Part II

Working with spatial data

5

Spatial data

Vast collections of spatial data are available from government agencies. You can readily download much of this data for free on the Internet, but before doing so it is helpful to get some background and see some of the major forms of this data. Spatial data is complex, with both vector and raster formats available in many file formats and with several attending characteristics such as coordinate system, feature or cell attribute properties, and intended map scale for application. This chapter provides a hands-on introduction to spatial data and then has you download or use samples from some of the major governmental suppliers.

Learning objectives

- *Learn about metadata*
- *Work with world projections*
- *Work with US map projections*
- *Work with systems of projections*
- *Learn about vector data formats*
- *Download US Census map layers*
- *Download US Census data*
- *Download American Community Survey data*
- *Explore web services for raster maps*
- *Use nationalatlas.gov*

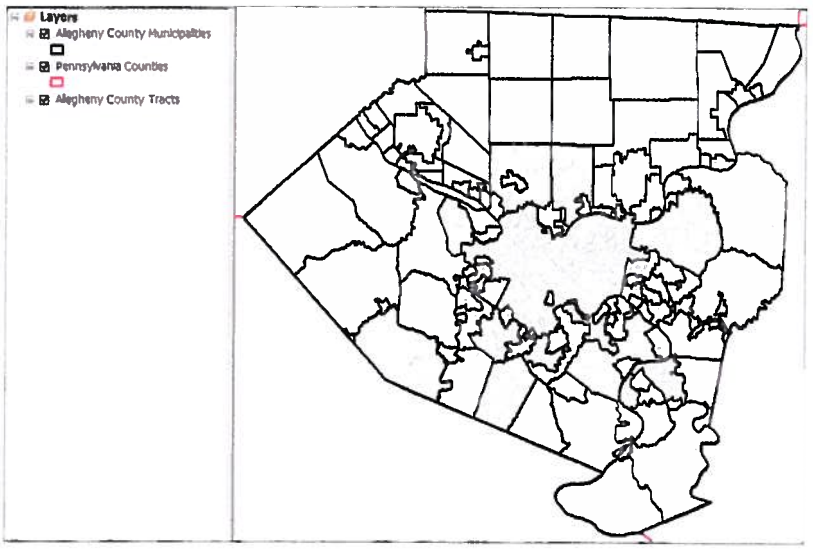
Tutorial 5-1

Examining metadata

Spatial data needs much documentation for interpretation and proper use. "Metadata" is the term for such documentation. It describes the context, content, and structure of GIS data. In ArcGIS for Desktop, data providers use ArcCatalog to create and view metadata.

Open a map document

1 **Start ArcMap and open Tutorial5-1.mxd from the Maps folder.** These map layers come from two different data sources. The Pennsylvania Counties and Allegheny Tracts layers were obtained from the US Census Bureau, and the Allegheny County Municipalities layer was obtained from a local GIS organization, the Southwestern Pennsylvania Commission.



2 Save the map document to the Chapter5 folder of MyExercises.

Open a metadata file

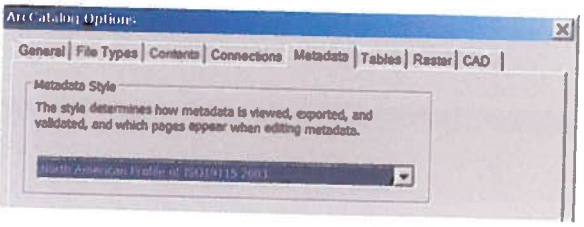
ArcGIS metadata is described in a metadata file that can be read using ArcCatalog.

1 On the taskbar, click Start > All Programs > ArcGIS > ArcCatalog 10.1. Depending on your operating system and how ArcGIS and ArcCatalog have been installed, you may have a different navigation menu.

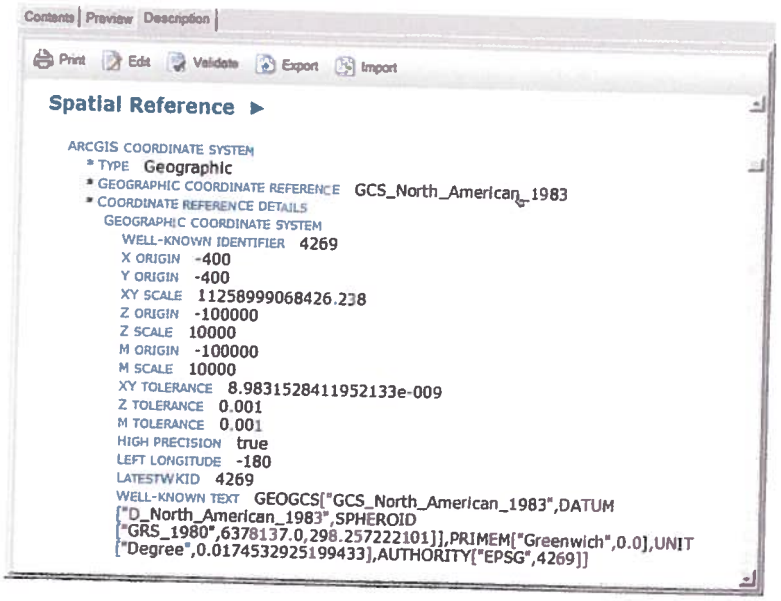
2 In the Catalog tree, browse to UnitedStates.gdb in the Data folder, click PACounties, and the Description tab. Be patient. It takes time for the description to appear.

3 Click Customize > ArcCatalog Options and the Metadata tab.

4 Click North American Profile of ISO19115 2003 as the Metadata style > OK.

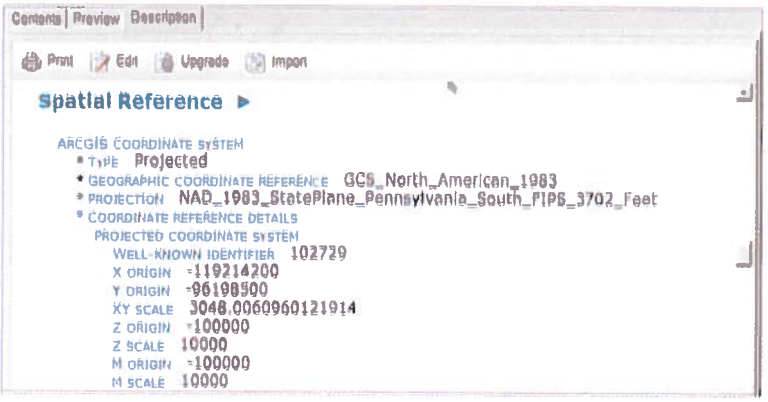


5 Scroll to the Spatial Reference option and read the entry. You learn that geographic coordinates are spherical, Geographic Coordinate System, NAD 1983 Datum.



6 In the Catalog tree, browse to AlleghenyCounty.gdb in the Data folder, click Munic, click the Description tab, and wait while this loads.

7 Scroll to the Spatial Reference option and read the entry. You learn that the layer's projection is rectangular, NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet. You will learn more about projections and coordinate systems in tutorials 5-2 through 5-4.



YOUR TURN

Explore some of the other metadata for Pennsylvania Counties, Allegheny Municipalities, and Allegheny County Tracts 2010, including source credits, fields, and other spatial information.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Tutorial 5-2

Working with world map projections

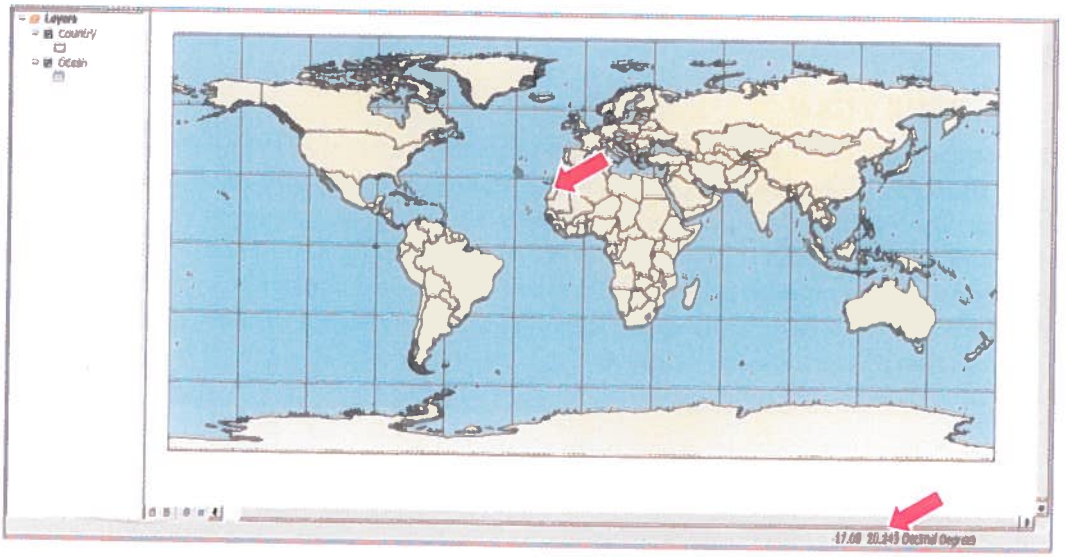
There are two types of coordinate systems—geographic and projected. Geographic coordinate systems use latitude and longitude coordinates for locations on the surface of a sphere while projected coordinate systems use a mathematical transformation to a flat surface and rectangular coordinates.

Set world projections

ArcMap has more than 100 projections from which you may choose. Typically, though, only relatively few are needed for most purposes.

1 Open Tutorial5-2.mxd from the Maps folder and save the map document to the Chapter5 folder.

2 Place your cursor over the westernmost point of Africa and read the coordinates on the bottom of the ArcMap window (approximately –17, 20 decimal degrees). The map and data frame are in geographic coordinates, decimal degrees, which are angles of rotation of the Earth's radius from the prime meridian at the equator. These coordinates are not intended for viewing on a flat surface such as your computer screen, so there are large distortions if you do so; for example, the north and south pole points are the horizontal lines bounding the top and bottom of the map. Instead of geographic coordinates, you should use one of the projected coordinate systems appropriate for viewing flat maps of the world. ArcMap has several and can easily project the map on the fly.



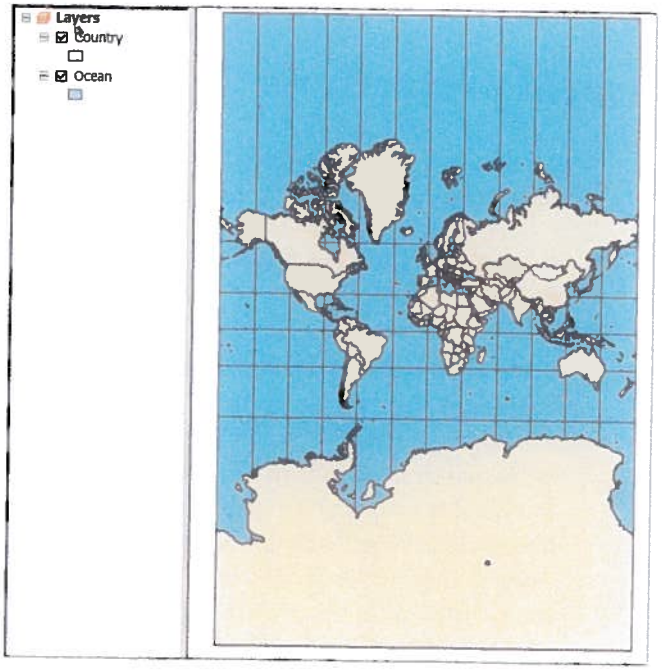
Change the map's projection to Mercator

1 In the table of contents, right-click Layers, click Properties > Coordinate System tab.

2 In the Select a coordinate system panel, scroll down to and click the plus (+) sign beside Projected Coordinate Systems, and click the plus sign beside the World folder.

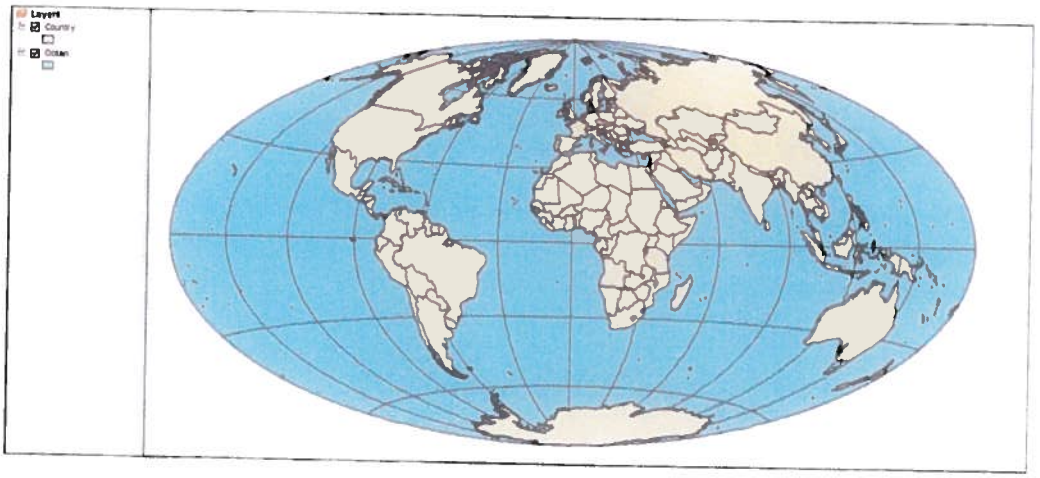
3 Scroll down the coordinate systems, click Mercator (world) > OK.

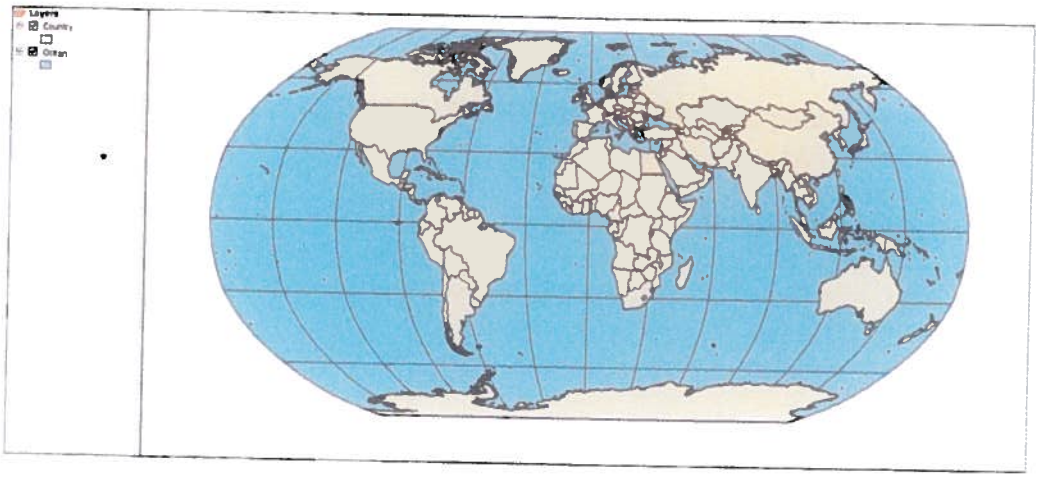
4 Zoom to full extent.
The purpose of the Mercator projection is for navigation. Straight lines on the projection are compass bearings for connecting two points. This projection greatly distorts areas near the polar regions and distorts distances along all lines except the equator. The Mercator projection is a conformal projection, meaning that it preserves small shapes and angular relationships.



YOUR TURN

Repeat the steps of the previous exercise, but this time select the Hammer-Aitoff projection in the third step. This projection, shown in the first image below, is nearly the opposite of the Mercator. The Hammer-Aitoff is good for use on a world map, being an equal-area projection that preserves area. However, it distorts direction and distance. Repeat the steps again, this time choosing the Robinson projection. As shown in the second image below, this projection minimizes distortions of many kinds, striking a balance between conformal and equal-area projections. Save the map document.


Layers
Country
Ocean


Layers
Country
Ocean

Tutorial 5-3

Working with US map projections

For most GIS applications it's good to use an equal-area projection of a large area such as the contiguous US states. Then you get accurate areas of polygons and can calculate or use accurate population densities.

Set projections of the United States

Next, you get some experience with projections commonly used for maps of the continental United States. Some projections are standard for organizations. For example, Albers Equal Area is the standard projection of both the US Geological Survey and the US Census Bureau.

1 Open Tutorial5-3.mxd from the Maps folder. Initially, the map display is in geographic coordinates. The coordinates will display as decimal degrees.

2 Save the map document to the Chapter5 folder.

3 In the table of contents, right-click Layers, click Properties > Coordinate System tab.

4 Expand Projected Coordinate Systems > Continental > North America.

5 Click North America Albers Equal Area Conic, and then click OK and Yes. Your map is now projected using the Albers Equal Area projection.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

YOUR TURN

Experiment by applying a few other projections to the US map such as North America Equidistant. As long as you stay in the correct group—Continental, North America—all of the projections look similar. The conclusion is that the smaller the part of the world that you need to project, the less distortion. There remains much distortion at the scale of a continent, but much less so than for the entire world. By the time you get to a part of a state, such as Allegheny County, practically no distortion is left, as you see next. Save your map document.

Tutorial 5-4

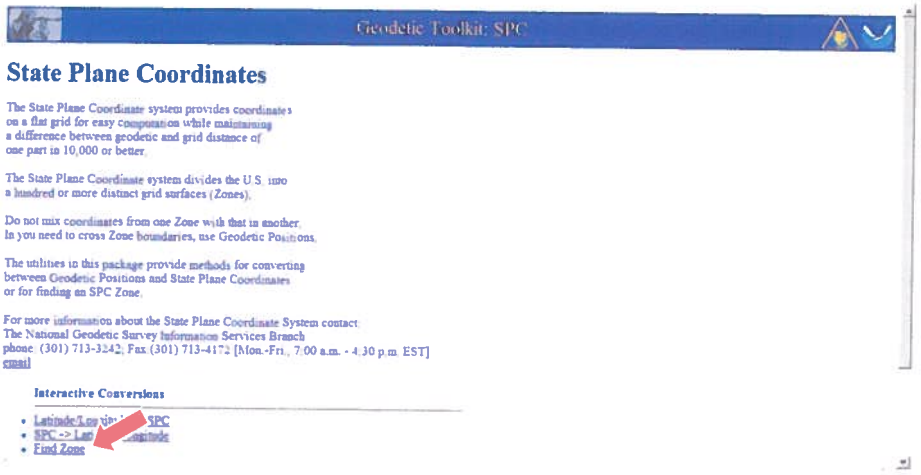
Working with rectangular coordinate systems

For medium- and large-scale maps it's helpful to have localized projections, tuned for the study area, that have little or no discernible distortion. For this purpose, there are collections of projections. You have to check a reference map to determine which zone your study area is in and select that projection for your map.

State Plane Coordinate System

The State Plane Coordinate System is not a projection but a coordinate system dividing the 50 US states, Puerto Rico, and the US Virgin Islands into more than 124 numbered zones, each with its own finely tuned projection. Used mostly by local government agencies such as counties, municipalities, and cities, the State Plane Coordinate System is for large-scale mapping in the United States. The US Coast and Geodetic Survey developed it in the 1930s to provide a common reference system for surveyors and mapmakers. The first step in using the State Plane Coordinate System is to look up the correct zone for your area and consequently a specific projection tailored to your study area.

1 Start your web browser, go to www.ngs.noaa.gov/TOOLS/spc.shtml, and click the Find Zone link. If the link does not work, navigate to www.nsg.noaa.gov, and click Tools > State Plane Coordinates.



2 In the resulting web page, with the By County option button selected, click Begin.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

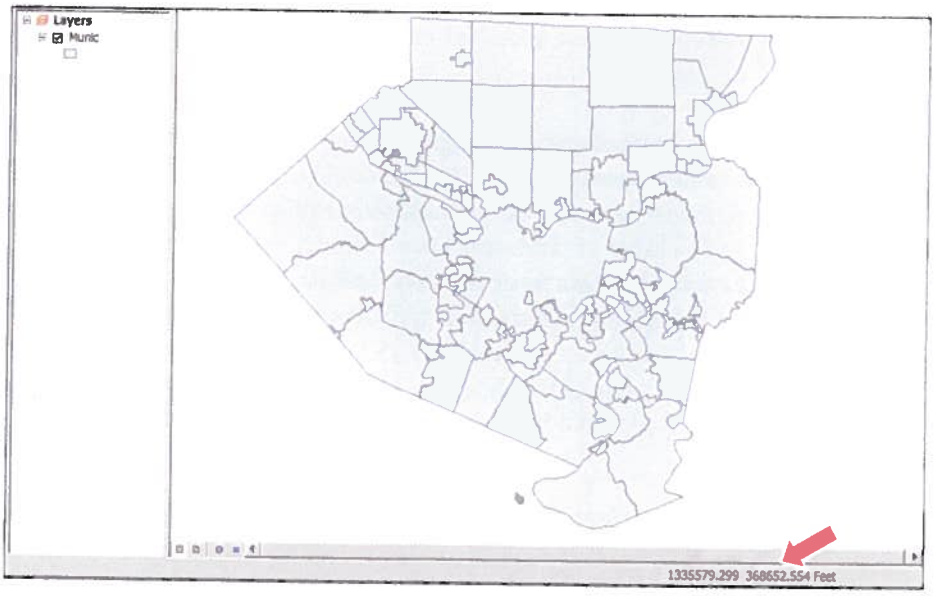
3 Select Pennsylvania, click Submit, and then click Allegheny and Submit. Pennsylvania's Allegheny County is in State Plane Zone 3702 (LAMBERT | SOUTHERN ZONE).

4 Close your browser.

Add projected layers to a map document

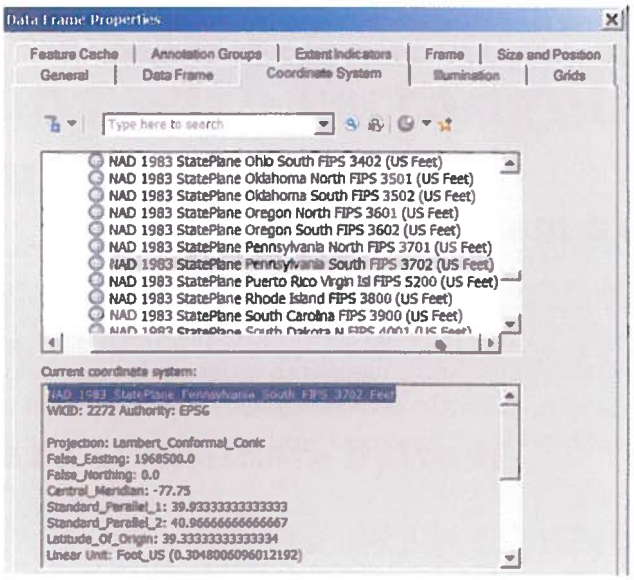
As a default, the first map layer that you add to a map document sets the coordinate system and projection for the data frame. If all of your map layers have spatial reference data included, you should have no problem combining maps with different coordinate systems or projections. ArcMap will reproject all map layers to the data frame's projection on the fly. Next, you add a layer with a State Plane Coordinate System projection and then a layer with geographic coordinates.

1 In a new blank map, click the Add Data button, browse to the Data folder, AlleghenyCounty.gdb, and add Munic to the map. The coordinates appearing in the lower right corner of the display now appear in state plane units (feet). The origin of these coordinates (0,0) is at the lower left corner of Pennsylvania.



2 Save your map document as **Tutorial5-4.mxd** to the Chapter5 folder.

3 In the table of contents, right-click Layers, click Properties > Coordinate System tab. Notice that the data frame coordinates are the same as the Munic layer, NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet. This is because it was the first layer added to the new map document. ArcMap will automatically project all additional layers to state plane, regardless of their original coordinates if the added layers have spatial reference data included.



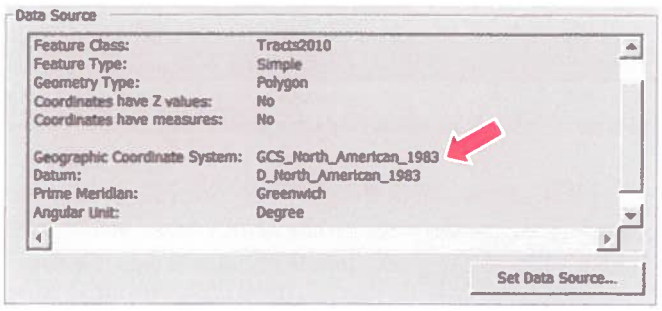
4 Click OK and change the Munic symbology to a hollow fill, black outline, width 1.15.

5 Click the Add Data button, browse to AlleghenyCounty.gdb, and add Tracts2010 to the map.

6 Change the Tracts2010 symbology to a hollow fill, light gray (20%) outline and move below Munic in the table of contents.

7 Right-click Munic in the table of contents, click Properties and the Source tab, and note the coordinate system in the Data Source panel. This layer has state plane coordinates, the same as the data frame.

8 Repeat step 7 except for Tracts2010. This layer has geographic coordinates but appears in the data frame using state plane coordinates because you added Munic first and it has state plane coordinates.



Change the data frame's coordinate system and projection to UTM

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

The US military developed the universal transverse Mercator (UTM) rectangular coordinate system in the late 1940s. It includes 60 longitudinal zones defined by meridians that are 6° wide. ArcGIS has UTM projections available for the northern and southern hemisphere of each zone. These zones, like state plane, are good for areas about the size of a state (or smaller) and have the advantage of covering the entire world.

1 Start your web browser, go to www.dmap.co.uk/utmworld.htm, and determine the UTM zone for western Pennsylvania. You should find that western Pennsylvania is in zone 17 north.

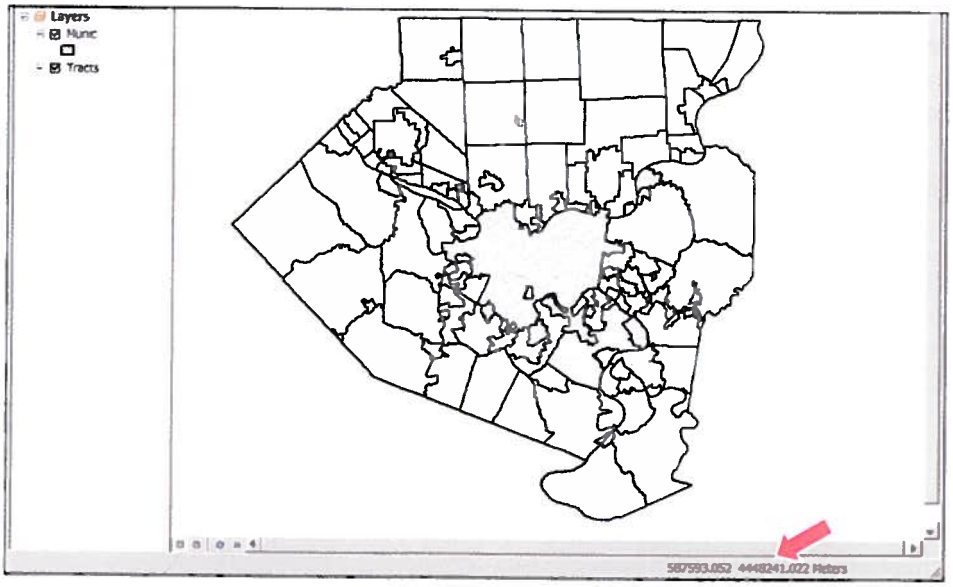
2 Close your browser.

3 In the table of contents, right-click the Layers data frame, and click Properties.

4 Click the General tab and note that the map units are feet.

5 Click the Coordinate System tab, expand Projected Coordinate Systems > UTM > NAD 1983. Click NAD 1983 UTM Zone 17N. UTM is a metric system and thus uses meters as the map unit. Your display remains in feet so you need to set the display units to meters.

6 Click the General tab and click Meters as the display units > OK. The coordinate system and map appearance change slightly accordingly. Notice that the coordinates are now in meters.



Assign a coordinate system and projection to a feature class

All GIS layers should have a coordinate system and projection defined (that is, have spatial reference data), but sometimes you will receive a shapefile or other GIS layer that does not have this data and you will need to assign this yourself. Note that the needed spatial reference data is not metadata but data that is part of the map layer. In a shapefile, it is a separate file and has a .prj extension. A common coordinate system for North American files is the Geographic Coordinate System (GCS), North American Datum 1983 (NAD 1983) projection, which is used by organizations such as the US Census Bureau and is the coordinate system of the shapefile that you are about to use.

1. In Catalog, navigate through the Data > DataFiles folder, right-click AlleghenyCountyBlockGroups.shp, click Properties > XY Coordinate System tab. The coordinate system projection for this shapefile is <Unknown>. Of course you must know the correct coordinate system to assign to the map layer from external information, metadata, or from other sources. If you assign the wrong coordinates, your map will not display correctly in your map document.

2. Expand Geographic Coordinate Systems, expand North America, click NAD 1983 and OK.

3. Repeat step 1 to see that the layer now has its coordinate system data included.

4. Add AlleghenyCountyBlockGroups to your map document. You might see a warning that the data is in a coordinate system different from that of the current data but this is OK because it has its native coordinate system assigned. Notice that the block groups overlay nicely with the other map layers that are now projected as UTM rectangular coordinates.

5. Remove AlleghenyCountyBlockGroups from the table of contents.

6. Save your map document.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Tutorial 5-5

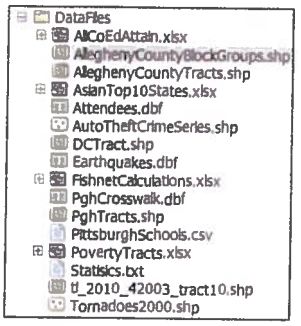
Learning about vector data formats

This tutorial reviews several file formats commonly found for vector spatial data, other than the file geodatabase covered in chapter 4. Included are Esri shapefiles and coverages as well as computer aided design (CAD) files and XY event files.

Examine a shapefile

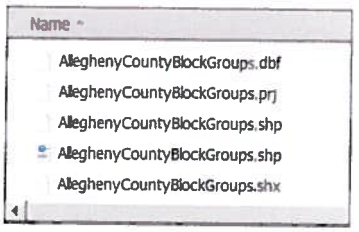
Many spatial data suppliers use the shapefile data format for vector map layers because it is so simple. Shapefiles appeared about the same time that personal computers became popular. A shapefile consists of at least three files: an SHP file, a DBF file, and an SHX file. Each of these files uses the shapefile's name but with the different file type extensions. The SHP file stores the geometry of the features, the DBF file stores the attribute table, and the SHX file stores an index of the spatial geometry for speeding up processing. Next, you examine AlleghenyCountyBlockGroups.shp in more detail.

1 Examine AlleghenyCountyBlockGroups.shp in Catalog.
It appears as an entry in one line with an icon representing a polygon map layer. ArcCatalog treats the several files as a unit and provides utilities such as renaming the shapefile in one location.



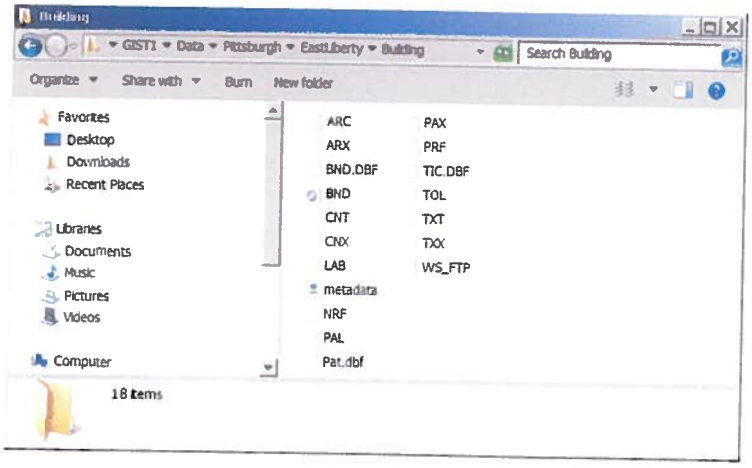
2 Open a Computer window and navigate to the Data > DataFiles folder. Now you can see that there are five files for the shapefile, including the projection (.prj) file that you created in tutorial 5-4 when you added a spatial reference for the layer's coordinate system. Shapefiles have three to seven associated files.

3 Close the Computer window.



Add a coverage to ArcMap

A coverage is a legacy Esri spatial data format from times when personal computers did not even exist. Coverages typically store one or more feature classes that are related in a folder named for the coverage. For example, in a cadastral (land ownership) dataset it is common for a coverage to store the parcel boundaries as polygons and the parcel lines making up the polygons as arcs (lines). You can add coverage data to ArcMap and use it for analysis and presentation, but you cannot edit coverage data with ArcMap. When browsing data within Windows Explorer, coverages appear as folders containing several files. In the following, you can see the four coverages in the EastLiberty folder with the contents of the Building coverage appearing in the right-hand side of Windows Explorer. The Building coverage has 18 files.



1 In a new blank map, click the Add Data button, browse through the Data > Pittsburgh > EastLiberty folder, and double-click Building.

2 Click the Polygon layer icon, click Add, and OK. A coverage behaves like any other vector layer in ArcMap. It has the same appearance and has an attribute table.

3 Save the map document as **Tutorial5-5.mxd** to the Chapter5 folder.

YOUR TURN

Add Curbs Arc and Parcel Polygon coverages to your map for the East Liberty neighborhood. Change the symbols to your liking and examine the attribute table for the Parcel layer.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Convert a coverage to a feature class

If you need to edit the attribute tables or geometry of a coverage, you must export it first as a shapefile or file geodatabase feature class.

1 In the table of contents, right-click the Building Polygon layer, click Data > Export Data.

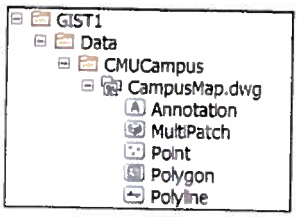
2 Browse to Chapter5.gdb in the Chapter5 folder of MyExercises and save the output feature class as **Building**.

3 Click OK > Yes to add the exported data to the map as a layer. Now you could edit the polygons in the Building feature class and add the missing spatial reference for the layer. You learn about editing features in chapter 7.

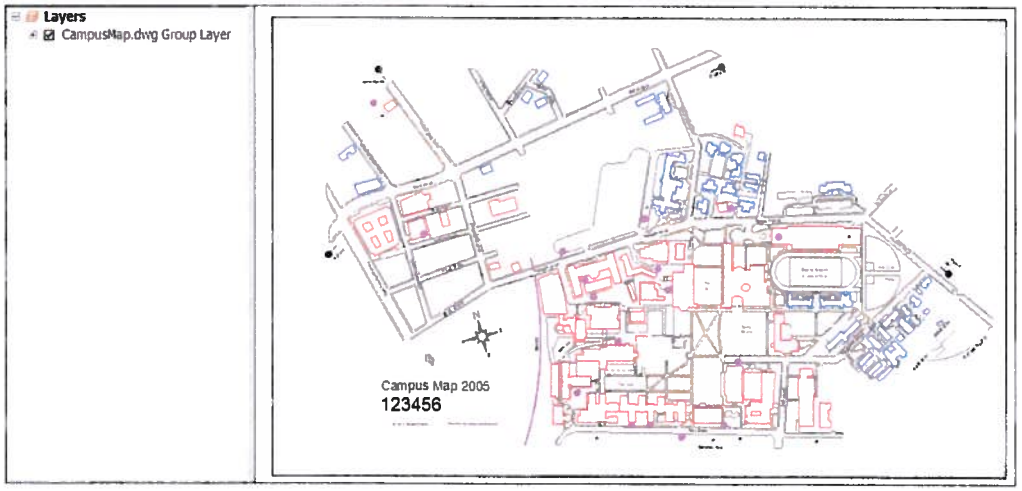
4 Save the map document.

Add a CAD drawing file

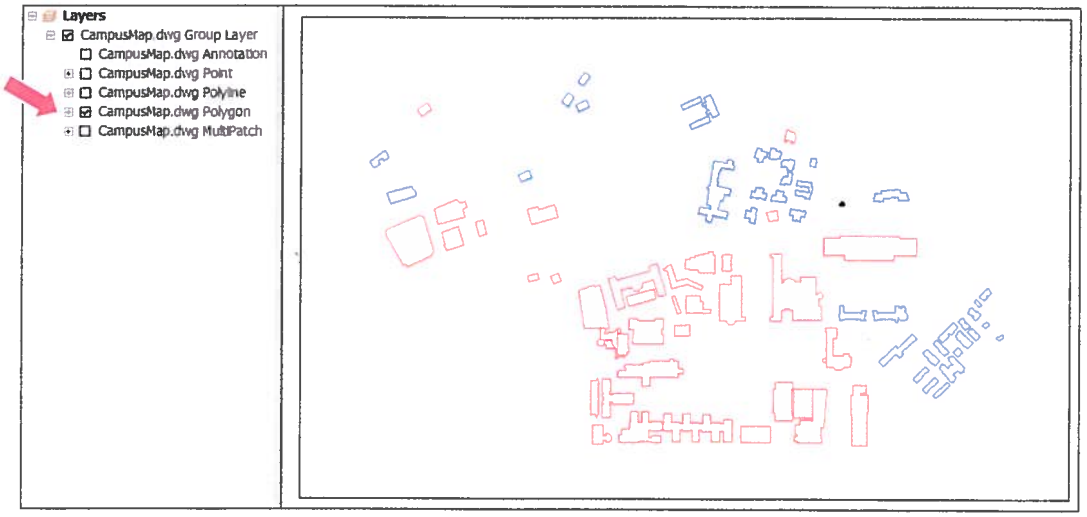
Many organizations have CAD (computer aided design) drawings that you can display in ArcMap in their native format. ArcMap can add CAD files in one of two formats: as native AutoCAD (.dwg) or as Drawing Exchange Files (.dxf) that most CAD software can create. When viewed in Catalog, a CAD dataset appears with a light blue icon. An AutoCAD file is much like a coverage in that it has different kinds of vector features in the same file. You can see CampusMap.dwg in ArcCatalog in the following:



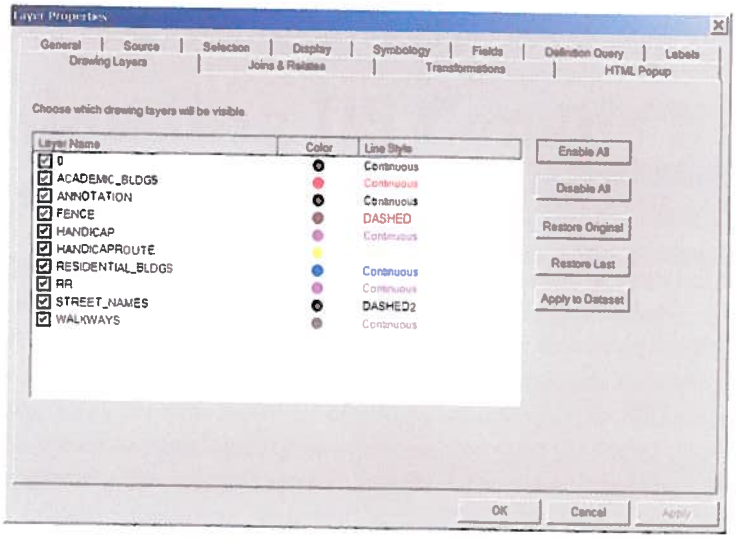
1 In a new blank map, click the Add Data button, browse through the Data > CMUCampus folder, click the CampusMap.dwg icon, click Add, and OK to the spatial warning message. The following map of the Carnegie Mellon University campus appears in ArcMap as a layer group that contains many feature types, including lines, polygons, and text. This map is from the Facilities Management Department and has spatial reference data.



2 In the table of contents, expand the CampusMap.dwg Group Layer, and turn off all layers except CampusMap.dwg Polygon. This shows academic and residential buildings on CMU's campus.



3 Right-click the CampusMap.dwg Polygon layer, click Properties > Drawing Layers tab. Notice that you can turn layers on and off. You can also symbolize the layers using the Symbology tab.



4 Close the Layer Properties window and remove CampusMap.dwg Group Layer from the table of contents.

Export GIS features to CAD

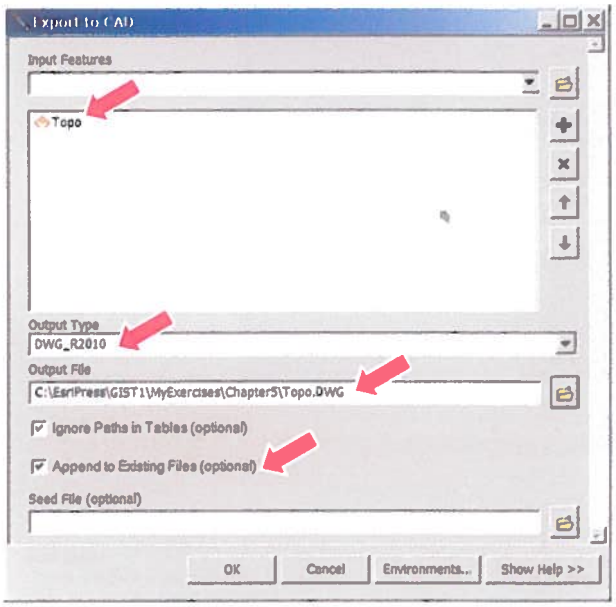
Sometimes you may need to deliver GIS features to a person working with CAD software. You can export features to AutoCAD (.dwg) or Drawing Exchange Files (.dxf) formats, which can then be opened by most commercial CAD applications.

1 Click the Add Data button, browse through the Data folder to 3DAnalyst.gdb, click Topo, and click Add. This is two dimensional topography.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

2 In the table of contents, right-click the Topo layer, and click Data > Export to CAD.

3 Type or make selections as follows:



The CAD drawing is automatically added to the table of contents. You can also open Topo.dwg in any computer application that supports the CAD .dwg format.

4 Remove the Topo and CAD drawing layers from the table of contents.

5 Do not save your map document.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Tutorial 5-6

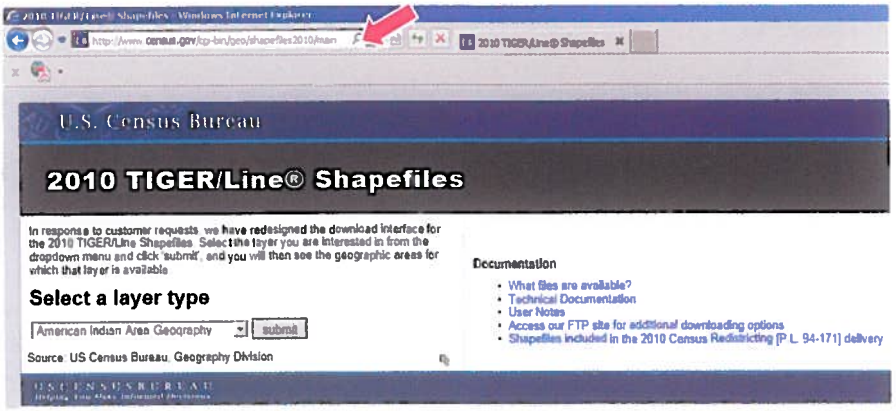
Downloading US Census Bureau boundary maps

There is a large and ever-expanding collection of spatial data—including vector and raster map layers and data tables with geocodes—available for free download from the Internet or for direct use as map layers in map documents. The advantage of downloading spatial data is that you can modify it as you wish. Government agencies provide much of this spatial data, as do GIS vendors. In this chapter you learn about and use a few of the major spatial data suppliers. Note that if you have difficulty downloading the data files for this chapter, they are also available in the Chapter5 folder of FinishedExercises.

Download US Census Bureau Cartographic Boundary Files

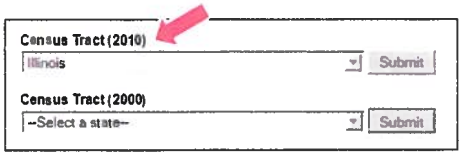
From the US Census Bureau's website, you can download census-related map layers with unique identifiers for polygons such as census tract IDs, but not census attribute data such as population, age, sex, race, income, and so forth. There are so many census variables—thousands—that it is impractical to provide them all in map layer attribute tables. The map layers would be excessively large and cumbersome files. Instead, the Census Bureau provides the American FactFinder website in which you build custom collections of variables for your needs. The US Census Bureau continually updates this website so you might find that some data is already joined or the menus vary. In this tutorial, you download selected census demographic data separately, perform some data preparation steps on it, and finally join it to the corresponding polygon, boundary map layer. First, you download boundary shapefiles for Cook County, Illinois, where the city of Chicago is located.

1 In your web browser, go to http://www.census.gov/cgi-bin/geo/shapefiles2010/main. US Census shapefiles with basic data already joined can also be found at www.census.gov.



2 Under Select a layer type, select Census Tracts and click submit.

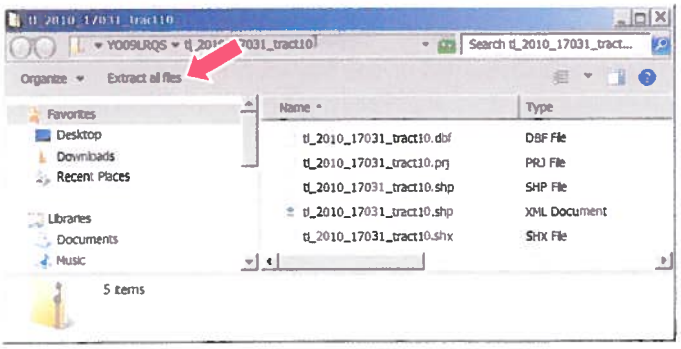
3 Under Census Tract (2010) select Illinois and click Submit.



4 Select Cook County and click Download.

5 Click Open for the downloaded compressed file tl_2010_17031_tract10.zip > Open.

6 Click Extract all files.



7 Extract the files to the Chapter5 folder of MyExercises.

YOUR TURN

Download and extract the shapefiles for Illinois, Cook County 2010 county subdivisions found in tl_2010_17031_cousub10.zip and census water features (area hydrology) found in file tl_2010_17031_areawater.zip.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Tutorial 5-7

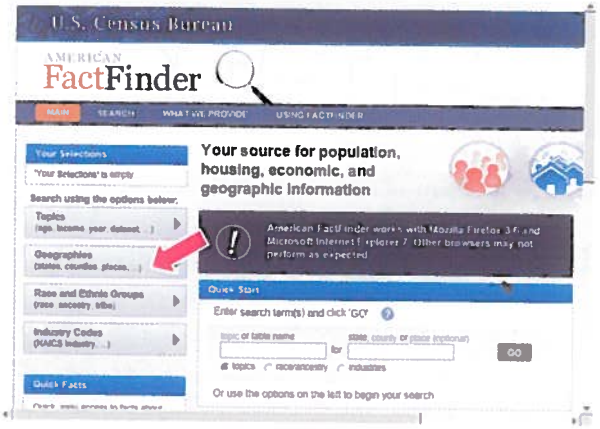
Downloading and processing Census SF 1 data tables

The US Census Bureau's American FactFinder website provides tabular census data including geocodes for joining to census boundary maps. Here you download a table with selected 2010 population attributes for Cook County, Illinois census tracts, process them in Microsoft Excel, and finally join them to the tract map layer for display. This is so-called SF 1 (Summary File 1) data that provides basic data on populations, housing units, and households. This data is available for all census levels including tracts, block groups, and blocks.

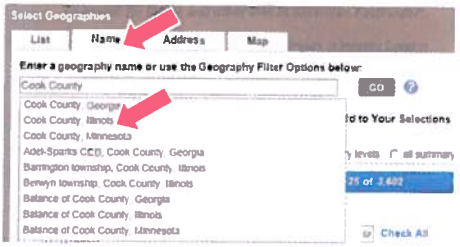
Get started on downloading 2010 SF 1 data

1 Using your web browser, go to http://factfinder2.census.gov and click the Advanced Search tab. This website includes data from both Census 2010 and Census 2000. Here you can build selections to download data for a specific topic in a specific geographic location. Note that the screen captures that follow might be different from yours as the US Census updates its website.

2 In the left navigation bar, click Geographies.

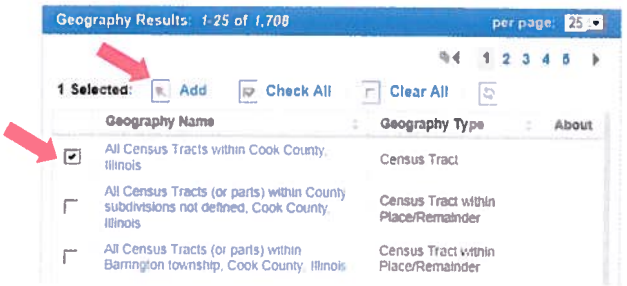


3 Click the Name tab, type **Cook County** in the Enter a geography name box, click Cook County, Illinois > click Go.

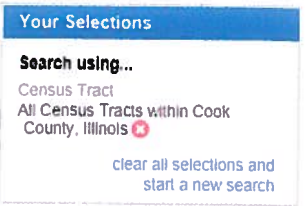


4 In the Select Geographies panel, click Census Tract from the Geography Filter Options.

5 In the Geography Results panel, select the check box for All Census Tracts within Cook County, Illinois > Add.

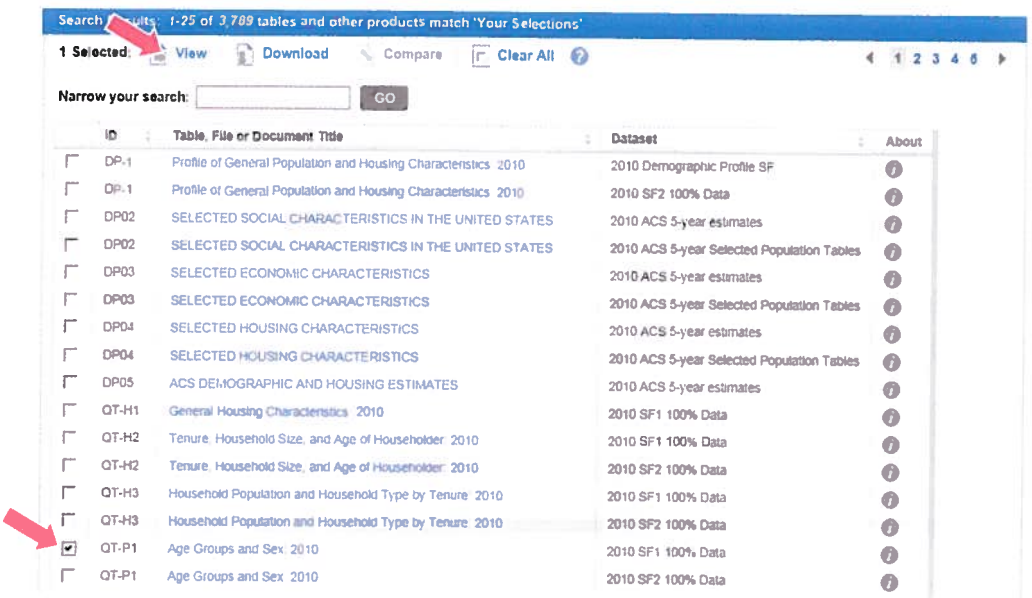


6 Close the Select Geographies window. The Search Results panel displays data collections that are available at the census tract level. Your selection should be as shown.



Finish up downloading SF 1 data

1 In the Search Results window, navigate to and select the check box beside QT-P1 Age Groups and Sex: 2010, 2010 SF1 100% Data, and click the View button. If you do not see the QT-P1 table in the Search Results type **QT** in the Narrow your search box.

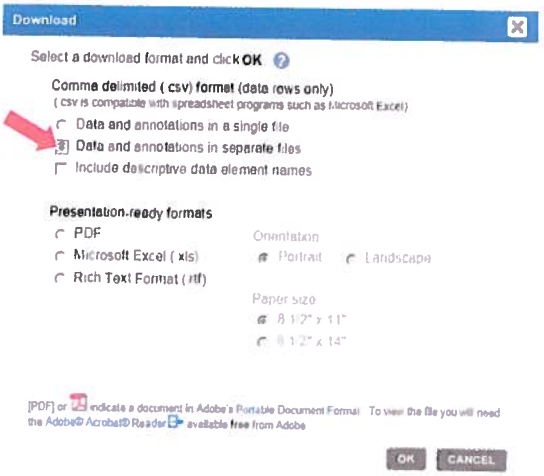


The resulting table shows the data included in this table that will be downloaded to a spreadsheet.

Geography Census Tract 101, Cook County, Illinois
POPGROUP Total population

Age	Number			Percent			Males per 100 females
	Both sexes	Male	Female	Both sexes	Male	Female	
Total population	4,854	2 326	2 528	100 0	100 0	100 0	92 0
Under 5 years	355	167	188	7.3	7.2	7 4	88.8
5 to 9 years	287	155	132	5 9	6 7	5 2	117 4
10 to 14 years	255	125	130	5 3	5.4	5.1	96.2
15 to 19 years	275	141	134	5 7	6 1	5 3	105.2
20 to 24 years	358	151	207	7.4	6.5	8 2	72 9
25 to 29 years	480	226	254	9 9	9.7	10 0	89.0
30 to 34 years	444	186	258	9.1	8 0	10 2	72 1
35 to 39 years	395	194	201	8 1	8 3	8 0	96 5
40 to 44 years	404	218	186	8 3	9.4	7 4	117.2
45 to 49 years	413	197	216	8 5	8 5	8 5	91 2
50 to 54 years	376	180	196	7.7	7.7	7 8	91 8
55 to 59 years	306	159	147	6 3	6 8	5 8	108 2
60 to 64 years	229	110	119	4 7	4 7	4 7	92 4
65 to 69 years	117	55	62	2 4	2 4	2 5	88 7
70 to 74 years	65	25	40	1 3	1.1	1 6	62.5
75 to 79 years	39	13	26	0 8	0 6	1.0	50 0
80 to 84 years	27	17	10	0 6	0 7	0 4	170.0
85 to 89 years	20	4	16	0 4	0 2	0 6	25 0
90 years and over	9	3	6	0.2	0 1	0 2	50.0

2 Click the Download button > Click Data and annotations in separate files > OK > Download > Open.



3 Extract all files to the Chapter5 folder. The resulting files include a readme document, DEC_10_SF1_QTP1.csv, DEC_10_SF1_QTP1.txt, DEC_10_SF1_QTP1_ann.csv, and DEC_10_SF1_QTP1_metadata.csv. The comma separated file, DEC_10_SF1_QTP1.csv, has the census data. If you have trouble downloading this data, the files are in the Chapter5 folder of FinishedExercises.

YOUR TURN

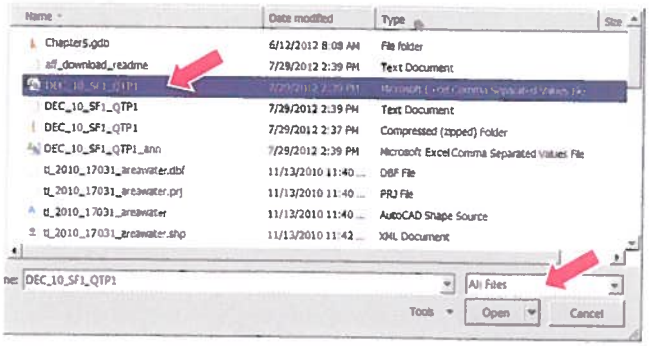
Explore a few other SF 1 tables for Cook County, Illinois. Click each table to see the data details. When finished close your browser.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Process data in Microsoft Excel

The census data that you downloaded in the previous exercise as a text table needs some cleaning up using software such as Microsoft Excel before using in your GIS.

1 Open Microsoft Excel on your computer, click File > Open, select All Files (*.*) for Files of type, browse to the Chapter5 folder, and double-click the CSV (comma separated values) file DEC_10_SF1_QTP1.

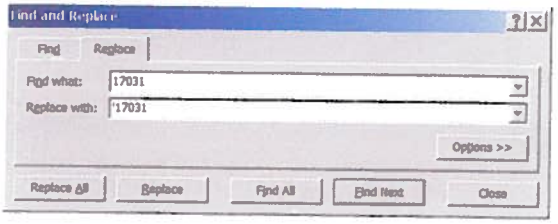


2 Delete column C and then columns F–KC.

3 Rename the columns **Id**, **Id2**, **Both sexes**, **Male**, and **Female**, as shown in the figure below. The resulting table shows only geocodes (Id and Id2) and basic population fields. One problem is that the fields for the join attributes do not match in data type and therefore cannot join. In the TIGER tracts polygon feature class, the join field (GEOID10) is a text field and in this table the corresponding join field (Id2) is a number field. You can tell because data in text fields is left-aligned and that in numeric fields is right-aligned. A simple solution is convert the number field, Id2, to text.

	A	B	C	D	E
1	Id	Id2	Both sexes	Male	Female
2	1400000US17031010100	17031010100	4854	2326	2528
3	1400000US17031010201	17031010201	6450	3245	3205
4	1400000US17031010202	17031010202	2818	1473	1345
5	1400000US17031010300	17031010300	6236	3168	3068
6	1400000US17031010400	17031010400	5042	2248	2794

4 Click the B column selector cell to select that column. On the Home ribbon in Excel, click the Find & Select button and click Replace. Type values as shown (note the single quotation mark in the "Replace with" text box).



5 Click Replace All. All cells get a note, indicated by a small green triangle, that numbers are stored as text.

	A	B	C	D	E
1	Id	Id2	Both sexes	Male	Female
2	1400000US17031010100	17031010100	4854	2326	2528
3	1400000US17031010201	17031010201	6450	3245	3205
4	1400000US17031010202	17031010202	2818	1473	1345
5	1400000US17031010300	17031010300	6236	3168	3068
6	1400000US17031010400	17031010400	5042	2248	2794

6 At the bottom of the spreadsheet, double-click the lower left tab that has the text DEC_10_SF2_QTP1, and type **TractsPop2010** to rename the tab.

	A	B	C	D	E
1	Id	Id2	Both sexes	Male	Female
2	1400000US17031010100	17031010100	4854	2326	2528
3	1400000US17031010201	17031010201	6450	3245	3205
4	1400000US17031010202	17031010202	2818	1473	1345
5	1400000US17031010300	17031010300	6236	3168	3068
6	1400000US17031010	17031010400	5042	2248	2794

TractsPop2010

7 Save your file as an Excel Workbook called **CookCountyTractPop2010.xlsx** to the Chapter5 folder.

8 Close Excel.

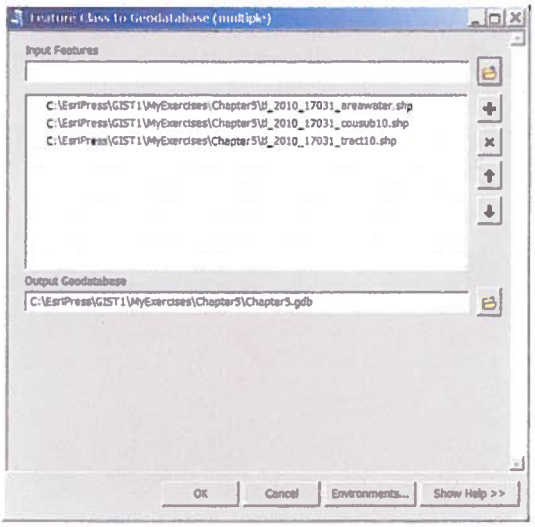
Import files into a file geodatabase

Before adding your features and tables to ArcMap, you will import them into Chapter5.gdb. Excel spreadsheet attribute tables cannot be edited directly in ArcMap so they must be added via a file geodatabase.

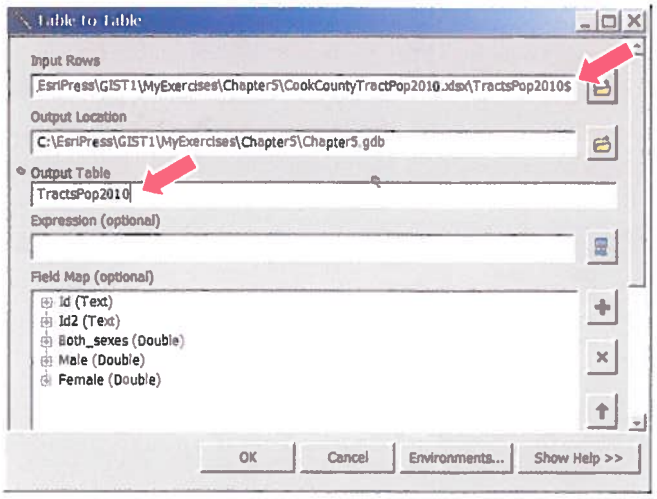
1 Launch ArcMap with a new empty map document.

2 Save your map document as **Tutorial5-7** to the Chapter5 folder.

3 In Catalog, right-click Chapter5.gdb, click Import > Feature Class (multiple...) and make the selections as shown in the graphic to the right.



4 Click OK and wait for the shapefiles to import into the file geodatabase. In Catalog, right-click Chapter5.gdb, click Import > Table (single...) and make the selections as shown in the following: TractsPop2010$ is the worksheet within the Excel spreadsheet with the population data.



5 Click OK and wait for the worksheet from Excel to import into the file geodatabase. The table is automatically added to the map document.

Add and symbolize features

1 Add polygon features tl_2010_17031_tract10, tl_2010_17031_cousub10, and tl_2010_17031_areawater to your map document from Chapter5.gdb.

2 In the table of contents, rename the data frame **Cook County Illinois**.

3 Rename the additional layers **Tracts 2010**, **County Subdivisions**, and **Lakes and Rivers**.

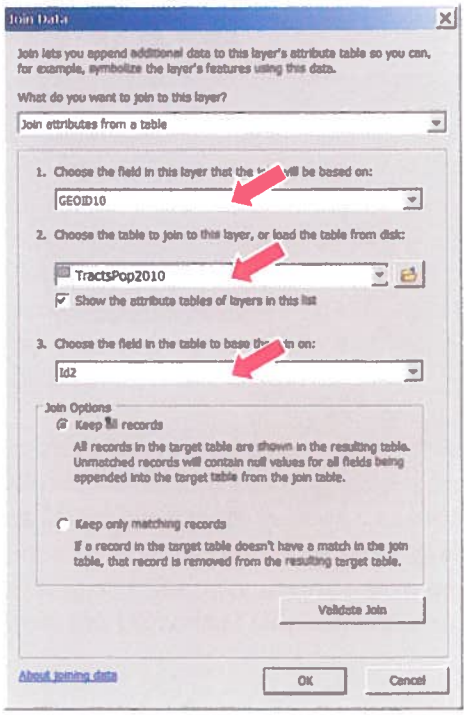
4 Symbolize County Subdivisions as a thick, hollow outline and move that layer to the top of the table of contents.

5 Symbolize Lakes and Rivers as a light blue color with no outline.

Add and Join tables

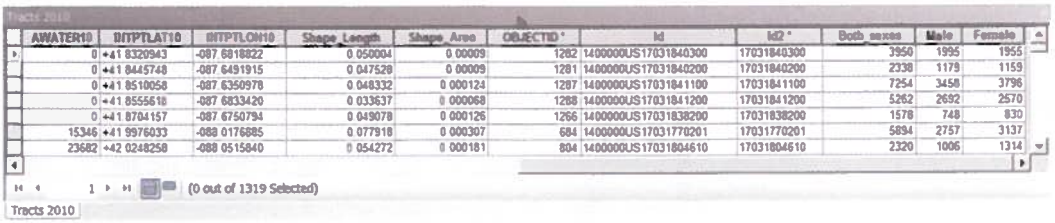
Next you join the census data in TractsPop2010 to the Tracts 2010 attribute table.

1 In the table of contents, right-click Tracts 2010, click Joins and Relates > Join, and type or make selections as follows:



2 Click OK > Yes.

3 Open the Cook County Tracts attribute table and verify that the census data attributes (Both_sexes, Male, and Female) are joined.



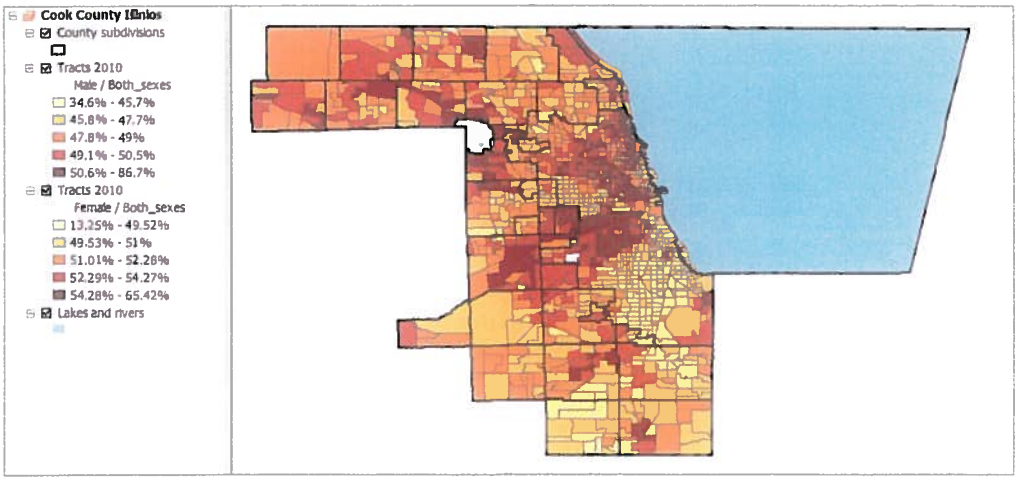
AWATER10	INTPTLAT10	INTPTLON10	Shape_Length	Shape_Area	OBJECTID *	Id	Id2 *	Both_sexes	Male	Female
0	+41 8320943	-087 6818822	0 050004	0 00009	1282	1400000US17031840300	17031840300	3950	1995	1955
0	+41 8445748	-087 6491915	0 047528	0 00009	1281	1400000US17031840200	17031840200	2338	1179	1159
0	+41 8510058	-087 6350978	0 048332	0 000124	1287	1400000US17031841100	17031841100	7254	3458	3796
0	+41 8555618	-087 6833420	0 033637	0 000068	1288	1400000US17031841200	17031841200	5262	2692	2570
0	+41 8704157	-087 6750794	0 049078	0 000126	1266	1400000US17031838200	17031838200	1578	748	830
15346	+41 9976033	-088 0176885	0 077918	0 000307	684	1400000US17031770201	17031770201	5894	2757	3137
23682	+42 0248258	-088 0515840	0 054272	0 000181	804	1400000US17031804610	17031804610	2320	1006	1314

4 Close the table.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

YOUR TURN

Using the newly joined fields, create a choropleth map showing the percentage of females by census tract. Copy the Tracts2010 layer with the joins to create a layer showing the percentages of males in Cook County, Illinois. Save your map document.



5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Tutorial 5-8

Downloading and processing American Community Survey (ACS) Census data

For more detailed data on education, income, transportation, and other subjects, you download estimates from the ACS tables. In the 2000 and previous censuses such data was collected in the census long-form along with the SF 1 data, randomly from one out of six households, and was called SF3 (Summary File 3) data. Now the Census Bureau collects ACS data monthly—approximately 3 million housing units receive a survey similar to the old long-form questionnaire. Annual, three-year, and five-year estimates produced from ACS samples are available. To learn more about the ACS, visit the website at www.census.gov/acs/www/.

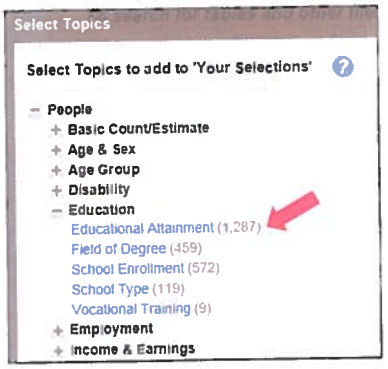
In this tutorial you download ACS data at the tract level for a county. The approach you take is to first select the topic (educational attainment) then the geography and location (tracts in Cook County, Illinois). American Community Survey data can also be downloaded by block groups but is currently available only at the following website: http://www.census.gov/acs/www/data_documentation/summary_file/ *or from the US census DataFerret,* http://dataferrett.census.gov/.

Download ACS data by tract

1 Save your map document as **Tutorial5-8.mxd** to the Chapter5 folder.

2 In your web browser, go to http://factfinder2.census.gov, click the Advanced Search tab, and clear selections that you might have from the previous tutorial.

3 Click the Topics link on the left, and then within the Topics panel expand People, expand Education, and click Educational Attainment.
Note that the number in parentheses might be different from the one in the figure.



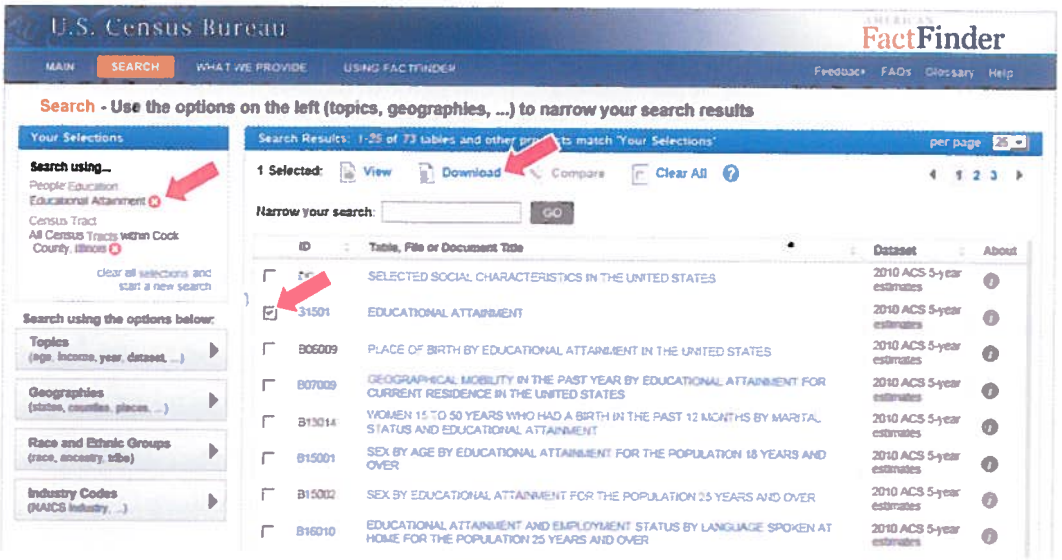
4 Close the Select Topics window.

5 Click the Geographies link on the left and the Name tab.

6 In the Enter a geography name box type **Cook County tracts**, click Go, select All Census Tracts within Cook County, Illinois, and click Add. That adds this geography to the Your Selections panel.

7 Close the Select Geographies window.

8 In the Search results large panel on the right, navigate to and click S1501 EDUCATIONAL ATTAINMENT 2010 ACS 5-year estimates > Download > OK > Download> Open > Extract all files, and extract to the Chapter5 folder. The downloaded files will be text files ACS_10_5YR_S1501 and aff_download_readme_ann, and comma separated files ACS_10_5YR_S1501_metadata.csv and ACS_10_5YR_S1501_with_ann.csv. Note that these are 2010 estimates, the data available at the time this tutorial was written. Newer estimates might be available but this tutorial uses 2010 data.



9 Close your browser.

Process data in Microsoft Excel

The census data that you downloaded in the previous steps needs cleaning up using software such as Microsoft Excel before using in GIS.

1 Open Microsoft Excel on your computer, click Open, select All Files (*.*) for Files of type, browse to the Chapter5 folder, and double-click ACS_10_5YR_S1501_with_ann.csv.

Next you need to mark the columns that you will keep so that you can delete other columns. Definitions for these columns are found in the metadata file called ACS_10_5YR_S1501_metadata.

2 Click the column heading cell A to select that column, click the color fill drop-down list under the Home tab, select a color (yellow).

3 Similarly, click the column heading buttons and use color fill for columns B, D, and J.

	A	B	C	D	E	F	G	H	I	J	K	L
1	GEO.Id	GEO.Id2	GEO.display-label	HC01_EST_VC01	HC01_MC	HC02_EST_VC01	HC02_MOE_VC01	HC03_EST_VC01	HC03_MO	HC01_EST_VC02	HC01_MO	HC0
2	1400000US17031010100	17031010100	Census Tract 101, Cook County, Illinois	549	237	95	78	454	206	33	19.4	
3	1400000US17031010201	17031010201	Census Tract 102.01, Cook County, Illinois	614	237	229	122	385	213	7.3	8.6	
4	1400000US17031010202	17031010202	Census Tract 102.02, Cook County, Illinois	164	136	61	67	103	78	41.5	18.8	
5	1400000US17031010300	17031010300	Census Tract 103, Cook County, Illinois	384	175	230	118	154	108	12.5	13.5	
6	1400000US17031010400	17031010400	Census Tract 104, Cook County, Illinois	1439	468	600	256	839	304	4.1	4.5	
7	1400000US17031010501	17031010501	Census Tract 105.01, Cook County, Illinois	477	226	247	146	230	134	28.5	19.1	
8	1400000US17031010502	17031010502	Census Tract 105.02, Cook County, Illinois	938	466	465	406	473	250	10.9	10.1	
9	1400000US17031010503	17031010503	Census Tract 105.03, Cook County, Illinois	573	367	142	133	431	270	0	5.5	
10	1400000US17031010600	17031010600	Census Tract 106, Cook County, Illinois	749	281	344	198	405	168	4.8	5.8	
11	1400000US17031010701	17031010701	Census Tract 107.01, Cook County, Illinois	288	123	161	113	127	72	23.6	24	
12	1400000US17031010702	17031010702	Census Tract 107.02, Cook County, Illinois	452	172	219	112	233	95	9.7	11.2	

ACS_10_5YR_S1501_with_ann

4 Delete all columns except the ones you marked as yellow.

5 Select columns A–D, click the color fill drop-down list > No Fill.

6 In row 1, type the column names shown in the following figure.

7 Select column B and on the Microsoft Excel Home ribbon, click the Find & Select button, click Replace, and replace values 17031 with '17031. The single quote before 17031 is essential. This converts column B to text values.

8 Type **ACSLessThanHighSch2005-10** as the sheet name.

	A	B	C	D
1	Id	Id2	Pop18to24	LessThanHighSchool
2	1400000US17031010100	'17031010100	549	33
3	1400000US17031010201	'17031010201	614	7.3
4	1400000US17031010202	'17031010202	164	41.5
5	1400000US17031010300	'17031010300	384	12.5
6	1400000US17031010400	'17031010400	1439	4.1
7	1400000US17031010501	'17031010501	477	28.5

ACSLessThanHighSch2005-10

9 Save the spreadsheet as **ACSLessThanHighSch.xlsx** to the Chapter5 folder of MyExercises and close Excel.

YOUR TURN

Import ACSLessThanHighSch2005-10 of ACSLessThanHighSch.xlsx into Chapter5.gdb, add it to your map document, join it to Tracts 2010, and create a choropleth map showing the percentage of population with no high school degree. Note that field LessThanHighSchool is already a percentage. Save your map document.

5-1 5-2 5-3 5-4 5-5 5-6 5-7 5-8 5-9 5-10 5-11 A5-1 A5-2

Tutorial 5-9

Exploring raster basemaps from Esri web services

While vector maps are discrete — consisting of points, lines connecting points, and polygons made up of lines — raster maps are continuous like photographs and use many of the same file formats as images on computers, including Joint Photographic Experts Group (.jpg) and tagged image file (.tif) formats. All raster maps are rectangular, consisting of rows and columns of cells known as pixels. Each pixel has an associated coordinate and an attribute value such as altitude for elevation. Raster maps do not store each pixel's location explicitly but rather store data such as the coordinates of the northwest corner of the map, cell size (assuming square pixels), and the number of rows and columns, from which a computer algorithm can calculate the coordinates of any cell. A key aspect of raster maps from your point of view is that they are very large files. So while you may store some important basemap raster files on your computer, these kinds of maps are perhaps best obtained as map services available for display on your computer but stored elsewhere.

Add a basemap layer

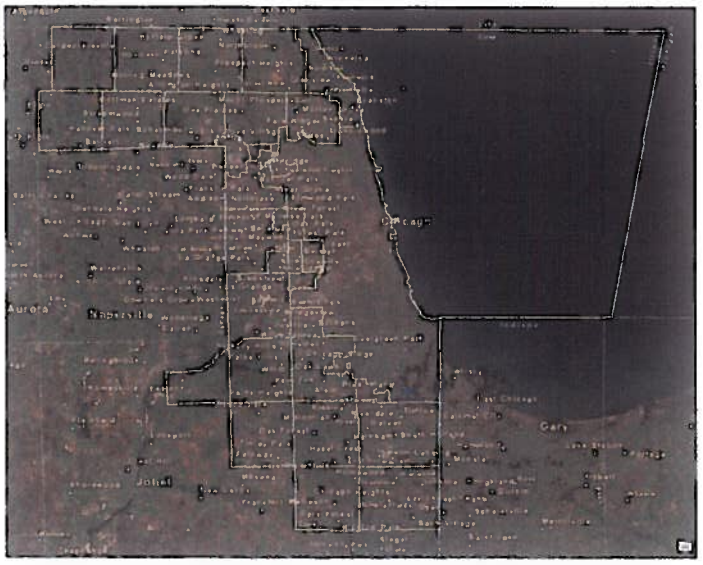
You can add several different basemap layers to a map document as services in addition to map layers from your computer or local area network. ArcGIS has built-in access to Esri servers for this purpose.

1. Save your map document as **Tutorial5-9.mxd** to the Chapter5 folder and remove all layers except County Subdivisions.

2. Symbolize the County Subdivisions layer with a hollow fill and a yellow outline, width 1.15.

3. Click File > Add Data > Add Basemap > Imagery with Labels > Add > Close. It takes a few moments for the map image to download to ArcMap. If your basemap does not appear, right-click County subdivisions and click Zoom To Layer. The map image that displays is from an Esri server instead of your computer's hard disk. You can now more clearly see Lake Michigan.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2



4 Zoom to an area in Chicago near Lake Michigan and Millennium Park.

YOUR TURN

Remove the current basemap from the table of contents and repeat step 3 for another basemap. Save your map document.

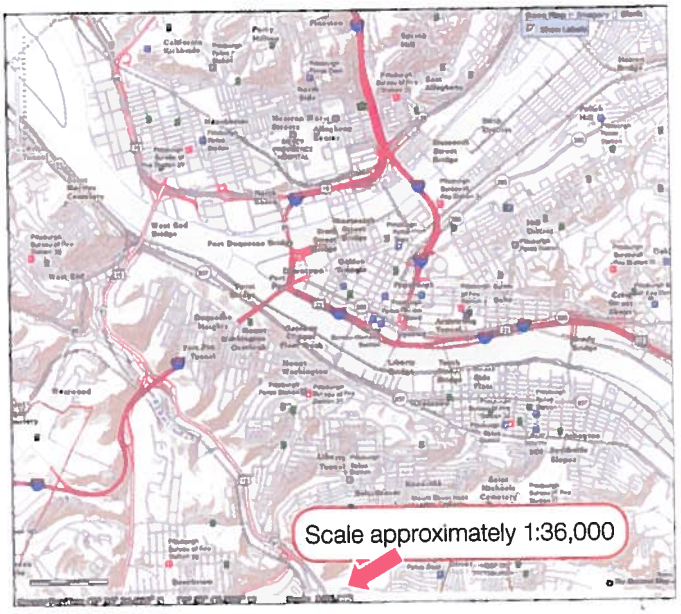
Tutorial 5-10

Downloading raster maps from the USGS

Next, you'll download an elevation raster from the US Geological Survey that can be added in ArcMap. The raster map in this exercise is a digital elevation model (DEM) that can be turned into a shaded relief map, meaning that it includes shadows from an artificial sun in the sky. In chapter 11 you will learn how to convert a DEM into a shaded relief model, as shown in the image below.

Launch the USGS National Map Viewer and zoom to Pittsburgh

1. In a web browser, go to http://viewer.nationalmap.gov/viewer/.
2. From the Standard toolbar, click the Zoom In Box button .
3. Zoom to western Pennsylvania and Pittsburgh where the three rivers meet until you see a scale of approximately 1:36,000 similar to the image on the next page. Note that the screen captures and layers might look different than what you see on your computer.



Order data for download

1 Click the Download Data button .

2 In the "Download options" dialog box, select "Click here" to download by current map extent.

3 Select the Elevation check box and click Next.

4 Select the National Elevation Dataset (1/9 arc second) check box and click Next. This will add the raster map of your zoomed area to the checkout cart. The spatial resolution of NED 1/9 is approximately one meter per pixel, the most detailed available from the USGS.

5 In the Cart window, click Checkout, enter your e-mail address, and click Place Order. You will get a message saying that your order has been placed and to check your e-mail. Later, you'll get an e-mail message summarizing your order and telling you that a link will arrive in the future, which you can use to download the order.

Download data

At some point, you'll get an e-mail message containing a link to download the data.

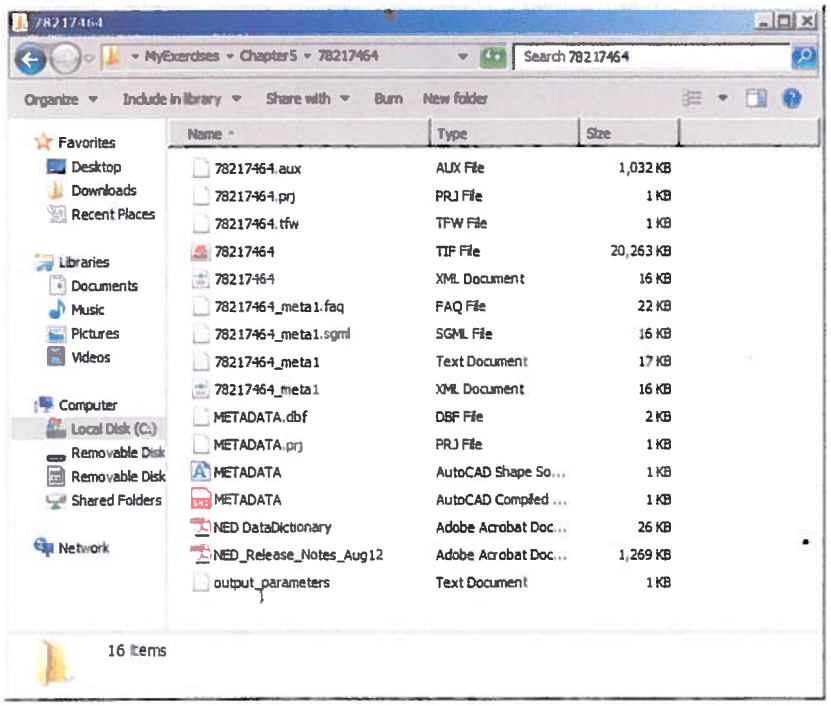
1 Click the link in your e-mail to download the data. You will see the following messages in succession: "Current order status ... Adding your request to the queue. ... Extracting data ... The data extraction has completed. ... Please wait for the data to be returned."

5-1 5-2 5-3 5-4 5-5 5-6 5-7 5-8 5-9 5-10 5-11 A5-1 A5-2

2 Click Save File and save the downloaded file to the Chapter5 folder in MyExercises.

3 In Windows Explorer, double-click the compressed file, click the "Extract all files" button, browse to your Chapter5 folder, and click OK. Then click Extract. A folder that has a unique number is created, containing all the files that are needed to display the raster image properly in the correct projections.

4 Use Windows Explorer to view these files. Close Windows Explorer when you are finished.



Add the raster image to the map

1 In ArcMap, create a new blank map and save it as **Tutorial5-10.mxd** to the Chapter5 folder.

2 Click the Add Data button, browse to Data, Pittsburgh folders, and City.gdb, click Neighborhoods and Add. Symbolize neighborhoods with a hollow fill.

3 Click the Add data button, navigate to MyExercises, Chapter5, and the folder with extracted raster files, click the .TIF file, click Add, and Yes to build raster pyramids. The DEM raster image will automatically be classified and added to the table of contents.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

YOUR TURN

Download the National Land Cover Database 2006 Land Cover from the National Map Viewer and add it to your map document. You will learn more about land cover definitions and how to classify them with unique values in chapter 11. Save your map document.

Tutorial 5-11

Exploring sources of GIS data from government websites

There are many sites to download GIS data from, including local, state, and federal websites. In this exercise, you will download data from an official website of the US government, nationalatlas.gov. Data from the National Atlas can also be found in links from federal websites such as Geo.Data.gov and Geoportal.org. Agencies that contribute geospatial data to these websites include the Department of Agriculture (USDA), the Department of Commerce (DOC), the National Oceanic and Atmospheric Administration (NOAA), the US Census Bureau (CENSUS), the Department of the Interior (DOI), the US Geological Survey (USGS), the Environmental Protection Agency (EPA), and the National Aeronautics and Space Administration (NASA). Many other agencies provide other data on nationalatlas.gov and Data.gov.

Download data from nationalatlas.gov

1 Open Tutorial5-11.mxd from the Maps folder and save the map document to the Chapter5 folder.

2 Click Bookmarks > 48 Contiguous States.

3 Open your web browser and go to http://nationalatlas.gov.

4 In the search box, type **africanized bees**, press ENTER, and click Spread of Africanized Honey Bees in the United States. The direct URL to the map layer information for Africanized (killer) bees is http://nationalatlas.gov/mld/afrbeep.html

5 From the right panel under Data Download, click Invasive Species - Africanized Honey Bees.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

6 Click Shapefile : afrbeep020.tar.gz, save the file to the Chapter5 folder, and uncompress the files there. The downloaded compressed file needs special software to extract the shapefile. The already extracted files, if needed, can be found in the DataGovShapefiles in the Chapter5 folder of FinishedExercises.

Import data and assign an x,y coordinate system

Sometimes downloaded GIS layers do not include a projection file with the x,y coordinate system defined. In this exercise you will import the shapefile into a file geodatabase and assign the x,y coordinate system.

1 Open Catalog, navigate to Chapter5.gdb, import the shapefile afrbeep020.shp and rename the layer **AfricanizedBees**.

2 In Chapter5.gdb, right-click AfricanizedBees and click Properties.

3 Click the XY Coordinate System tab, expand Geographic Coordinate Systems, expand North America, click NAD 1983 > OK.

4 Click the Add Data button, navigate to Chapter5.gdb, and add the AfricanizedBees layer.

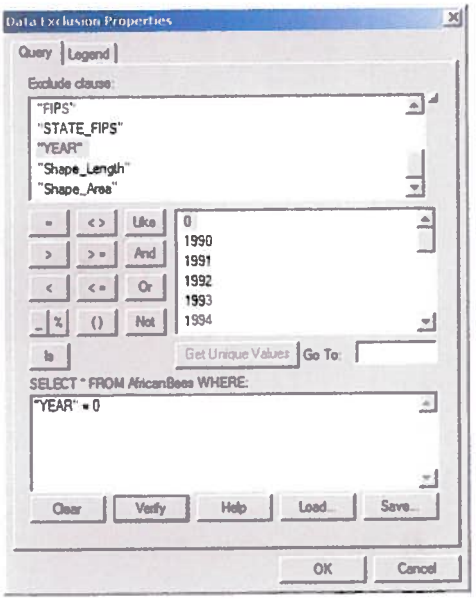
Display layer using classification by year

1 In the table of contents, right-click layer AfricanizedBees, click Properties, and the Symbology tab.

2 Click Quantities > Graduated colors > YEAR as the fields value.

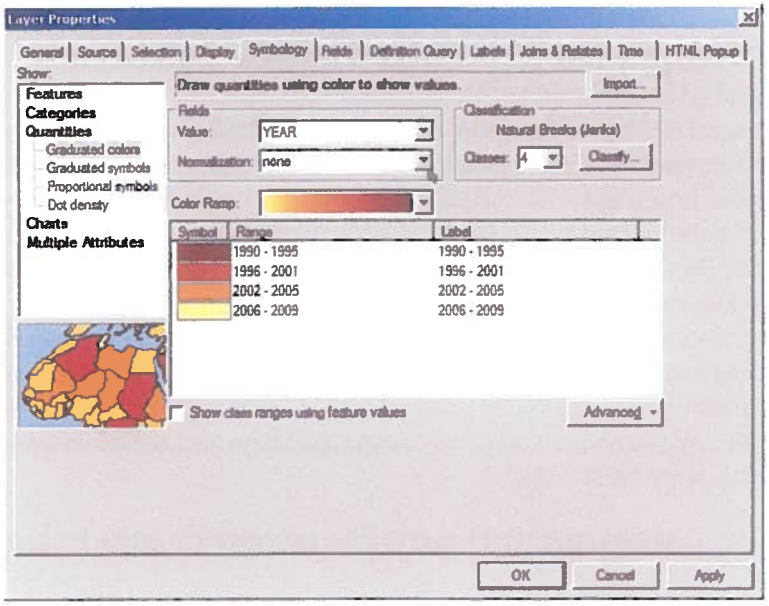
3 Click the Classify button, and in the Classification window click the Exclusion button.

4 Create the query "YEAR" = 0. This shows only the year that Africanized Bees began populating US states.

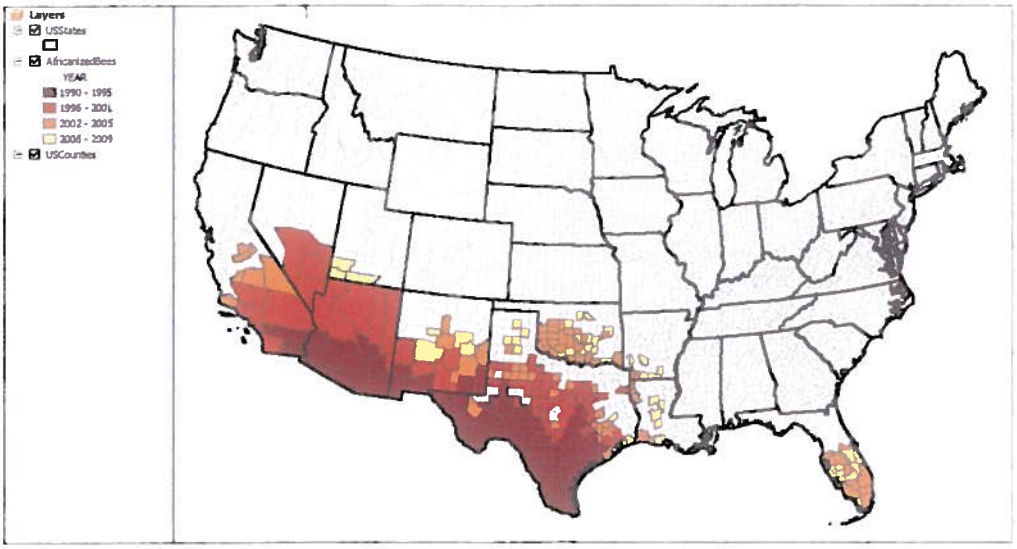


5 Click OK > OK. Click YEAR as the fields value again. This will remove years 0 and 1 from the classification ramp.

6 Change the number of classes to 4 and use the following colors:



7 Click OK and move the layer just below USStates. You can now clearly see the years that Africanized bees populated US states and counties.



8 Save your map document.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

YOUR TURN

Download two other GIS layers from the National Atlas, United States Tornado Touchdown Points 1950-2008 (http://nationalatlas.gov/mld/tornadx.html) and Bailey's Ecoregions and Subregions of the United States, Puerto Rico, and the U.S. Virgin Islands (http://nationalatlas.gov/mld/ecoregp.html). Import these shapefiles into Chapter5.gdb and assign the x,y coordinate system GCS NAD 1983. Classify ecoregions using unique values and the field DOMAIN. Create a definition query showing tornados with injuries greater than 500 with graduated symbols using the INJ field. Label tornados using the YEAR field. Save your map document and close ArcMap.

Assignment 5-1

Compare heating fuel types by US counties

The US Census collects data about the fuel used to heat houses in the United States. In this assignment, you explore where different fuel types are used throughout the country. To do so you download the American Community Survey data from 5-year estimates at the county level, clean and join two data tables together, and create a layout with two choropleth maps comparing fuel heating types in the country.

Get set up

- Rename the folder \EsriPress\GIST1\MyAssignments\Chapter5\Assignment5-1YourName\ to your name or student ID. Store all files that you produce for this assignment in this folder.
- Create a new map document called **Assignment5-1YourName.mxd** with relative paths.

Download and process data

Download American Community Survey data

- (http://factfinder2.census.gov). Click Topics > Housing > Physical Characteristic > Heating Fuel. Click Geographies > Geographic type County > All Counties within United States and add this to your selection. Use the search box to find tables B25040, select and download table B25040 (HOUSE HEATING FUEL) for 2010 5-year estimates and save it to your Assignment5-1YourName folder.
- In Excel, open ACS_10_5YR_B25040_with_ann.csv to clean up this data. The only attributes that you need are Id or Id2 and the heating fuel type fields. Rename these with logical names (for example, **TOTAL, UTIL_GAS, TANK_LP_GAS, ELECTRICITY, OIL_KEROSENE, COAL_COKE, WOOD, SOLAR, OTHER, NO_FUEL**). Prepare the Id or Id2 field to join to the GEOID10 fields in the USCounties feature class. Save the workbook as **HeatingFuel2010.xlsx**. Import the worksheet of the workbook into your file geodatabase as **CountyHeatingFuel2010**. Join this table to the USCounties attribute table.

Build the map

Create a new file geodatabase called **Assignment5-1YourName.gdb**. Import the following data into it:

- \EsriPress\GIST1\Data\UnitedStates.gdb\USCounties—polygon features of US counties: An attribute, GEOID10 is the county geocode in this table that you will join your downloaded table to. It has the text data type.
- \EsriPress\GIST1\Data\UnitedStates.gdb\USStates—polygon features of US States.
- You will import the worksheet of HeatingFuel2010.xlsx into your file geodatabase as **CountyHeatingFuel2010**.

5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
A5-1
A5-2

Requirements

- Create a layout that compares two attributes for alternative fuel types, SOLAR and WOOD.
- Use two data frames and two separate choropleth maps, one for each new attribute.
- Rename both data frames and map layers.
- Show USStates as a hollow fill, black outline 1.5, and label with a white halo using state abbreviations.
- Use the same projected coordinate system for both layouts, Continental > North America > USA_Contiguous_Albers_Equal_Area_Conic.
- Zoom to the 48 contiguous states at the same map scale.
- Use the map layer and table in your file geodatabase (and not the shapefile or Excel table).
- Use separate quantile classifications with no decimal places, and colors that you think are effective for each map.
- List the data source and the date that census data was collected in your layout.
- Click File > Export Map and save your map as **Assignment5-1YourName.jpg** with 150 dpi resolution.

Assignment 5-2

Create a map of Maricopa County, Arizona, voting districts, schools, and voting-age population using downloaded data and a web service image

Maricopa County, Arizona is one of the nation's fastest-growing areas with 3.2 million residents and 1.5 million registered voters. Suppose that Maricopa County officials plan to use GIS to ensure accurate voting boundaries, maintain voter lists, locate polling places, plan voting precincts, recruit poll workers, and deliver voting supplies. Trained analysts will use the GIS, so it needs much relevant detail.

In this assignment you focus on skills needed to download and prepare data from websites to use GIS. You download voting districts, streets, and census block groups for the purpose of building an interactive GIS to be used in selecting schools for use as polling sites. You clean the census data, join it to the block group features, and use it to display the spatial distribution of the voting-age population. Of course, the number of registered voters by block and estimates of voter turnout would be better than voting-age population, but it's not available. An x,y table that you download shows schools that are open and their locations.

Get set up

- Rename the folder \EsriPress\GIST1\MyAssignments\Chapter5\Assignment5-2YourName\ to your name or student ID. Store all files that you produce for this assignment in this folder.
- Create a new map document called **Assignment5-2YourName.mxd** with relative paths.
- Create a new file geodatabase called **Assignment5-2YourName.gdb**. Import the spatial data and tables you will download and process into it.

Download data

Download the following 2010 TIGER shapefiles for Maricopa County, Arizona:

- Block Groups—tl_2010_04013_bg10.shp (import as **MaricopaBlockGroups**)
- Voting Districts—tl_tl_2010_04013_vtd10.shp (import as **MaricopaVotingDistricts**)
- All lines—tl_2010_04013_edges.shp (process and import as instructed below)

From http://factfinder2.census.gov, download SF 1 2010 population by sex data for Maricopa County, Arizona block groups.

- Click the Geographies link, Name tab, and Geographic Type Block Group.
- Click the plus (+) sign beside Within State, click Arizona, click Within County, Maricopa. Select the check box for All Block Groups within Maricopa County, Arizona, and Add.

- Close the Select Geographies window and scroll the pages until you find the table P12 (Sex by Age 2010 SF1 100% Data). Download and extract the file **DEC_10_SF1_P12.csv**. Be patient. This may take a while.

From http://nces.ed.gov/ccd/ (National Center for Education Statistics), download school data for Maricopa County, Arizona. Use the following steps to download open schools in Maricopa County, Arizona:

- Click the Build a Table link, select **School** for Select Row Variable, click **2009-2010** for Select Years, click Next and I Agree.
- Under Select Columns select **Basic Information (X)**, and then click **School Name-by survey year (School) 2009-10** and **County Name (School) 2009-10**.
- Under Select Columns select **Contact Information**, and then click **Location Address (School) 2009-10**, **Location City (School) 2009-10**, and **Location ZIP (School) 2009-10**.
- Under Select Columns select **School/District Classification Information**, and then click **School Type-most recent year (School) Same All Years**, **Latitude (School) 2009-10**, and **Longitude (School) 2009-10**.
- Under Select Columns select Total Enrollment, and then click **Total Students (School) 2009-10**.
- Click Next.
- Under Row Variable, select **AZ - Arizona**. Under Other Filters, select **County Name (School)**.
- In the pop-up window called Column Filter Criteria, select **2009-10** for Select Years, type **Maricopa** for Column contains, and click Save Filter.
- You'll get a large red X with County Name (School) [2009-10] contains Maricopa, but that's in case you want to delete the filter. So just leave that alone and don't click it.
- Click View Table, click the Excel link > Download Excel File, save **NCES_Report_12345.xls** Note that the report name will vary.
- Click Close.

Process the data

The shapefile, tl_2010_04013_edges.shp, has all lines used to build census blocks including lines from streets, water features, railroads, and so forth. You need to extract streets from the shapefile, using its FEATCAT attribute, to create a new feature class, MaricopaStreets. Streets have the FEATCAT code value S, while railroad tracks have R, water (hydrology) features have H, and so forth.

- Add tl_2010_04013_edges features to a new map document. Use Selection, Select By Attributes, to build the query "FEATCAT" = 'S'. In the table of contents, right-click tl_2010_04013_edges, click Data > Export Data, change the Save as type to File and Personal Geodatabase feature classes, and save the selected lines as **MaricopaStreets** in Assignment5-2YourName.gdb.

- Open Excel and then open dc_dec DEC_10_SF1_P12.csv to clean up this data. The only attributes that you need are **Id** or **Id2** and **AGE18UP**, which you will have to create and compute from the individual age fields. The voting age in Arizona is 18. You can compute the AGE18UP column in Excel or in ArcGIS using the field calculator. If you compute in Excel be sure that the column contains the actual data and not an expression. Save the spreadsheet as **POP18UP.xlsx**. Import the worksheet of the spreadsheet into your file geodatabase as a table called **POP18UP**.
- Open NCES_Report.xls in Excel and ignore the warning message on opening. Clean the data by deleting extraneous rows and columns and renaming columns to reasonably short names without embedded blanks (use Latitude and Longitude for those two names).
- Click File, Save As, change the Save as type to CSV (MS-DOS), type the File name as **MaricopaSchools.csv**. Note that saving the data as a CSV file gets rid of some troublesome text formatting of Latitude and Longitude so that ArcMap will import the columns as numbers.
- Import MaricopaSchools.csv into your file geodatabase as a table called **MaricopaSchools**

Requirements

- Add the census features to your map document and symbolize voting districts as a hollow fill, black outline, width 1.50 and streets as medium gray (40%).
- Join the table POP18UP to the block group layer and symbolize as a choropleth map, which represents the demand for voter registration facilities. Use a logical mathematical progression.
- Add MaricopaSchools as an x,y table using GCS_North_American_1983 (NAD*1983.prj) coordinates.
- Create a definition query so that only open schools are included (assuming enrollment over zero implies that a school is open) and export these points as a feature class called **MaricopaSchoolsOpen** in your file geodatabase.
- Symbolize schools using size-graduated point markers for total number of students (enrollment). ***Hint:*** An equal interval scale works well here.
- Use visible scale ranges to display detailed layers (streets and schools) when zoomed in below a scale of 1:50,000. Display block groups when zoomed in below a scale of 1:100,000. Display voting districts at all scales. Label voting districts and schools, but not streets or block groups. This provides a tool for analyzing potential voting places.
- Zoom to Tempe voting district 10, and then zoom out to a scale of 1:20,000. Create a bookmark called **SampleTempeVotingDistricts**.
- From the Esri web service, add basemap imagery with labels. Turn off the block group layer and export your zoomed bookmark area as an image called **Assignment5-2YourName.jpg**.