

- What are the advantages and disadvantages of each labeling method?
14. Figure 9.17 shows a layout template available in ArcMap for the conterminous USA. Will you consider using the layout template for future projects? Why, or why not?
 15. What is visual hierarchy in map design? How is the hierarchy related to the map purpose?
 16. Figure 9.19 shows an example of using interposition in map design. Does the map achieve the intended 3-D effect?
 17. What is subdivisional organization in map design? Can you think of an example, other than the climate map example in Chapter 9, to which you can apply the principle?
 18. Explain why color symbols from a color printer do not exactly match those on the computer screen.
 19. Define the RGB and CMYK color models.

APPLICATIONS: DATA DISPLAY AND CARTOGRAPHY

This applications section consists of three tasks. Task 1 guides you through the process of making a choropleth map. Task 2 introduces cartographic representations and lets you experiment with text labeling and highway shield symbols. Task 3 focuses on the placement of text. Because a layout in ArcMap will include all data frames, you must exit ArcMap at the end of each task to preserve the layout design. Making maps for presentation can be tedious. You must be patient and willing to experiment.

Task 1: Make a Choropleth Map

What you need: *us.shp*, a shapefile showing population change by state in the United States between 1990 and 2000. The shapefile is projected onto the Albers equal-area conic projection and is measured in meters.

Choropleth maps display statistics by administrative unit. For Task 1 you will map the rate of population change between 1990 and 2000 by state. The map consists of the following elements: a map of the conterminous United States and a scale bar, a map of Alaska and a scale bar, a map of Hawaii and a scale bar, a title, a legend, a north arrow, a data source statement, a map projection statement, and a neatline around all elements. The basic layout of the map is as follows: The map page is 11" (width) × 8.5" (height), or letter size, with a landscape orientation. One-third of the map on the left, from top to bottom, has the title, map of Alaska, and map of

Hawaii. Two-thirds of the map on the right, from top to bottom, has the map of the conterminous United States and all the other elements.

1. Start ArcCatalog, and connect to the Chapter 9 database. Launch ArcMap. Maximize the view window of ArcMap. Add *us.shp* to the new data frame, and rename the data frame Conterminous. Zoom in on the lower 48 states.
 2. This step symbolizes the rate of population change by state. Right-click *us* and select Properties. On the Symbology tab, click Quantities and select Graduated colors. Click the Value dropdown arrow and choose ZCHANGE (rate of population change from 1990 to 2000). Cartographers recommend the use of round numbers and logical breaks such as 0 in data classification. Click the first cell under Range and enter 0. The new range should read $-5.7-0.0$. Enter 10, 20, and 30 for the next three cells, and click the empty space below the cells to unselect. Next, change the color scheme for ZCHANGE. Right-click the Color Ramp box and uncheck Graphic View. Click the dropdown arrow and choose Yellow to Green to Dark Blue. The first class from -5.7 to 0.0 is shown in yellow, and the other classes are shown in green to dark blue. Click OK to dismiss the Layer Properties dialog.
- Q1.** How many records in *us.shp* have $ZCHANGE < 0$?

3. The Alaska map is next. Insert a new data frame and rename it Alaska. Add *us.shp* to Alaska. Zoom in on Alaska. Follow the same procedure as in Step 2, or click the Import button on the Symbology tab in the Layer Properties dialog, to display ZCHANGE.
 4. The Hawaii map is next. Select Data Frame from the Insert menu. Rename the new data frame Hawaii. Add *us.shp* to Hawaii. Zoom in on Hawaii. Display the map with ZCHANGE.
 5. The table of contents in ArcMap now has three data frames: Conterminous, Alaska, and Hawaii. Select Layout View from the View menu. Click the Zoom Whole Page button. Select Page and Print Setup from the File menu. Check Landscape for the page orientation, uncheck the box for Use Printer Paper Settings, set the page size to be 11.0" × 8.5", and click OK.
 6. The three data frames are stacked up on the layout. You will rearrange the data frames according to the basic layout plan. Click the Select Elements button. Click the Conterminous data frame. Use the handles around the data frame to move and adjust the data frame so that it occupies about two-thirds of the layout in both width and height on the upper-right side of the layout. Click the Alaska data frame, and move it to the center left of the layout. Click the Hawaii data frame, and place it below the Alaska data frame.
 7. Now you will add a scale bar to each data frame. Begin with the Conterminous data frame by clicking on it. Select Scale Bar from the Insert menu. Click the selection of Alternating Scale Bar 1, and then Properties. The Scale Bar dialog has three tabs: Scale and Units, Numbers and Marks, and Format. On the Scale and Units tab, start with the middle part of the dialog: select Adjust width when resizing, choose Kilometers for division units, and enter km for the label. Now work with the upper half of the dialog: enter 1000 (km) for the division value, select 2 for the number of divisions, select 0 for the number of subdivisions, and opt not to show one division before zero. On the Numbers and Marks tab, select divisions from the frequency dropdown list and Above bar from the position dropdown list. On the Format tab, select Times New Roman from the font dropdown list. Click OK to dismiss the dialogs. The scale bar appears in the map with the handles. Move the scale bar to the lower-left corner of the Conterminous data frame. The scale bar should have the divisions of 1000 and 2000 kilometers. (You can set Zoom Control on the Layout toolbar at 100% and then use the Pan tool to check the scale bar.) Separate scale bars are needed for the other two data frames. Click the Alaska data frame. Add its scale bar by using 500 kilometers for the division value. Click the Hawaii data frame. Add its scale bar by using 100 kilometers for the division value.
- Q2. Explain in your own words the number of divisions and the number of subdivisions on a scale bar.
 - Q3. In Step 7, you have chosen the option of "Adjust width when resizing." What does this option mean?
8. So far, you have completed the data frames of the map. The map must also have the title, legend, and other elements. Select Title from the Insert menu. An Enter Map Title box appears on the layout. Click outside the box. When the outline of the box is shown in cyan, double-click it. A Properties dialog appears with two tabs. On the Text tab, enter two lines in the text box: "Population Change" in the first line, and "by State, 1990–2000" in the second line. Click Change Symbol. The Symbol Selector dialog lets you choose color, font, size, and style. Select black, Bookman Old Style (or another serif type), 20, and B (bold) respectively. Click OK to dismiss the dialogs. Move the title to the upper left of the layout above the Alaska data frame.

9. The legend is next. Because all three data frames use the same legend, it does not matter which data frame is used. Click ZCHANGE of the active data frame, and click it one more time so that ZCHANGE is highlighted in a box. Delete ZCHANGE. (Unless ZCHANGE is removed in the table of contents, it will show up in the layout as a confusing legend descriptor.) Select Legend from the Insert menu. The Legend Wizard uses five panels. In the first panel, make sure *us* is the layer to be included in the legend. The second panel lets you enter the legend title and its type design. Delete Legend in the Legend Title box, and enter “Rate of Population Change (%)” Then choose 14 for the size, choose Times New Roman for the font, and uncheck B (Bold). Skip the third and fourth panels, and click Finish in the fifth panel. Move the legend to the right of the Hawaii data frame.
 10. A north arrow is next. Select North Arrow from the Insert menu. Choose ESRI North 6, a simple north arrow from the selector, and click OK. Move the north arrow to the upper right of the legend.
 11. Next is the data source. Select Text from the Insert menu. An Enter Text box appears on the layout. Click outside the box. When the outline of the box is shown in cyan, double-click it. A Properties dialog appears with two tabs. On the Text tab, enter “Data Source: US Census 2000” in the Text box. Click on Change Symbol. Select Times New Roman for the font and 14 for the size. Click OK in both dialogs. Move the data source statement below the north arrow in the lower right of the layout.
 12. Follow the same procedure as for the data source to add a text statement about the map projection. Enter “Albers Equal-Area Conic Projection” in the text box, and change the symbol to Times New Roman with a size of 10. Move the projection statement below the data source.
 13. Finally, add a neatline to the layout. Select Neatline from the Insert menu. Check to place inside margins, select Double, Graded from the Border dropdown list, and select Sand from the Background dropdown list. Click OK.
 14. The layout is now complete. If you want to rearrange a map element, select the element and then move it to a new location. You can also enlarge or reduce a map element by using its handles or properties.
 15. If your PC is connected to a color printer, you can print the map directly by selecting Print in the File menu. There are two other options on the File menu: save the map as an ArcMap document, or export the map as a graphic file (e.g., EPS, JPEG, TIFF, PDF, etc.). Exit ArcMap.
- Q4.** In Task 1, why did you have to prepare three data frames (i.e., Conterminous, Alaska, and Hawaii)?

Task 2: Use Graduated Symbols, Line Symbols, Highway Shield Symbols, and Text Symbols

What you need: *Task2.mdb* with three feature classes: *idlcity*, showing the 10 largest cities in Idaho; *idhwy*, showing interstate and U.S. highways in Idaho; and *idoutl*, containing the outline of Idaho.

Task 2 introduces cartographic representations for symbolizing *idoutl* and *idhwy*. Because cartographic representations require the use of an ArcEditor or ArcInfo license, separate instructions are provided for ArcView users. Task 2 also lets you experiment with text labeling and highway shield symbols.

1. Make sure that ArcCatalog is still connected to the Chapter 9 database. Launch ArcMap. Rename the data frame Task 2, and add *idlcity*, *idhwy*, and *idoutl* from *Task 2.mdb* to Task 2. Select Page and Print Setup from the File menu. Make sure that the page has a width of 8.5 (inches), a height of 11 (inches), and a portrait orientation.

2. Select the properties of *idoutl*. The Symbology tab has Representations in the Show list. Click Representations. The cartographic representation has only one rule, which consists of one stroke (squiggle) symbol layer and one fill symbol layer. Click the stroke symbol layer. This is an outline symbol in black with a width of 0.4 (point). Click the fill symbol layer. This is a fill symbol in gray. The cartographic representation therefore displays *idoutl* in gray with a thin black outline. Click OK. (For ArcView users, click the symbol for *idoutl* in the table of contents. Select gray for the fill color and black with a width of 0.4 for the outline.)
3. Select Properties from the context menu of *idhwy*. Click on Representations in the Show list. The cartographic representation has two rules, one for Interstate and the other for U.S. Click Rule 1; rule 1 consists of two stroke symbol layers. Click the first stroke symbol layer, which shows a red line symbol with a width of 2.6. Click the second stroke symbol layer, which shows black line symbol with a width of 3.4. The superimposition of the two line symbols result in a red line symbol with a black casing for the interstate highways. Click Rule 2; rule 2 consists of one stroke symbol layer, which shows a red line symbol with a width of 2. Click OK. (For ArcView users, symbolize *idhwy* as follows. On the Symbology tab, select Categories and Unique values for the show option and select ROUTE_DESC from the Value Field dropdown list. Click Add All Values at the bottom. Interstate and U.S. appear as the values. Uncheck all other values. Double-click the Symbol next to Interstate and select the Freeway symbol in the Symbol Selector box. Double-click the Symbol next to U.S. Select the Major Road symbol but change its color to Mars Red. Click OK in both dialogs.)
4. Select Properties from the context menu of *idlcity*. On the Symbology tab, select the show option of Quantities and Graduated Symbols and select POPULATION for the Value field. Next change the number of classes from 5 to 3. Change the Range values by entering 28000 in the first class and 46000 in the second class. Change the labels to read 14302–28000, 28001–46000, and 46001–125659. Click Template, and choose Solar Yellow for the color.
5. Labeling the cities is next. Click the View menu, point to Toolbars, and check Labeling to open the Labeling toolbar. Click the Label Manager button on the Labeling toolbar. In the Label Manager dialog, click *idlcity* in the Label Classes frame and click the Add button in the Add label classes from symbology categories frame. Click Yes to overwrite the existing labeling classes. Expand *idlcity* in the Label Classes frame. You should see the three label classes by population.
6. Click the first label class of *idlcity* (14302–28000). Make sure that the label field is CITY_NAME. Select Century Gothic (or another sans serif type) and 10 (size) for the text symbol. Click the SQL Query button. Change the first part of the query expression from “POPULATION” > 14302 to “POPULATION” >= 14302. Unless the change is made, the label for the city with the population of 14302 (Rexburg) will not appear. Click the second label class (28001–46000). Select Century Gothic and 12 for the text symbol. Click the third label class (46001–125659). Select Century Gothic, 12, and B (bold) for the text symbol. Make sure that *idlcity* is checked in the Label Classes frame. Click OK to dismiss the dialog.
7. All city names should now appear in the map, but it is difficult to judge the quality of labeling in Data View. You must switch to Layout View to see how the labels will appear on a plot. Select Layout View from the View menu. Select 100% from the Zoom Control list on the Layout toolbar. Use the Pan tool to see how the labels will appear on an 8.5-by-11-inch plot.

8. All labels except Nampa are well placed. But to alter the label position of Nampa, you have to convert labels to annotation. Right-click *idlcity* and check Convert Labels to Annotation. In the next dialog, select to store annotation in the map, rather than in the database. Click Convert. To move the label for Nampa, click the Select Elements tool on the standard toolbar, click Nampa to select it, and then move the label to below its point symbol. (Nampa is between Boise and Caldwell. You can also use the Identify tool to check which city is Nampa.)
9. The last part of this task is to label the interstates and U.S. highways with the highway shield symbols. Switch to Data View. Right-click *idhwy*, and select Properties. On the Labels tab, make sure that the Label Field is MINORI, which lists the highway number. Then click Symbol, select the U.S. Interstate HWY shield from the Category list, and dismiss the Symbol Selector dialog. Click Placement Properties in the Layer Properties dialog. On the Placement tab, check Horizontal for the orientation. Click OK to dismiss the dialogs. You are ready to plot the interstate shield symbols. Click the New Text (A) dropdown arrow on the Drawing toolbar and choose the Label tool. Opt to place label at position clicked. Move the Label tool over an interstate in the map, and click a point to add the label at its location. (The highway number may vary along the same interstate because the interstate has multiple numbers such as 90 and 10, or 80 and 30.)
10. Follow the same procedure as in Step 9 but use the U.S. Route HWY shield to label U.S. highways. Switch to Layout View and make sure that the highway shield symbols are labeled appropriately. Because you have placed the highway shield symbols interactively, these symbols can be individually adjusted.
11. To complete the layout, you must add the title, legend, and other map elements. Switch to the layout view. Start with the title. Select Title from the Insert menu. When Enter Map Title appears in a box, click outside the box. When the outline of the box is shown in cyan, double-click it. On the Text tab of the Properties dialog, enter “Idaho Cities and Highways” in the text box. Click Change Symbol. Select Bookman Old Style (or another serif type), 24, and B for the text symbol. Move the title to the upper right of the layout.
12. Next is the legend. But before plotting the legend, you want to remove the layer names of *idlcity* and *idhwy*. Click *idlcity* in the table of contents, click it again, and delete it. Follow the same procedure to delete *idhwy*. Select Legend from the Insert menu. By default, the legend includes all layers from the map. Because you have removed the layer names of *idlcity* and *idhwy*, they appear as blank lines. *idoutl* shows the outline of Idaho and does not have to be included in the legend. You can remove *idoutl* from the legend by clicking *idoutl* in the Legend Items box and then the left arrow button. Click Next. In the second panel, highlight Legend in the Legend Title box and delete it. (If you want to keep the word Legend on the map, do not delete it.) Skip the next two panels, and click Finish in the fifth panel. Move the legend to the upper right of the layout below the title.
13. The labels in the legend are Population and Representation: *idhwy_Rep* (or *Route_Desc* for ArcView Users). To change them to more descriptive labels, you can first convert the legend to graphics. Right-click the legend, and select Convert To Graphics. Right-click the legend again, and select Ungroup. Select the label Population, and then double-click it to open the Properties dialog. Type City Population in the Text box, and click OK. Use the same procedure to change

Representation: `idhwy_Rep` to Highway Type. To regroup the legend graphics, you can use the Select Elements tool to drag a box around the graphics and then select Group from the context menu.

14. A scale bar is next. Select Scale Bar from the Insert menu. Click Alternating Scale Bar 1, and then click Properties. On the Scale and Units tab, first select Adjust width when resizing and select Miles for division units. Then enter the division value of 50 (miles), select 2 for the number of divisions, and select 0 for the number of subdivisions. On the Numbers and Marks tab, select divisions from the Frequency dropdown list. On the Format tab, select Times New Roman from the Font dropdown list. Click OK to dismiss the dialogs. The scale bar appears in the map. Use the handles to place the scale bar below the legend.
15. A north arrow is next. Select North Arrow from the Insert menu. Choose ESRI North 6, a simple north arrow from the selector, and click OK. Place the north arrow below the scale bar.
16. Finally, change the design of the data frame. Right-click Task 2, and select Properties. Click the Frame tab. Select Double, Graded from the Border dropdown list. Click OK.
17. You can print the map directly, save the map as an ArcMap document, or export the map as a graphic file. Exit ArcMap.

Task 3: Label Streams

What you need: *charlie.shp*, a shapefile showing Santa Creek and its tributaries in north Idaho.

Task 3 lets you try the dynamic labeling method in ArcMap. Although the method can label all features on a map and remove duplicate names, it requires adjustments on some individual labels and overlapped labels. Therefore, Task 3 also requires you to use the Spline Text tool.

1. Launch ArcMap. Rename the data frame Task 3, and add *charlie.shp* to Task 3.

Select Page and Print Setup from the File menu. Uncheck the box for Use Printer Page Settings. Enter 5 (inches) for Width and 5 (inches) for Height. Click OK to dismiss the dialog.

2. Click the View menu, point to Toolbars, and check Labeling to open the Labeling toolbar. Click the Label Manager button on the Labeling toolbar. In the Label Manager dialog, expand *charlie* in the Label Classes frame and click Default. Make sure that the label field is NAME. Select Times New Roman, 10, and *I* for the text symbol. Notice that the default placement properties include a parallel orientation and an above position. Click Properties. The Placement tab repeats more or less the same information as in the Label Manager dialog. The Conflict Detection tab lists label weight, feature weight, and buffer for resolving the potential problem of overlapped labels. Check *charlie* in the Label Classes frame. Click OK to dismiss the dialogs.
- Q5. List the position options available for line features.
3. Switch to the layout view. Click the Zoom Whole Page button. Use the control handles to fit the data frame within the specified page size. Select 100% from the Zoom Control dropdown list, and use the Pan tool to check the labeling of stream names. The result is generally satisfactory. But you may want to change the position of some labels such as Fagan Cr., Pamas Cr., and Short Cr. Consult Figure 9.14 for possible label changes.
4. Dynamic labeling, which is what you have done up to this point, does not allow individual labels to be selected and modified. To fix the placement of individual labels, you must convert labels to annotation. Right-click *charlie*, and select Convert Labels to Annotation. Select to save annotation in the map. Click Convert.
5. To make sure that the annotation you add to the map has the same look as other labels,

you must specify the drawing symbol options. Click the Drawing dropdown arrow, point to Active Annotation Target, and check *charlie anno*. Click the Drawing arrow again, and select Default Symbol Properties. Click Text Symbol. In the Symbol Selector dialog, select Times New Roman, 10, and *I*. Click OK to dismiss the dialogs.

- Switch to Data View. The following instructions use Fagan Cr. as an example. Zoom to the lower right of the map. Use the Select Elements tool to select Fagan Cr., and delete it. Click the New Text (A) dropdown arrow on the Drawing toolbar and choose the New Spline Text tool. Move the mouse pointer to below the junction of Brown Cr. and Fagan Cr. Click along the course of the stream, and double-click to end the spline. Enter Fagan Cr. in the Text box. Fagan Cr. appears along the clicked positions. You can follow the same procedure to change other labels.

Challenge Task

What you need: *country.shp*, a world shapefile that has attributes on population and area of over 200 countries.

This challenge task asks you to map the population density distribution of the world.

- Use POP_CNTRY (population) and SQMI_CNTRY (area in square miles) in *country.shp* to create a population density field. Name the field POP_DEN and calculate the field value by [POP_CNTRY]/[SQMI_CNTRY]. One of the records in *country.shp* has a population of —99999. Change its density value to 0.
- Classify POP_DEN into five classes by using class breaks of your choice.
- Prepare a layout of the map, complete with a title (“Population Density Map of the World”), a legend (with a legend description of “Persons per Square Mile”), and a neatline around the map.

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