

Mapping Census 2000 with ArcGIS

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This *ArcUser* exercise shows how to create four maps in ArcGIS that replicate summary maps for the entire population of the United States presented in Section 1 of *Mapping Census 2000: The Geography of U.S. Diversity* by Cynthia A. Brewer and Trudy A. Suchan. This atlas, published by ESRI Press, showcases maps prepared using ArcGIS and provides a riveting portrait of the country.

Before actually working with data in ArcMap, you will visit the U.S. Census Web site (www.census.gov), explore the extensive data available on this site, and download a summary table. The maps created in the exercise use data on counties provided with ArcGIS that will be joined to a DBF file containing data from the 2000 census. Fields from joined attribute and census data tables will be used to calculate values for a new field. This data will be used to thematically map different population characteristics. Although this exercise was designed for ArcGIS 8.1, similar maps can be created using ArcView 3.x.

What You Will Need

- ArcGIS 8.1 Desktop (ArcInfo, ArcEditor, or ArcView license)
- An Internet browser and connection
- Sample data from the *ArcUser* Online Web site
- WinZip or a similar unzipping utility

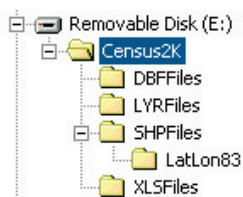
In addition to these required items, Microsoft Excel is helpful because data available from the U.S. Census Web site is provided in this format. The book, *Mapping Census 2000: The Geography of U.S. Diversity* (see page 45), can also serve as a useful reference for finished maps and a source of inspiration for other thematic legends and

Figure 1

Download the zipped file containing the sample data for this exercise from the

ArcUser Online

Web site. Once downloaded, double-click on the file to extract it. It should create the directory structure shown here.



display maps.

Download the zipped file containing the sample data for this exercise from the *ArcUser* Online Web site. Once downloaded, use WinZip or a similar utility to extract the files. The archive should create the directory structure shown in Figure 1.

Visiting the Census Web Site

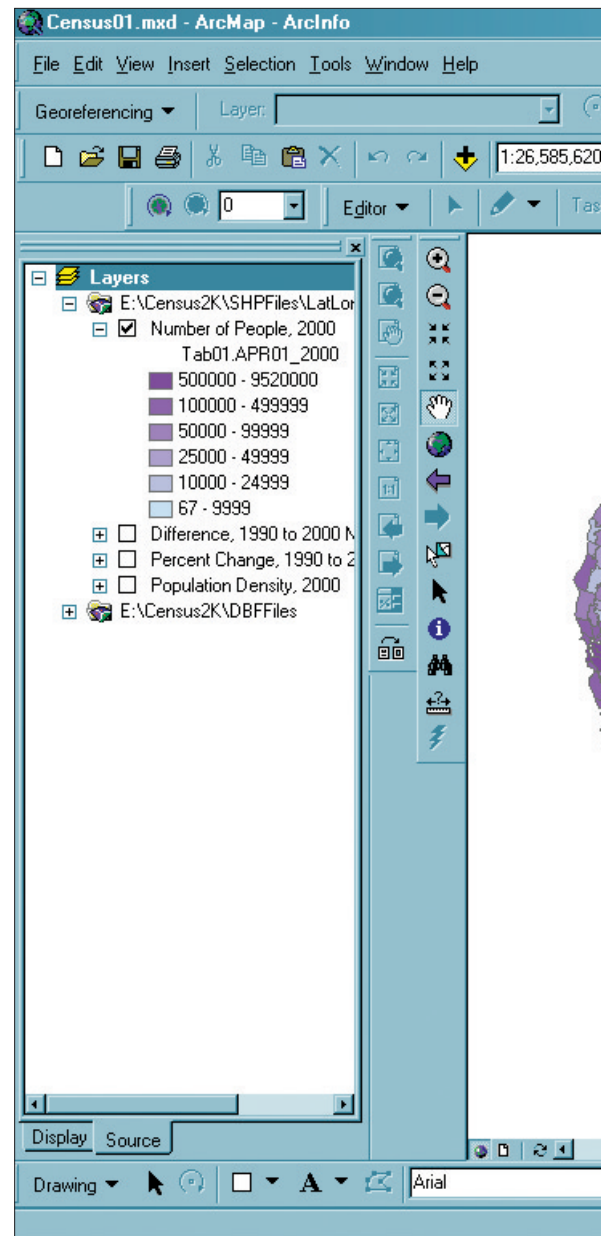
Before working with the sample data, visit the U.S. Census Web site (www.census.gov) to explore the available data. Once at the Census home page, look at the navigation located on the left side of the page and click on the People selection, located below the Census 2000 logo and above the link to Business data. This page lists the information about people and populations available from the site. Select the Search option, located in the upper left corner of the People page, and type the text string “Ranking Tables for Counties” into the search box. Click Search.

This search should return several population and housing tables. Look for Ranking Tables for Counties (PCH-T-4). PCH-T tables supplement information available through the Census Bureau’s American FactFinder (www.factfinder.census.gov). PCH-T-4 includes four statistical tables that sort counties alphabetically and by 2000 population. These tables also include calculations of numeric population change and percent change between 1990 and 2000. Click on the PCH-T-4 link to access the data.

The next screen lists four tables available in Excel, PDF, and ASCII format. Since Table 1 contains all necessary information to show population change by county, select it. If Excel is installed on your computer, select the Excel dataset (424 K) and wait for it to open the browser window. If you don’t have Excel, skip the next section, “Examining the Table in Excel.” Don’t worry—a dBASE table containing the same information has been included with the sample data for the exercise.

Examining the Table in Excel

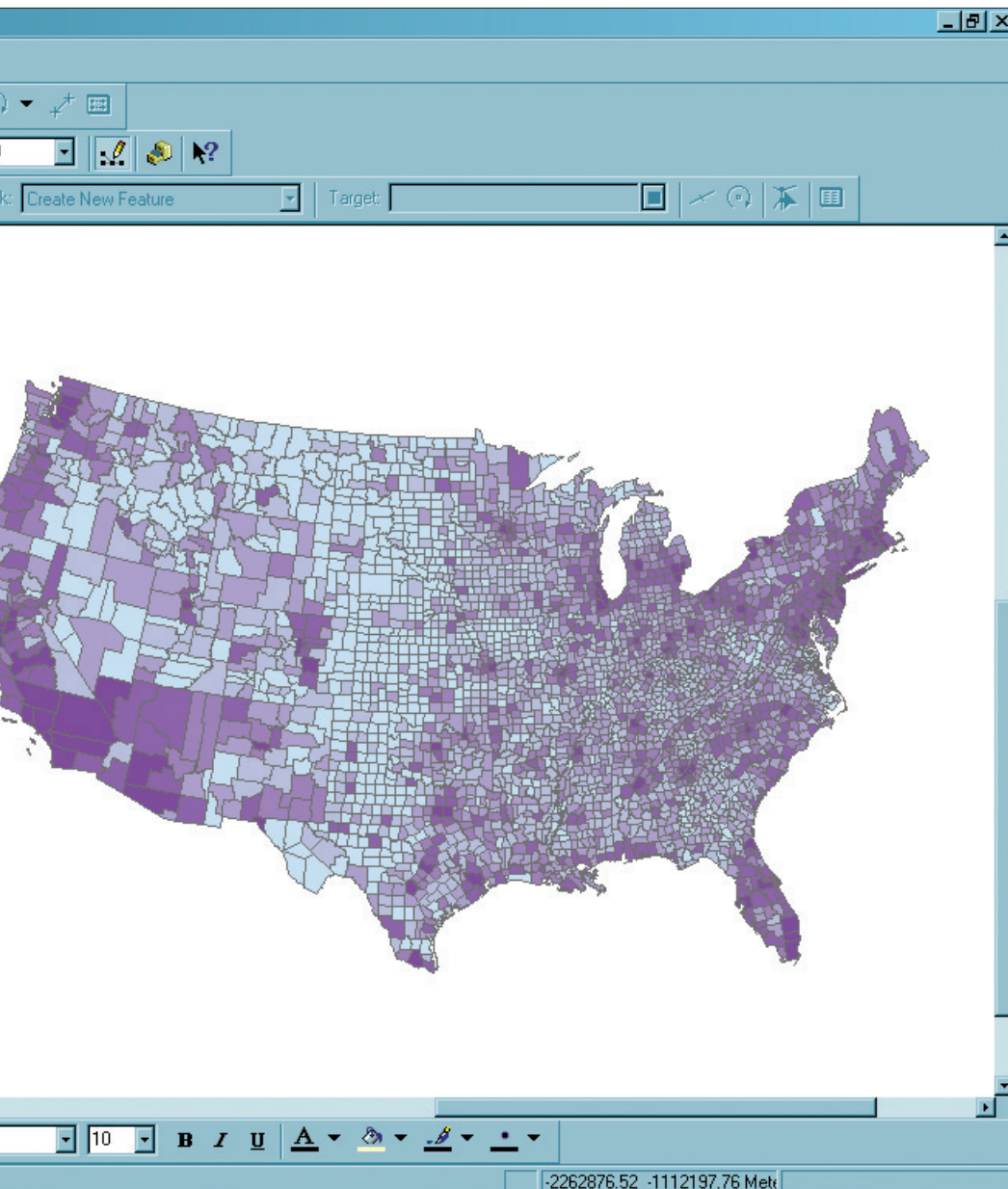
With the Excel file open in the browser window, choose File > Save As from the menu and save



the data locally to the Census2K\XLSFiles sub-directory. Name the file Tab01raw.xls. Close the browser and open Tab01raw.xls in Excel. Notice that actual data begins in cell A15 and extends to cell G3155. Sort on columns such as Change-Number and Change-Percent. Sort on the Federal Information Processing Standard (FIPS) code field. The FIPS code will be very useful for joining this table to county polygons later in this exercise.

Using the Sample Data

Several different procedures can be used to open Tab01raw.xls in ArcGIS. An entire training session could easily be devoted to covering the procedures used to mine tabular data stored in Excel files. To simplify this exercise, the pertinent data was extracted into a dBASE file, prepared for immediate use, and placed in the DBFFiles folder that was created when the sample data was downloaded and extracted. Also included in the sample dataset is a simplified version of Counties.shp that ships with ArcGIS.



Number of People, 2000

Follow the step-by-step directions in the article to adjust the classification and color ramp for the “Number of People, 2000” map. Table 2 lists the value field and number of classes for the other maps. Use the same procedure and the color values and class break values supplied in the tables accompanying each map in this series.

From ArcCatalog, use the Launch ArcMap button to start an ArcMap session. Size the windows so both applications are accessible. Drag Counties.shp from ArcCatalog to ArcMap. Return to ArcCatalog and open the DBFFiles folder and select Tab01.dbf. Preview the table and verify that it contains the same data contained in the Excel spreadsheet downloaded from the Census site. This file contains 3,141 records, one for each county in Counties.shp. The ST_CO_FIPS field is an alphanumeric concatenation of the two-character State code (STATE_FIPS) and the three-character County code (CNTY_FIPS) that will be useful as a key field. Drag Tab01.dbf from ArcCatalog to the ArcMap Table of Contents. The Table of Contents changes from the Display to the Source tab. Close ArcCatalog.

Joining Census Data to Counties.shp

To add the Census 2000 data in Tab01.dbf to the Counties shapefile, join it to the shapefile attribute table.

1. Right-click on the Counties file in the Table of Contents and choose Joins and Relates > Join from the context menu.
2. In the Join dialog box, keep Join Attributes from a Table as a default.
3. Specify ST_CO_FIPS as the Counties field used to create the join. Choose Tab01.dbf as the table to join to and ST_CO_FIPS as the joining field.
4. Click OK. Open the Counties attribute table. Verify that the join was built. The fields added will have the prefix Tab01.
5. If so, save this ArcMap document in the Census2K directory as Census01.mxd.

Copying Layers to Save Time

With the Census 2000 county data joined to Counties.shp, the next step will be thematically mapping this data to replicate four maps, listed below, that are found in *Mapping Census 2000: The Geography of U.S. Diversity*.

- Number of People, 2000 (page 11)
- Difference, 1990 to 2000 Number of People (page 10)

Continued on page 42

Setting Up the Project

Open ArcCatalog and navigate to the sample data that was extracted into the Census2K folder. In Census2K, open the SHPFiles folder, then the LanLon83 folder; locate Counties.shp; and select it. Use the ArcCatalog Preview tab to display the data both as a geography set and a table. The table should contain 3,141

records. Many fields from the original shapefile have been removed and one field, filled with zeroes, has been added. This new field will be used to calculate population density values for one of the maps. Click on the Spatial Metadata tab and verify that the data is in a geographic coordinate system that uses the North American Datum of 1983 (NAD83).

Table 1: New Break Values for Number of People, 2000

Default Value	New Value
136364	9999
472822	24999
1131184	49999
2465326	99999
5376741	499999
9519338	9520000

Mapping Census 2000 with ArcGIS

Continued from page 41

- Percent Change, 1990 to 2000 Total Population (page 6)
- Population Density, 2000 (page 7)

The first three maps can be created directly from the joined census table. The fourth requires calculating values for a field. To begin thematic mapping, make three copies of the modified Counties.shp. Joining the census data to Counties.shp, then copying and renaming it is more efficient than copying and renaming the layer and making three table joins.

1. Right-click on Counties.shp in the Table of Contents. Choose Copy from the context menu.
2. Right-click on Layers at the top of the Table of Contents and choose Paste Layer from the context menu.
3. Paste two more copies of Counties.shp in the same way for a total of four copies.
4. Right-click on the first copy of Counties.shp. Choose Properties from the context menu. In the Properties dialog box, click on the General tab, and change Layer Name to Number of People, 2000. Use the same procedure to rename the other three copies of Counties.shp to Difference, 1990 to 2000 Number of People; Percent Change, 1990 to 2000 Total Population; and Population Density, 2000.
5. Save the project. Zoom the display to the continental United States.

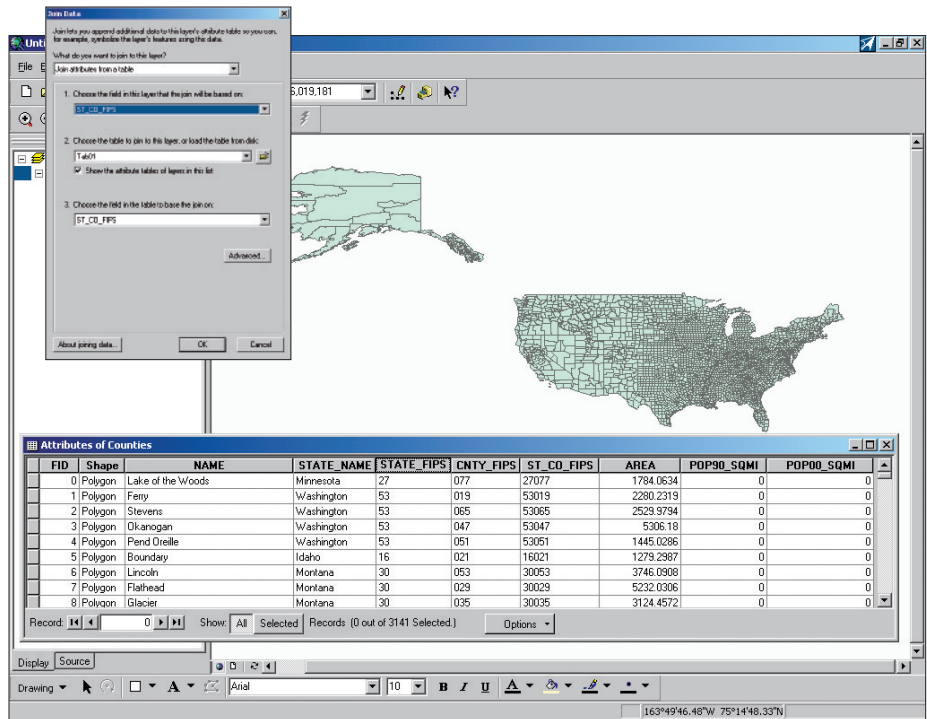
Displaying Data in a Conic Projection

To approximate the conic projection applied to maps in *Mapping Census 2000: The Geography of U.S. Diversity* requires modifying the way ArcMap displays layers in the data frame. Changing the coordinate system used to display data in a data frame does not alter the coordinate system of the source data.

1. Right-click on Layers in the Table of Contents and choose Properties from the context menu.
2. In the Properties dialog box, click on the Coordinate System tab. Choosing a predefined projection requires drilling down through a series of folders—Predefined > Projected Coordinate Systems > Continental > North American—to select North American Lambert Conformal Conic.
3. Click OK and zoom to the continental United States.
4. Save the file.

Calculating Population Density

The last task before thematically mapping these layers is calculating population density in units of people per square mile. This procedure will perform the calculation outside an editing session to speed the process. This means that edits cannot be undone. However,



To add the Census 2000 data in Tab01.dbf to the Counties shapefile, join it to the shapefile attribute table using ST_CO_FIPS as the key field.

in many cases, it is advisable to perform table edits only inside an editing session.

1. Right-click on the Population Density, 2000 layer and choose Open Attribute Table from the context menu.
2. In the attribute table, scroll to the right and locate the field called Counties.POP00_QSMI.
3. Click on the field name at the top of the column to select the entire field.
4. Right-click on the field name and choose Calculate Values from the context menu. Click on Yes in the message box warning that calculations will be made outside an editing session.
5. In the Field Calculator, click in the field and operator windows to build the expression [Tab01.APR01_1990]/[Counties.AREA].
6. Make sure this expression has been typed correctly. Click OK. The new values for the Counties.POP00_QSMI will be calculated.
7. Save the map.

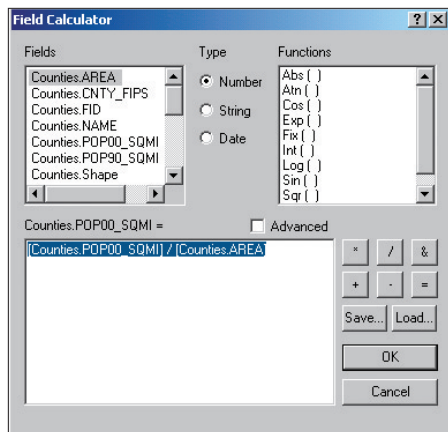
Setting the Color Ramp

Quantities graduated color legends will be created for each of the maps. The methodology used for creating the Number of People, 2000 map can be applied to the other three maps.

1. Turn off all datasets. Turn on the Number of People, 2000 layer and right-click on it.
2. In the context menu, choose Properties. In the Layer Properties dialog box, click on the Symbology tab.
3. Click on Quantities in the left-hand text box

to draw quantities using color to show values and select graduated colors as the method.

4. In the Fields section, choose Tab01.APR01_2000 as the Value. In the Classification section, change the number of classes to 6.
 5. In the color ramp section, left-click on the field heading for Symbol and choose Flip Symbols from the context menu. In the same section, left-click on the Range heading and choose Reverse Sorting. Click Apply and OK.
 6. In the Table of Contents, left-click on color for the top value range to invoke the color palette. Click on a dark purple color called Blackberry to apply it.
 7. Left-click on the color for the last value range. In the color palette, click on Sodalite Blue. Right-click on the color box that now contains Sodalite Blue and click on the More Colors button on the bottom of the dialog box.
 8. In the Color Selector dialog, set the sliders to the following values or simply type the values into the appropriate text box—Red (204), Green (219), Blue (240).
 9. Click OK when done.
 10. Left-click on the Number of People, 2000 layer; choose Properties from the context menu and click on the Symbology tab. In the Color Ramp section, left-click on Symbols and choose Ramp Colors from the context menu.
 11. Save the Map.
- ArcMap will create the colors between the darkest and lightest values that were manu-



Use the Field Calculator to generate population density values.

ally created. These colors displayed on screen will only approximate the printed version of this map found in *Mapping Census 2000: The Geography of U.S. Diversity*. Printed (CMYK) and screen (RGB) colors belong to different color spaces and do not directly correlate.

Improving the Classification

Cartographers employ classification strategies that take into account knowledge of the data

and the map topic. The default classification method, natural breaks, does not best represent the data in this map and the other maps in this series. The class breaks that will be applied to this map and the other maps in this exercise are the same ones developed by cartographers and used in *Mapping Census 2000: The Geography of U.S. Diversity*.

1. Right-click on the Number of People, 2000 layer and choose Properties from the context menu.

2. In the Layer Properties dialog box, click on

the Symbology tab.

3. Click on the Classify button.

In the Classification dialog box, go to the Break Values section and locate the **lowest** value range and select it. Type 9999 as the new break value. Continue to replace default break values with more meaningful values as shown in Table 1. **Be sure to work from lowest to highest values.**

Use this procedure and information on break values and color ramping contained in Tables 2 through 6 to make the Difference,

Continued on page 44

Table 2: Value Fields and Number of Classifications

Map Name	Value Field	No. of Classes
Difference, 1990 to 2000 Number of People	Tab01.POP_CHANGE	6
Percent Change, 1990 to 2000 Total Population	Tab01.PERCENT	6
Population Density, 2000	POP00_QSMI	7

Mapping Census 2000 with ArcGIS

Continued from page 43

Difference, 1990–2000 Number of People

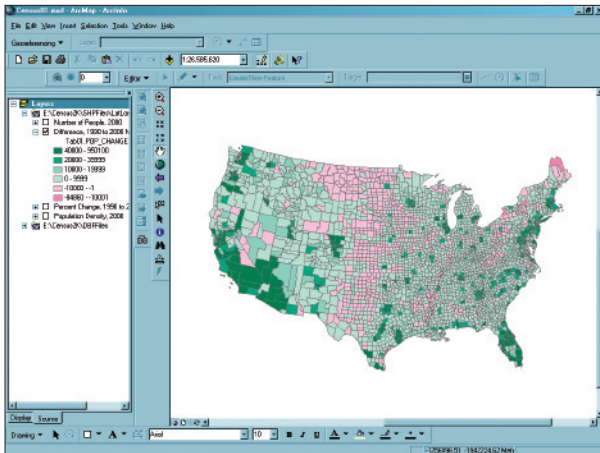


Table 3: Difference, 1990 to 2000 Number of People

Color	Default Break Value	New Break Value
Peacock Green	950048	951100
Malachite Green	435733	39999
Turquoise Dust	207537	19999
Indicolite Green	88626	9999
Rhodolite Rose	24937	-1
Medium Fushia	-26826	-10.1

1990 to 2000 Number of People; Percent Change, 1990 to 2000 Total Population; and Population Density, 2000 maps. When creating legends, predefined and named colors from the ArcMap palette were used when possible. Non-named (i.e., custom colors) are specified by the RGB values that are entered in the Color Selector in the same fashion used when modifying Sodalite Blue in the first map. *When changing the break values for the classification ranges, be sure to start with the smallest value and work to the largest value and include a minus sign for all negative values.*

Summary

Census 2000 data, joined to sample data that comes with ArcGIS, can be used to create four interesting maps that show current population characteristics and changes in the total population between 1990 and 2000. Additional data obtained from the Census Web site can be mapped in a similar fashion. *Mapping Census 2000: The Geography of U.S. Diversity* can be purchased online at the GIS Store at www.esri.com/gisstore. **AD**

Here are some suggestions for further exploration of the maps created in this tutorial.

- Display the joined attribute data and experiment by sorting data on different fields.
- Which county had the largest population in 2000? Which one did in 1990?
- Which county gained the most total population?
- Which county shows the greatest percent gain or loss between 1990 and 2000?
- Which part of the country appears to have grown the fastest?
- Which areas have lost population over the last 10 years?
- Look at population statistics in and around your county.

Percent Change, 1990–2000 Total Population

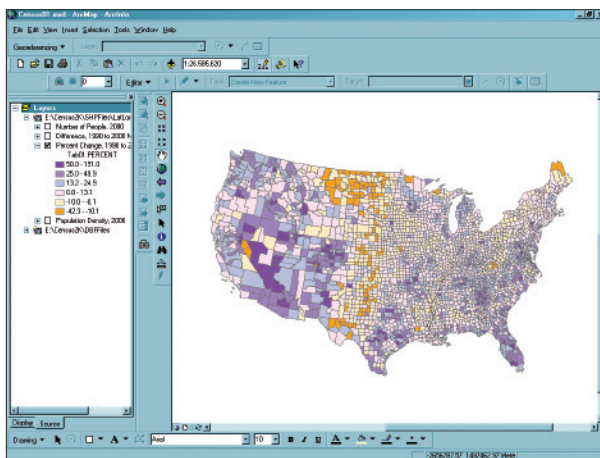


Table 4: Percent Change, 1990 to 2000 Total Population

Color	Default Break Value	New Break Value
Dark Navy Blue	65274.59	66940.0
Ultra Blue	38478.50	2999.9
Delft Blue	18532.66	299.9
Malachite Green	8614.54	159.9
Sage Dust	3889.34	79.5
Tzavorite Green	1726.72	6.9
237-252-240	502.44	0.9

Population Density, 2000

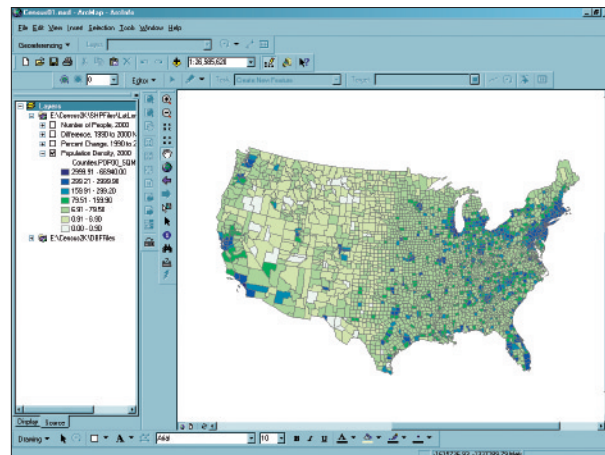


Table 5: Population Density, 2000

Color	Default Break Value	New Break Value
Blackberry	191.0	191.0
148-123-176	63.4	49.9
184-184-217	35.6	24.9
255-222-255	18.9	13.1
Topaz Sand	7.1	-0.1
Seville Orange	-3.7	-10.1

Census 2000 in Context


Every 10 years, the United States Census Bureau, part of the United States Department of Commerce, carefully counts the population of the United States. The decennial census is mandated in Article 1, Section 2 of the Constitution.

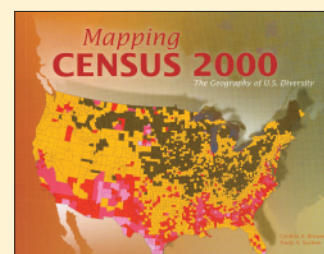
The first national census, conducted in 1790, showed a population of 3.9 million. Since that time, the geographic extent of the census has grown as new states and territories have been added. Not only has the population grown, but—in the interest of learning more about the population of this increasingly complex nation—the type of information collected has also expanded. This additional information was necessary to help

understand the changing characteristics of the population. To provide a basis for planning, statistics were applied to census data.

The primary purpose of the census is to secure general statistical information so the election of members of the House of Representatives is based fairly on population. In December 1975, Congress passed Public Law 94-171, requiring the Census Bureau to send each state data that can be used to redraw federal, state, and local legislative districts within one year of Census Day (i.e., April 1 in a census year).

Census 2000 represents the largest collection of spatially referenced data ever collected

in the United States. For the past two years, the Census Bureau has been interpreting, mapping, and posting the information generated by the census. Census datasets cover a wide variety of topics, and summary data is available online from the Census Bureau's Web site (www.census.gov) and its American FactFinder database (factfinder.census.gov). New datasets will continue to be released. Visit the Census 2000 Data Products at a Glance Web page (www.census.gov/population/www/censusdata/c2kproducts.html) for information on currently available data and planned releases. For more information about the history of the census, visit www.census.gov/acsd/www/history.html and www.usconstitution.net/consttop_cens.html. 



Census Atlas

Mapping Census 2000: The Geography of U.S. Diversity is an atlas of the American people that presents key data from Census 2000. Using GIS software from ESRI, cartographers Cynthia A. Brewer, associate professor of geography at Pennsylvania State University, and Trudy A. Suchan, a geographer with the Population Division of the United States Census Bureau, have created maps that illustrate American diversity in rich and vivid detail.

The nearly 100 maps in the atlas feature county-level information for all 50 states, the District of Columbia, and Puerto Rico. Each map also includes a state-level inset map, giving a simplified view of the population theme. The first section of the book contains maps showing the total population and overall diversity. The remaining three sections provide maps of racial and ethnic groups. Census 2000 provided new and expanded categories for racial and ethnic identity. Also, for the first time, residents could choose more than one ethnic category, resulting in a new and more accurate portrait of the population. These changes in census data collection make this atlas of America notable for its comprehensiveness and precision. This book is available online from the GIS Store (www.esri.com/gisstore). 