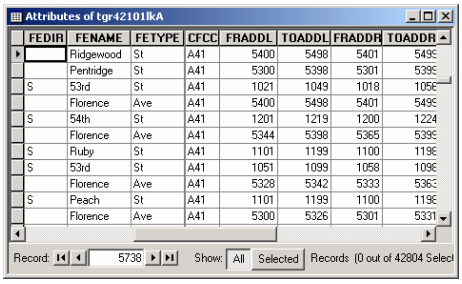
If you have more than a few hyperlinks for a map layer, it might be easier to add them using the attribute table. Create a new text field called “Hyperlinks.” Start an edit session (from the Edit toolbar, go to “Start editing”). Type the full name of the image file, including the path (for example, c:/esri/maps/image.tif) 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 Addresses

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.

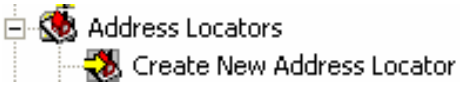
Preparing Tabular Data

In order to geocode, you need a table (.dbf or comma-delimited .txt) that has a field with street addresses. If the parts of the 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.



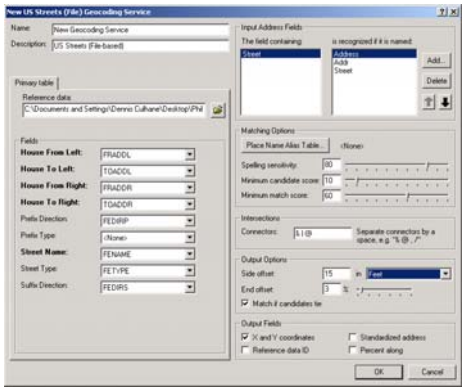
Creating an Address Locator

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. In order to be able to use the street file for geocoding, you need to create an address locator from it. To do this, open ArcCatalog, expand the Address Locator (click on the +), and double click on "Create New Address Locator." Choose "US Streets (file)" from the list and click "OK."



You can also use the US Streets with zone (file). This allows you to include zip code along with house number and street. While this is a more careful approach, it will generally make it more difficult to obtain a good match rate.

On the next screen, use the folder icon to browse for your streets shapefile and click "add." In the "Fields" section below, ArcView may be able to identify the appropriate fields on its own. If no field names appear in the drop down menus, or if they do not look right to you, you'll need to identify these yourself. The "Input Address Fields" section allows you to identify the names for the field(s) in your tabular data that contain the street address. You don't need to include the field name at this point.

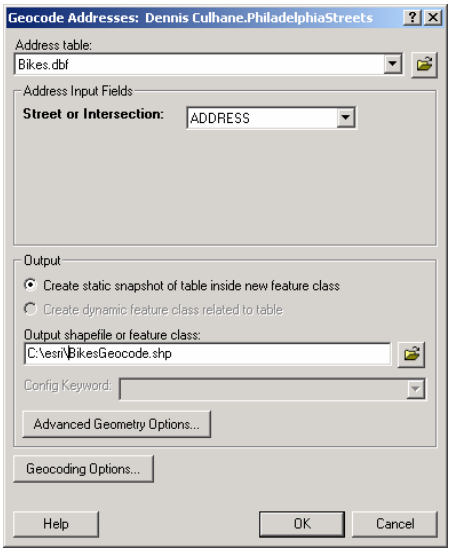


The “Matching Options” allow you to indicate the level of sensitivity for the matching process. Essentially, ArcView needs to match the house numbers and street names in your tabular data with information in the streets shapefile. If the spelling of the street name is slightly different or an appropriate range of house numbers cannot be located, ArcView will assign the match a less than perfect score (100 is a perfect match).

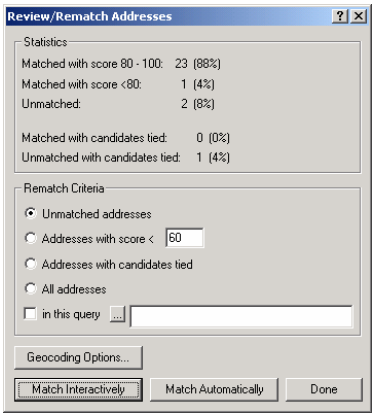
ArcView can geocode based on street intersections in addition to specific house numbers. In the “Intersections” section you can identify symbols (or “AND”) used in your tabular data to indicate intersections. The “Side Offset” option allows you to place points slightly away from the middle of the street 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).

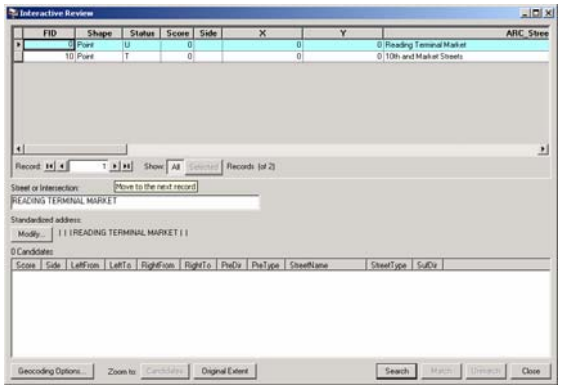
Geocoding Addresses

To geocode your addresses, you need to be in ArcMap. You don’t need to have your table with addresses OR your street file in your map document. From the Tools menu, go to “Geocoding” and “Geocoding Addresses.” In the “Add Address Locator” screen, click on “Add” and navigate to the “Address Locators” at the far right. Double click, locate your address locator, 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” give you access to many of the same options available when you create an address locator.



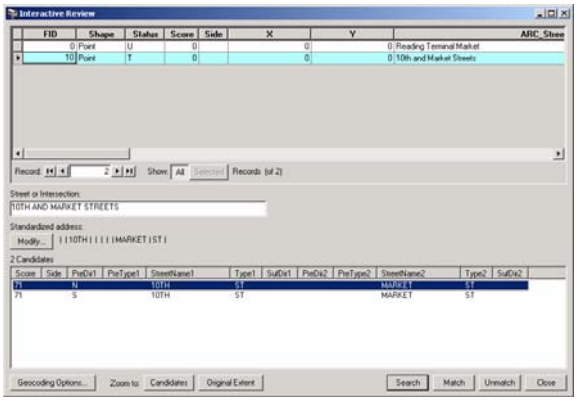
When you click “OK,” ArcMap begins the geocoding process. The next screen indicates how well ArcView was able to match the addresses. You can review different subsets of the addresses (unmatched addresses, addresses that matched below a certain score…) by checking the radio button and clicking “Match Interactively.” If you have thousands of addresses in your address table, you may not be able to review all of the unmatched records. But for smaller data sets it’s very important to review the unmatched records. If you didn’t choose the “match if tie” option when you set up your address locator, the addresses with candidate ties will appear with the unmatched addresses.





From here, you can change the address in order to get a match/better match (don't worry, this only changes the address that ArcView uses for geocoding; it does not change the data in your original table of addresses). To edit an address, simply click in the text box "Street or intersection" and make the changes, then hit the Enter key. ArcView will list possible matches at the bottom. Highlight the best candidate and click "match."

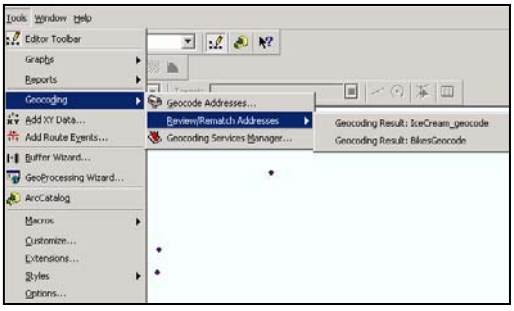
Street intersections are the most likely to create ties in the matching process. In the example at right, ArcView doesn't know if it should place the 10th and Market point on 10th Street just north or just south of Market Street. Most likely, it will not matter for your work. If it does, you are better off using a house number and street, rather than an intersection. Choosing the "match if candidates tie" box in the geocoding options will help you avoid having to match these individually.



When you click "done," a new point shapefile should appear in your table of contents. If you open the attribute table associated with the shapefile, 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."

Rematching Addresses

You can resume the "Interactive Review" even after you've clicked "done" and stopped geocoding. This allows you to collect additional information about unmatched addresses. 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.

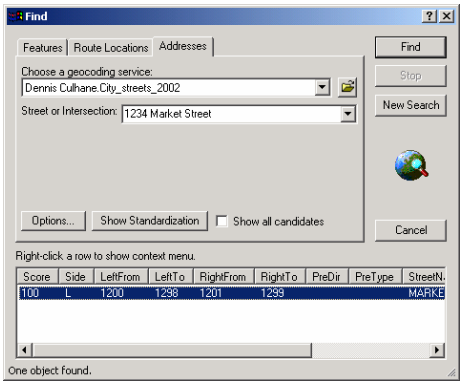


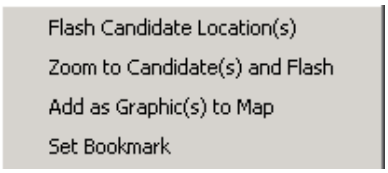
Determining an acceptable match rate

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.

Locating 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.



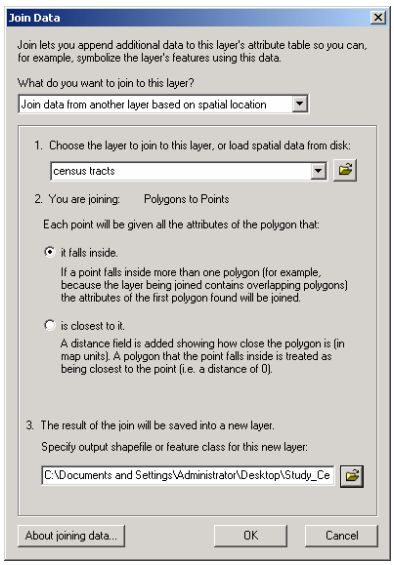


Spatial Joins

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 census tract each of your study participants lives. 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 Study_CensusTract

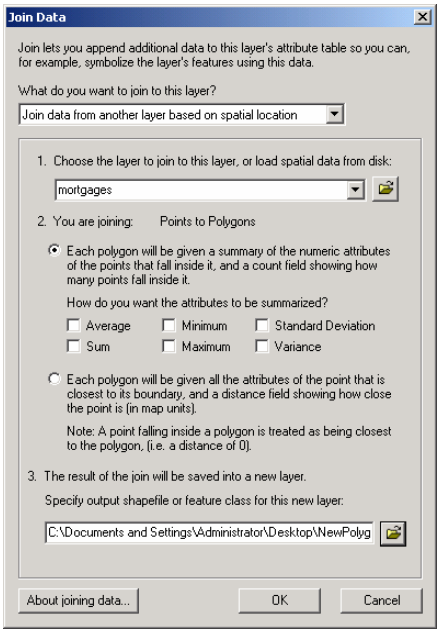
FID	Shape	H_NUM	STREET	X_COORD	Y_COORD	CENSUSTRA	CENSUSTR_1	TRACT	TRACT_NU	CENSUS
0	Point	558	Selma St	0	0	3	2	0358	358	421010358.00
1	Point	245	E Gravers Ln	2681030.05418	281071.13168	26	5	0227	227	421010227.00
2	Point	1411	E Mt. Pleasant St	2689956.64347	280906.00801	28	2	0260	260	421010260.00
3	Point	1411	E Mt. Pleasant St	0	0	28	2	0260	260	421010260.00
4	Point	2433	78th Ave	2693726.40154	279563.12894	34	5	0263	263	421010263.00
5	Point	7538	Beverly Rd	2695228.19437	278939.62575	34	5	0263	263	421010263.00
6	Point	1432	E Upsal St	0	0	34	5	0263	263	421010263.00
7	Point	1432	E Upsal St	2692708.37588	279198.73294	34	5	0263	263	421010263.00
8	Point	2229	E Washington Ln	2694732.69475	279457.29554	34	5	0263	263	421010263.00
9	Point	7807	Michener St	0	0	34	5	0263	263	421010263.00

Record: 1 Show: All Selected Records (0 out of 1315 Selected.) Options

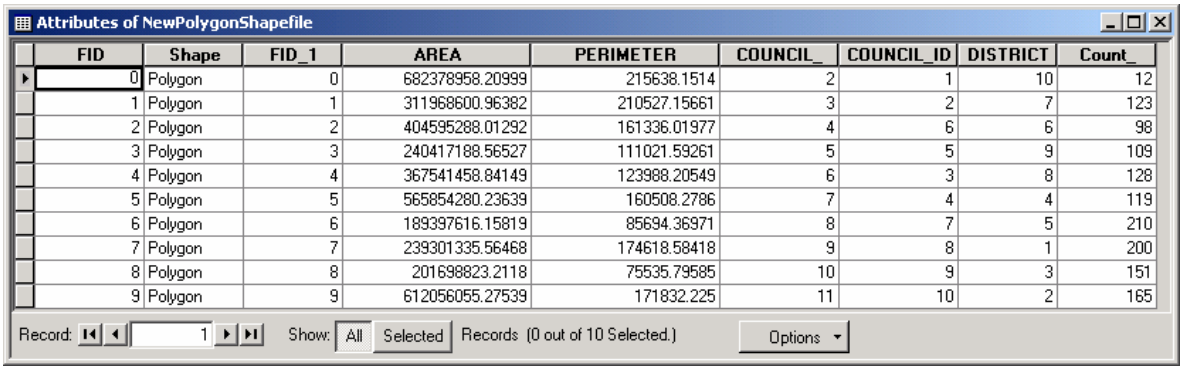
Aggregating Points by Polygons

Using a spatial join, you can also determine how many points fall in each polygon. For example, you might need to determine how many mortgages were made in each city 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. 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 “MortgageCount,” for example, and calculating it as equal to “Count”). Now you can use this count value as the basis of a thematic map.

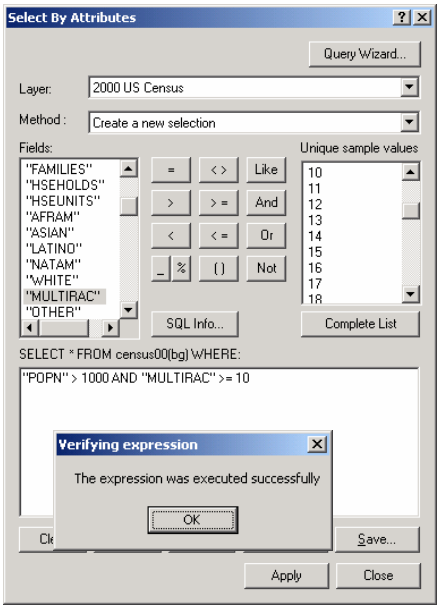


FID	Shape	FID_1	AREA	PERIMETER	COUNCIL_	COUNCIL_ID	DISTRICT	Count_
0	Polygon	0	682378958.20999	215638.1514	2	1	10	12
1	Polygon	1	311968600.96382	210527.15661	3	2	7	123
2	Polygon	2	404595288.01292	161336.01977	4	6	6	98
3	Polygon	3	240417188.56527	111021.59261	5	5	9	109
4	Polygon	4	367541458.84149	123988.20549	6	3	8	128
5	Polygon	5	565854280.23639	160508.2786	7	4	4	119
6	Polygon	6	189397616.15819	85694.36971	8	7	5	210
7	Polygon	7	239301335.56468	174618.58418	9	8	1	200
8	Polygon	8	201698823.2118	75535.79585	10	9	3	151
9	Polygon	9	612056055.27539	171832.225	11	10	2	165

Querying by Attribute

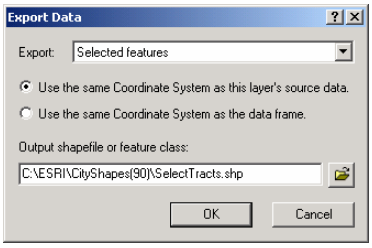
In GIS, you can identify a subset of map features based on their attributes or their location. You may use queries as an intermediary step, as part of getting to know your data, to create new values, or to answer your research questions.

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 "Calculate Fields." 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. You can perform an additional query (adding, removing, or selecting from this selected group) or close the query dialog. 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 (for example, calculating the percent of multiracial people only in block groups with non-zero populations). You can also generate summary statistics for only the selected records by right clicking on a column name and going to "Statistics." To see all of the selected records at the closest extent, from the Selection menu, go to "Zoom to Selected Records."



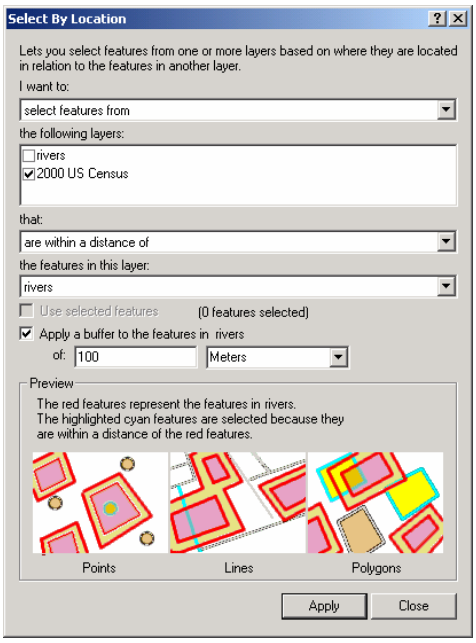
You can create a new shapefile that only includes your selected map features by right clicking on its name in the Table of Contents, going to "Data" and "Export Data." Choose the radio button regarding coordinate systems (you'll probably want the default). Make sure you have "Selected Records" chosen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

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.

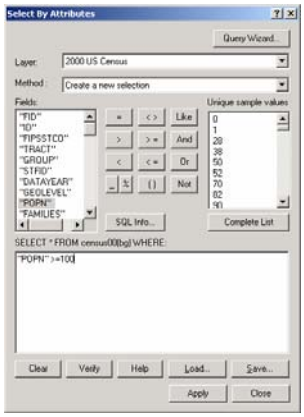
Select by Location

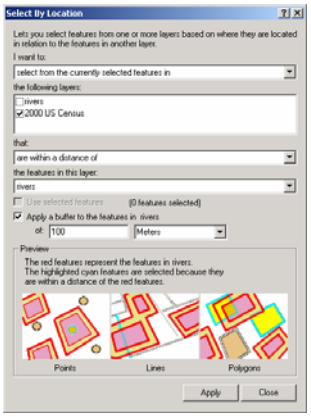
To select features in a map layer based on their location, from the Selection menu go to “Select by Location.” Your first choice involves the nature of the selection. Are you starting from scratch or querying a subset of map features already selected? In the next box, put a check mark next to the map 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. The images at the bottom of the dialog change as you choose a different type of relationship as the basis of your location query (they may or may not be helpful).

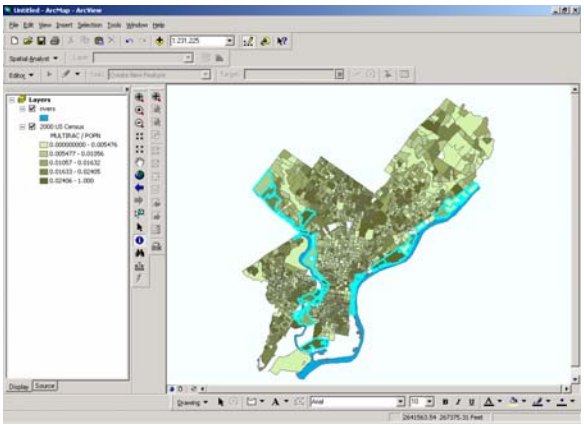


Combining Attribute and Location Queries

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 what census tracts are located along a river, but you are only interested in census tracts that have at least 100 people living in them. It doesn’t 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.

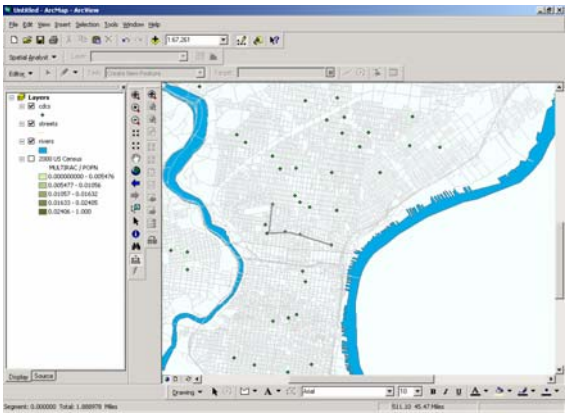






Measuring Distances

Using the Measure Tool

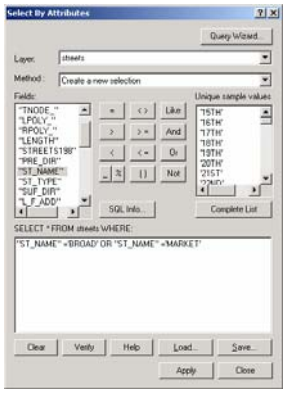


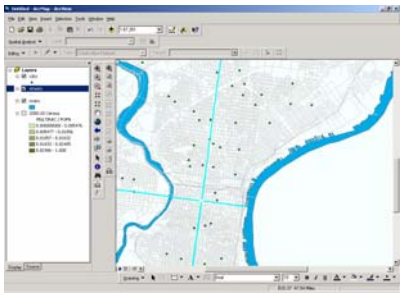
The measure tool allows you to draw a line, or a series of connected lines, to roughly measure the Euclidean (as the crow flies) distance between points. The measure tool will use the display units you specified in the Data Frame Properties (right click on the name of the Data Frame, go to Properties, and the General tab). 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.

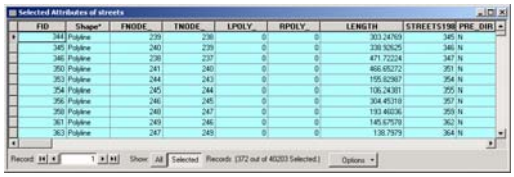
ArcMap will display the cumulative distance in the bottom left part of the GUI (below the table of contents). Once you move your cursor outside of the map window, your results will disappear. Try following a street centerline layer if you want to generate more realistic travel distances.

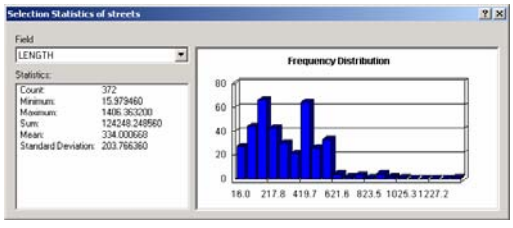
Measuring with Attribute Data

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.





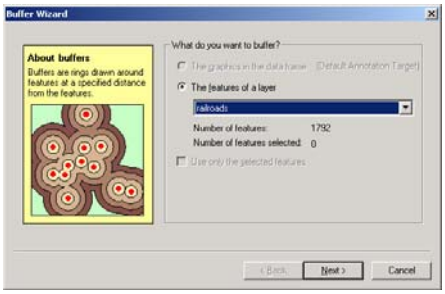




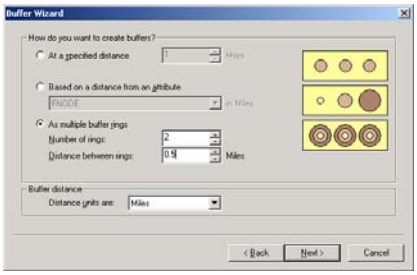
Measuring Distance with Networks

Euclidean is just one method of measuring distance, and a rather crude one at that. Using ArcView’s Network Analyst, it is possible to factor in travel times and traffic patterns, among other considerations.

Creating Buffers

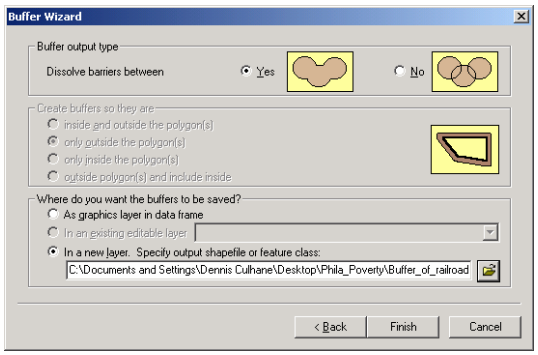


Buffers allow you to create temporary graphics or permanent shapefiles around existing map features. You can create buffers around any type of vector data (points, line, or polyons) and around selected or all features in a map layer. The Buffer Wizard is a custom tool that must be added to the ArcMap interface. From the tools menu, go to "customize" and click on the "commands" tab. From the "categories" list, click on "tools." You can then drag the Buffer Wizard to one of your active toolbars. From the drop down menu, choose the map layer you wish to buffer. If some of your layers are selected, you can choose to buffer only the highlighted features.



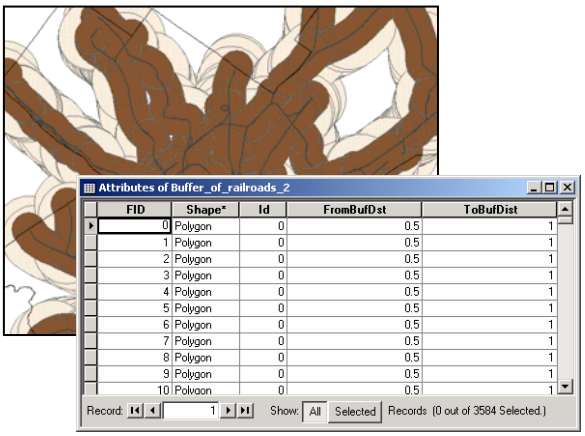
On the next screen, you choose how you want to create buffers. You can make buffers based on a certain distance or based on an attribute in your map layer (this would allow you to have larger and smaller buffers around different features). If necessary, change the distance units at the bottom of the screen. You can make multiple rings of a certain distance.

On the final screen, you must decide what to do if the buffers overlap: dissolve the intersecting lines or leave them? If the map layer you are buffering contains polygons, you can specify whether buffers should be drawn inside, outside, or both.



Finally, specify how ArcMap should save the layer. If you save it as a graphic, it will be temporary. This is helpful if you are just playing to get the right buffer since it can easily be deleted. Saving the buffers as a separate shapefile is more permanent and deleting a shapefile involves more work. To save the buffer as part of an existing layer, you must start an edit session and make that layer edit-able.

Buffering can take ArcView a long time, especially if you choose to dissolve the barriers within the buffers. However, if you do not dissolve the barriers, your buffers may involve lots of separate polygons. If you saved the buffers as a shapefile, there will be an attribute table with records corresponding to the separate polygons making up the buffer. If you choose to dissolve the barriers, there will be just one record (and just one polygon).

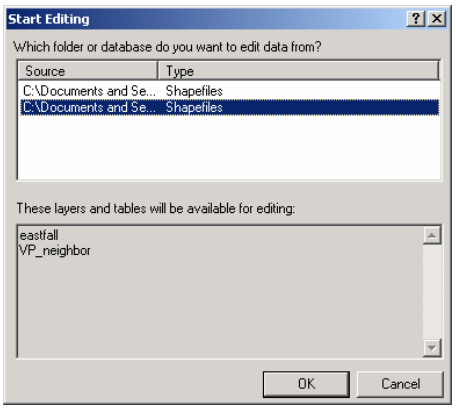


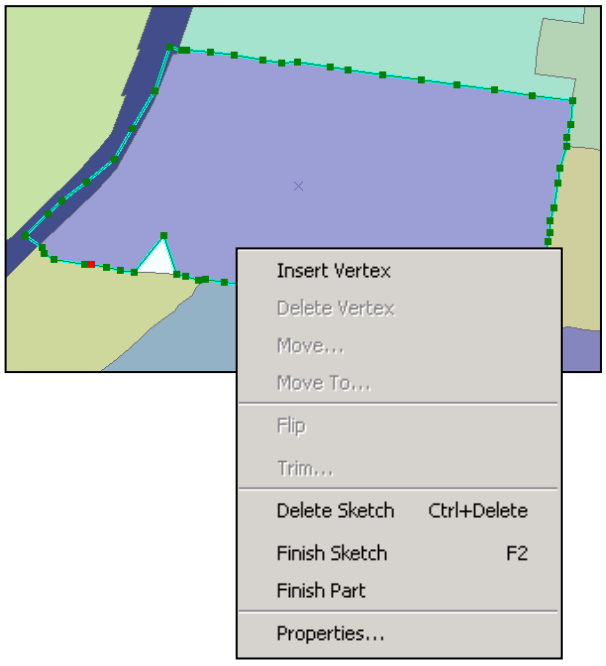
Editing Shapefiles

Editing shapefiles is tricky—and a bit dangerous—territory. If possible, use the geoprocessing tools to make changes to your shapefiles rather than using the editing tools described below. Keep in mind also that editing shapefiles can change attribute values (such as area and perimeter) that you may need to update.

Deleting and Modifying Features

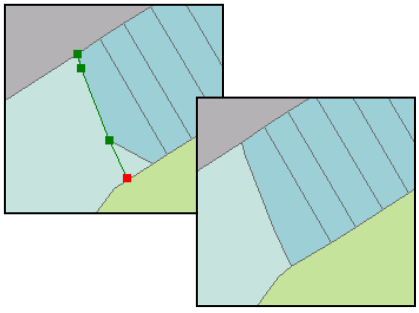
In order to make changes to a shapefile, you must start an edit session. From the Editor toolbar, choose "start editing." If you have multiple shapefiles in your map document that are from different subdirectories on your computer, you will need to specify which directory will be part of the edit session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



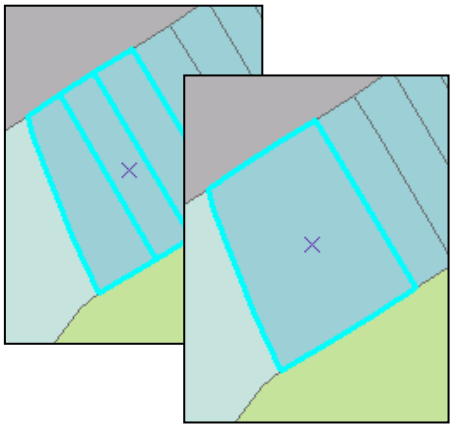


To edit an existing feature (point, line, or polygon), click on the edit tool and click on the feature you wish to edit (it should become highlighted). By clicking and holding down the mouse button, you can move your map feature to a new location. To modify a line or polygon feature, double click on 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.

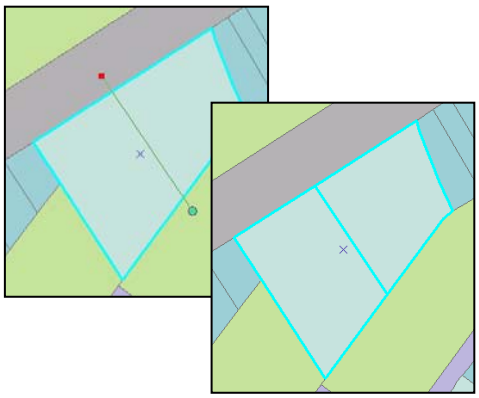


Merging Features

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.

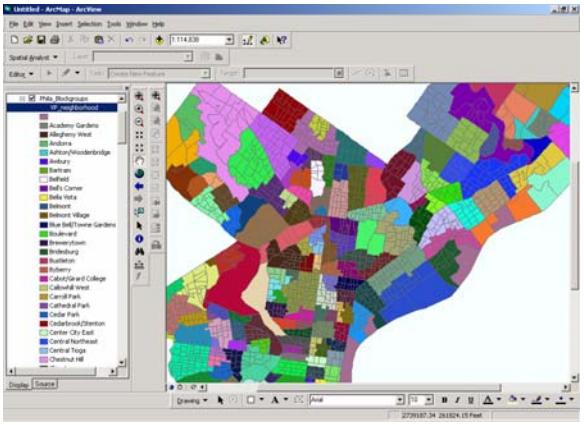
Splitting Features

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.



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." In ArcView 8, these were called "geoprocessing" function. In ArcView 9, they have been incorporated into an expanded suite of data management tools. 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.



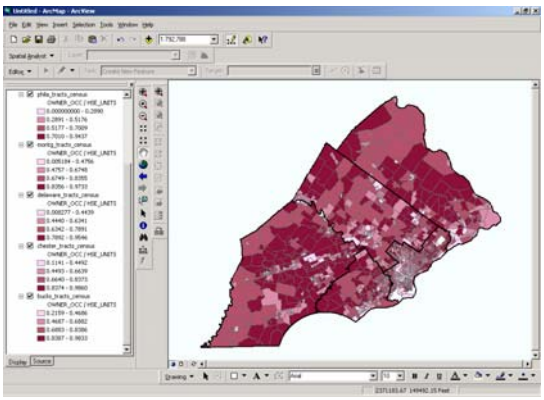
Dissolve

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 blockgroup 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."

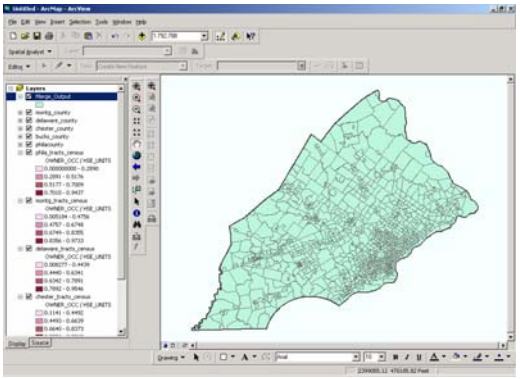
Append

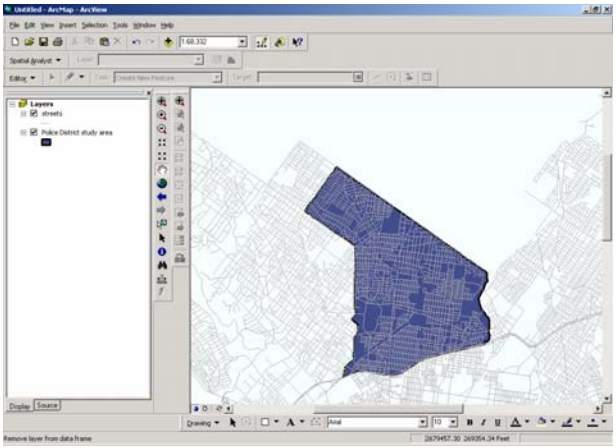
Appending (referred to as "merging" in ArcView 8) allows you to incorporate two or more non-overlapping layers into a single map layer without changing their map features. You can append point, line, and polygon layers. Appending can save you time when it comes to symbolizing features and lead to more 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 specific and 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

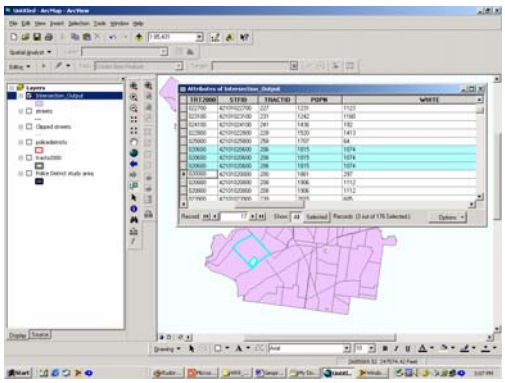
Clipping allows you to turn one shapefile into a cookie-cutter in order to cut out part of a larger shapefile. For example, you might need to create a map layer of streets for the area within a single police district but your street centerline file covers the entire city. Using a street file that is 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 “_Dissolve.” 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

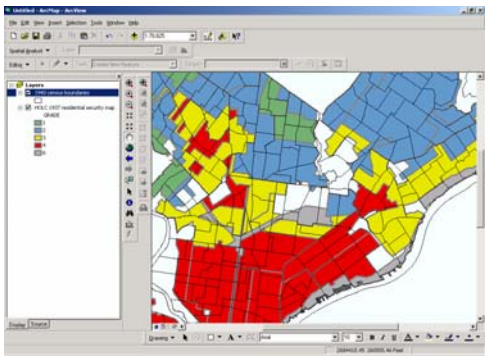
Intersect allows you to fuse two overlapping layers together to create a new shapefile that includes the attributes of both layers for the area in which the layers overlap. In effect, this combines the union (described below) and clip operations. You can intersect two polygon layers or a line and polygon 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.

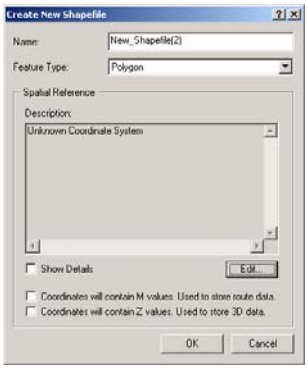


As with shapefiles created through intersections, the shapefiles created by a union will most likely have some attribute values that no longer make sense. Be sure to recalculate length, perimeter, and area if you need these variables.

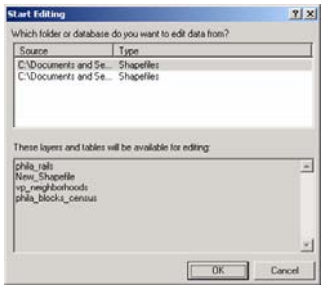
Creating Shapefiles

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.This process used to involve tracing a paper map on a digitizing tablet and then assigning real world coordinates to certain parts (like georectifying). ArcView 8.x has some great on-screen digitizing tools that allow you to create new shapefiles without additional hardware or software.

Creating New Shapefiles



Open ArcCatalog to create a new shapefile. Right click on the folder where you want to store the new shapefile, go to new, and choose "shapefile." In the dialog box, give your new shapefile a name and indicate what type of features the shapefile will have: point, line, or polygon. Use the Edit button to set the projection. This shapefile is essentially just a shell since it contains no information. But you need this before you can start to create new map features.



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:

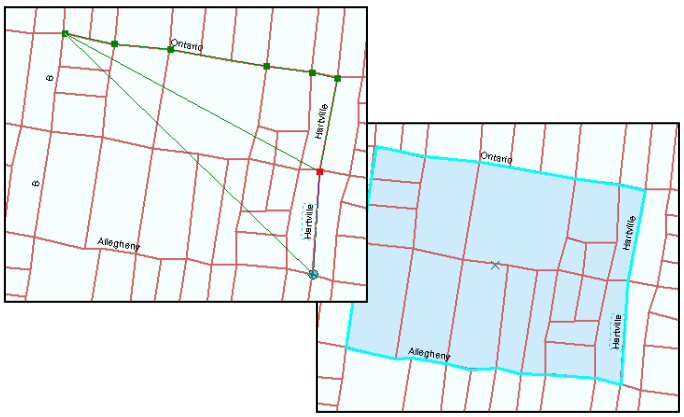
The Create New Feature tool allows you to draw points, lines, or polygons.

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.

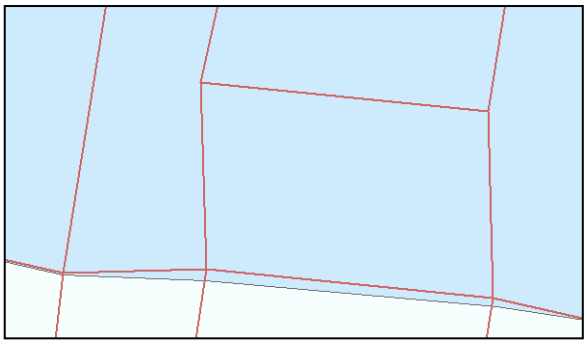
The Trace tool creates features that follow existing map features.

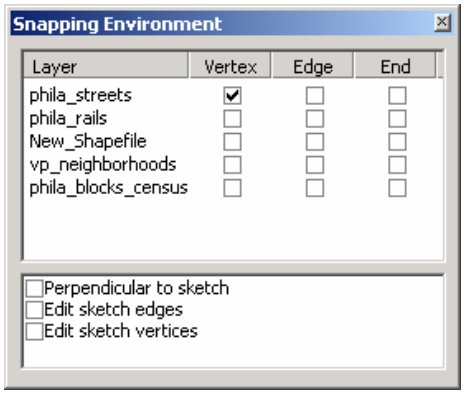


The Create New Features tool is the most basic and allows you to draw new map features. Click to create a new vertex and double click to finish. In the example at left, a new polygon feature was drawn that follows four streets. Use the delete tool to start over. Use the undo tool to remove the last vertex.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

Snapping to an Existing Feature

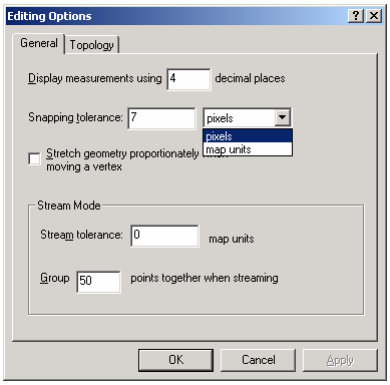
It is nearly impossible to draw features that match an existing layer just by looking at it. Zooming in to the polygon shapefile created above shows that there are gaps between the new shapefile and the street centerline that was used as a guide. This looks sloppy and can impact the result of your analyses.





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 "Genera" 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. Census blocks are bounded by streets, so any new polygon feature with streets as borders can be created by dissolving the boundaries between census blocks.

To start, add a street centerline layer and census block layer to ArcMap. To avoid making permanent changes to your census block file, create a new copy of it (right click on it, go to “Data” and “Export Data”) and add it to your map. With the streets and (new) block layers drawn, zoom into the area where you wish to create new features. Use the label tool to identify street names (that’s why you need the street file; census block files don’t contain street names). Using the Select Features tool, highlight the blocks that cover the area of your new feature. 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.