Chapter 2. Working with ArcMap

Mastering the Concepts

Objectives

- Learning how to manage and use ArcMap windows and menus

- Adding feature datasets and tables to a map document

- Drawing features using different symbols

- Getting information about features using Find and Identify

- Understanding and using map scale when displaying features

- Labeling features as simple text, dynamic labels, and annotation

Concepts

Map documents

ArcMap works with map documents, just as Microsoft Word works with Word documents. A map document is a collection of different spatial data layers and tables, along with instructions for how the layers will be displayed. Just as text on a page has properties such as its font, size, and style, map features have properties that control the symbol, color, and style with which they are drawn. Tables have properties that specify which fields are shown, how many decimal places are included, and so on. The map document keeps track of all these layers and their properties, so that when it is opened again, the map appears exactly as it was when it was last saved. Even the size of the windows and the locations of the toolbars are stored when saving the document.

Map documents organize the data using **data frames.** A data frame is a window in the document that contains groups of related layers that are drawn together. Maps can contain multiple data frames. For example, a document could contain a data frame with a detailed map of South Dakota, and another frame showing the location of South Dakota in the United States (Fig. 2.1). Both frames are included when printing the map.
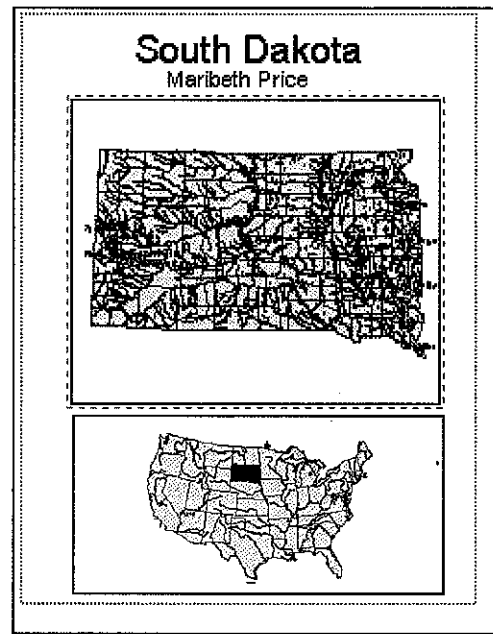

Fig. 2.1. A map document with two data frames, one of South Dakota and one of the United States

Unlike the pictures placed in this book document, which are completely saved within the document itself, a map document does not store the features and tables of the data sets within the map document. Instead, the map stores the name and disk location of the spatial data—its **source.** Changes to the map document do not affect the source data except for specific actions such as adding fields or editing shapes. Changing display symbols, sorting tables—these actions do not affect the source data at all.

It is important to realize that, because the source data are stored outside the map document, changes to source data made in one map document affect all map documents using the same data set. For example, imagine that Jim creates a map of the United States, saves it, and goes to lunch. During lunch, Peggy opens her map, which uses the same states shapefile, and begins to practice editing. She deletes the states of California and Texas, and then accidentally saves her changes. When Jim comes back from lunch and opens his map again to continue working, he finds that California and Texas are missing.

Most organizations take steps to protect their spatial data sets from being accidentally changed, precisely because the mistake of one can affect the work of many. Often the source files are write-protected so that only specific users are authorized to make changes. Others like Peggy, who want to practice editing the data, must make a copy of the original to work with. Before making any permanent changes to source files, stop and carefully consider who owns and uses the data, and who else might be affected by changes. If in doubt, create a copy to work on.

The storage of the map document and the source data in separate locations also has implications for sharing map documents. Giving a colleague a copy of a map document, by e-mail for example, only works if the recipient has access to exactly the same data in the same disk location as the original user. Map documents keep track of the source files by storing the name and location of each file as a **pathname**.

Map documents and pathnames

A **pathname** is the list of folders that one must traverse to reach a particular file on the disk. A pathname begins with the drive letter and lists successive folders, each one beneath the previous, separated by backslashes. The pathname c:\mgisdata\usa\states.shp thus refers to the shapefile states.shp which resides in the Usa folder, which in turn resides in the mgisdata folder, which is found on drive C:\ (Fig. 2.2).

The pathname c:\mgisdata\Usa\States.shp is termed an absolute pathname because it starts at the drive letter and proceeds downward to the file. When searching for a file using an absolute pathname, the search begins at the drive level.

A relative pathname is used to indicate that a search should be made starting at the current folder location, rather than from the drive letter. A double dot indicates movement up one folder. Thus the pathname ..\Usa\States.shp indicates a search up one folder and then down into the Usa folder and thus to the States shapefile. It provides an alternate route from the MapDocuments folder to States.
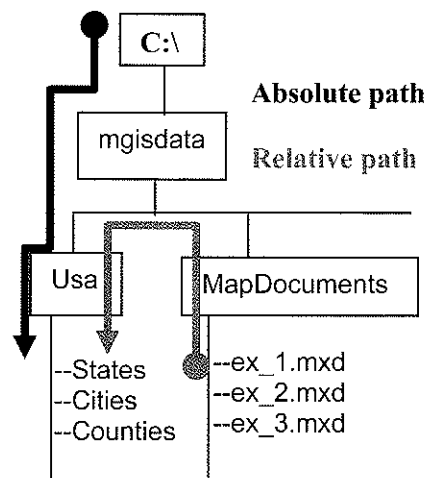

Fig. 2.2. Pathnames

Map documents can store either absolute or relative pathnames, and the choice is made by the user creating the map document. By default a map document stores absolute pathnames. Imagine that the map document ex_1.mxd in Figure 2.2 refers to the States file in the Usa folder. When the map document is opened in ArcMap, it searches starting at the C:\ drive down through C:\mgisdata\Usa\States.shp in order to locate and draw the states in the map.

However, what if the user decides to move the mgisdata folder to another location on a network drive designated with the letter F:\? Upon opening the ex_1.mxd map document in the new location, it searches down the C:\ path as before but can no longer locate the mgisdata folder or its contents. The links to the spatial data are broken, and in ArcMap the States layer will appear with a red exclamation point (Fig. 2.3). The user can manually locate the data to fix the links, but this can be time-consuming if the document contains many layers. In ArcCatalog one can right-click the map document and choose Set Data Source(s) to fix multiple links more efficiently.
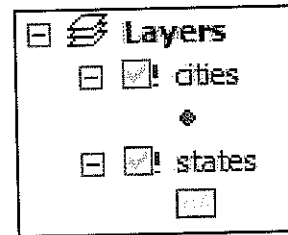

Fig. 2.3. The red exclamation point indicates that the pathname link is broken.

A better solution is to direct the map document to store relative pathnames. In this case the States pathname is stored as ..\Usa\States.shp, and it no longer matters whether the mgisdata folder exists on the C:\ drive, the F:\ drive, or even under C:\students\project\mystuff. As long as the relative positions of the MapDocuments and Usa folders remain the same, the map document can always locate the data it is looking for.

The choice of absolute or relative pathname depends on the situation. If the map documents will always refer to a central data server folder that all users on a network have access to from many different computers, and the users want to transfer map documents from computer to computer, then absolute pathnames will more reliably locate the data layers. On the other hand, if a user plans to move the map documents and data together as a unit, then relative pathnames work better. The map documents on the CD that comes with this book store relative pathnames, so that the links to the data layers continue to work no matter where you install the mgisdata folder.

> **VERY IMPORTANT TIP:** Pathnames, including the names of map documents and spatial data sets, should not contain spaces or unusual characters such as #, @, &,*, etc. Use the underscore character _ to create spaces in names if needed. Although ArcCatalog and ArcMap allow spaces in names, the spaces create problems for certain functions. Thus, it is wise to avoid them entirely.

ArcMap windows and menus

The ArcMap Graphical User Interface (GUI) packs a lot of functionality into a deceptively simple space. This section introduces the primary features and functions of the interface, including the menus, toolbars, and layout of the ArcMap main window.

The menu bar

The menu bar usually lies at the top of the window and includes groups of commands in several categories (Fig. 2.4). The Customize function allows the user to add commands to the menu bar. Many functions can also be accessed using buttons in the toolbars. The menu bar can be torn off its location and moved to another site in the GUI, or even off the GUI entirely.

The toolbars

The toolbars contain buttons that perform actions, or buttons that convert the mouse cursor into different types of tools (Fig. 2.4). For example, the Add Data button launches a dialog box to add layers to the map, and the Identify button converts the cursor into a tool for getting information about individual features in the map (Fig. 2.5). Toolbars are organized into groups of related tasks, such as the Zoom/Pan toolbar, the Editing toolbar, the Layout toolbar, etc.
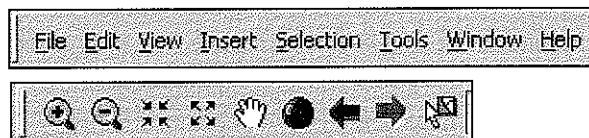
Fig. 2.4. A menu bar (top) and a toolbar (bottom)

Like the menu bar, toolbars can be torn from their locations and docked somewhere else, including off the GUI. Buttons can be added to existing toolbars, and the user can create entirely new toolbars for favorite sets of commands.
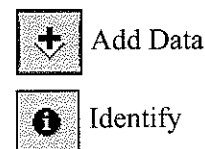
Add Data

Identify

Fig. 2.5. Some buttons

Context menus

A context menu appears when the user *right*-clicks certain objects, such as layer names, symbols, field headings, and more (in contrast to the more usual *left*-click for most operations). The menus that appear will depend on the object clicked, and even the situation at hand. To determine whether an object has a context menu, simply right-click it to see if one appears.

The Table of Contents

The Table of Contents window lists the data layers and tables that have been added to the map (Fig. 2.6). It also provides access to several functions. The window has three modes: **Display, Source,** and **Selection.** In Display mode, only the layers are listed. In Source mode, the layers are organized into their home directories, and additional nondisplaying objects such as tables are listed as well. The Selection tab shows the selection status of each layer, i.e., the number of features that have been selected using a query, as discussed in Chapter 6. Clicking the tabs at the lower right corner of the Table of Contents determines the current mode.
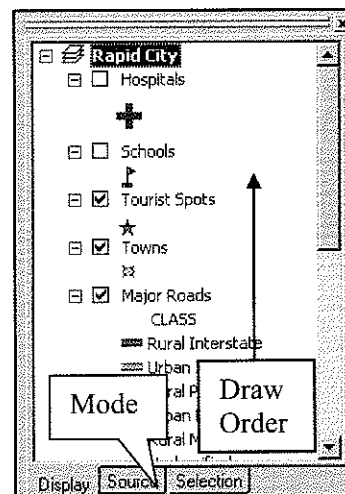
Fig. 2.6. The Table of Contents

➤ Checking and unchecking the boxes by each layer turns the layer display on and off.

➤ In Display mode, you can control the order in which layers are drawn by clicking the layer and dragging it to a new position in the list. The map is drawn from the bottom up. When adding layers, ArcMap automatically puts polygon layers at the bottom, then line layers, then point layers. The order can be important. If a polygon layer appears above a point layer in the list, then the points will be obscured by the polygons being drawn on top of them.

➤ The Table of Contents shows the symbols being used to draw each layer, and also provides access to the menus and tools that manage the symbols. Clicking and right-clicking a layer symbol launch different ways to modify it.

➤ Double-clicking a data layer name opens its Layer Properties window.

➤ Right-clicking a layer name in the Table of Contents produces a context menu which provides access to many functions and properties associated with the layer.
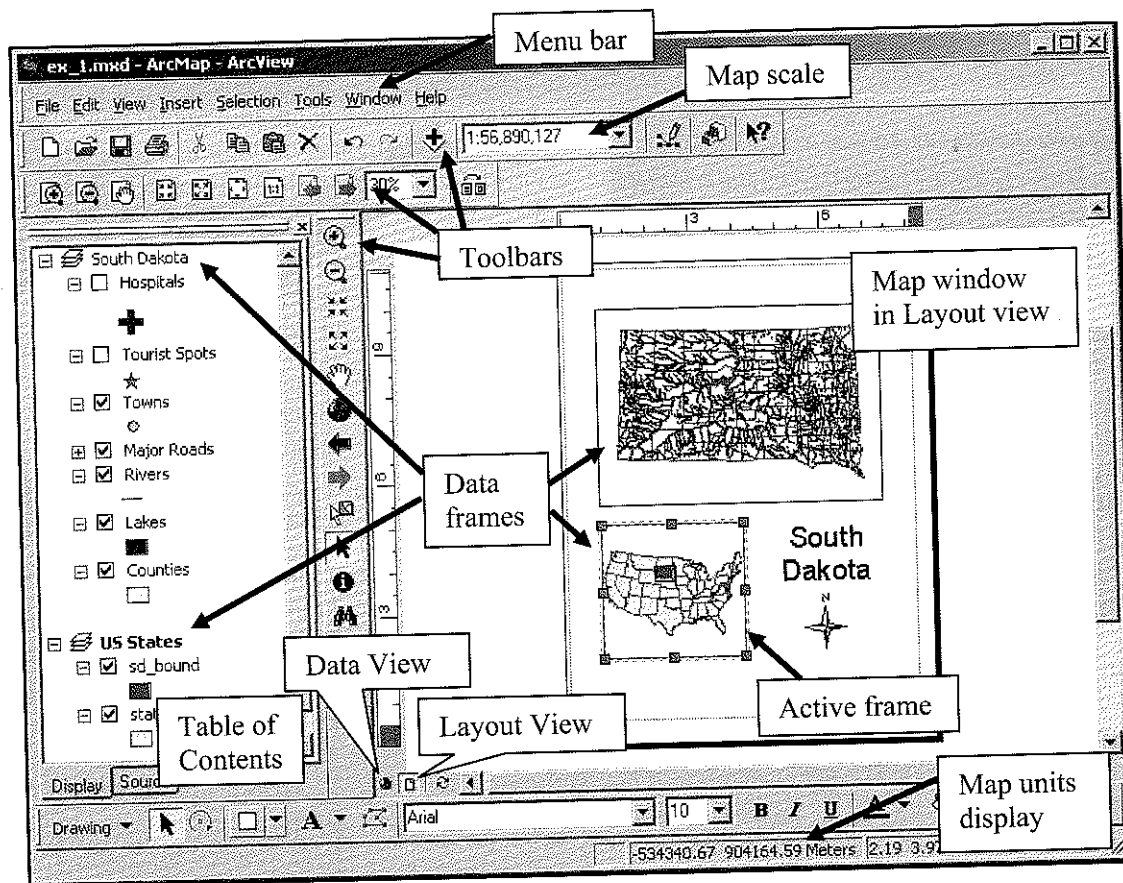

Fig. 2.7. Layout and features of the map window in ArcMap

The map window

The map window is the main display area (Fig. 2.7). Data in the window are organized into groups called **data frames,** which are boxes containing views of the data in the group. The map window has two view modes: Data view mode and Layout view mode. In Data view, only a single data frame is displayed. Layout view is a picture of what the map document would look

like if printed, and it shows all of the data frames on the page, along with titles, scale bars, legends, and any other map information that has been placed on the page. The ArcMap interface in Figure 2.7 shows a map with two data frames in Layout view.

Data frames

Data frames contain layers and tables to display and analyze together and are used to help organize the map. A map document can have multiple data frames. The map document in Figure 2.7 has two: a frame called South Dakota and another called US States. The US States frame is outlined with blue squares because it is currently the **active frame.** All commands and actions, such as Adding Data, occur in the active frame. When the map window is in Data view, only the active frame is visible. In Layout view, all the frames are visible.

Data frames have properties, just like other objects in ArcMap. Frame properties include the coordinate system, size and position, borders, rules for labeling features in the frame, and others. The chapters ahead explain more about data frame properties.

The coordinate system of a data frame defaults to the coordinate system of the first data set loaded into it. The coordinate system can also be set explicitly. ArcMap practices on-the-fly projection, meaning that every data layer in the frame is automatically reprojected to the frame coordinate system so that they will all display together.

Layers and layer files

Once a data set, whether a shapefile, feature class, coverage, or table, is added to ArcMap, it becomes a **layer** and is listed in the Table of Contents. Each layer has properties that control how it is displayed and used. Some of these properties you have already encountered, such as Map Tips and the symbols used to display the layer. You will learn others soon, such as labeling properties, relationships with other tables, and whether any features have been selected as the result of a query.

Many layer properties are accessed by right-clicking the name of the layer and choosing Properties from the context menu. The Properties dialog box has many tabs, each of which provides the interface for setting layer properties. For example, the General tab specifies the name of the layer, whether it is currently visible, and at what range of scales it is displayed. Many of these options can also be set elsewhere. The Symbology tab provides detailed control of the colors, sizes, and shapes of symbols being used to draw the layer.

Layers reference a specific data set such as a shapefile; however they are not exactly the same as the data they reference. For one thing, the Table of Contents may contain several layers that reference the same shapefile. The Table of Contents in Figure 2.8 contains three layers all based on the same vegetation feature class. The lowest layer displays the vegetation in terms of its tree crown cover percentage, one of the fields in the attribute
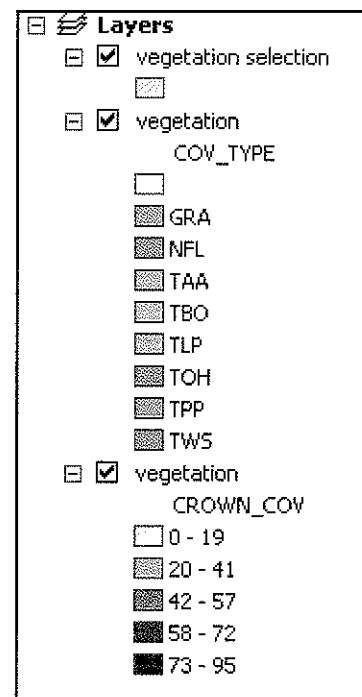

Fig. 2.8. Several layers all based on the same vegetation feature class.

table. The middle layer uses a different field, the cover type or species, to display the polygons. The top layer is based on a query, and contains only the ponderosa pine (TPP) polygons.

One use of layers is to present multiple views of the same data based on different fields, as shown in Figure 2.8. Another use is in processing data when only a subset of features is needed for a command. The vegetation selection layer could be passed to a command or tool, which would then only act upon the ponderosa pine polygons instead of all the polygons in the feature class.

The current settings and properties of a layer may be stored in a layer file. These files include a pathname specifying the name and location of the data set, plus all of the properties that have been set for the layer. Layer files have many uses, such as storing symbols and labels for use in multiple map documents or keeping a subset of selected features ready for use over and over in different commands.

Working with symbols and styles

Symbols come in three types: marker symbols for point data, line symbols for line data, and fill symbols for polygon data (Fig. 2.9). Each type has its own basic properties to set.

Marker symbols have a symbol, a size, a color, and an angle. Line symbols have a symbol, a color, and a thickness. Polygon symbols have a fill style, a fill color, an outline thickness, and an outline color. The fill can be a solid color, or it can be patterns such as stripes, or even pictures made from bitmap files.

The Symbol Selector allows the user to select an existing symbol, use it as it is, or modify its properties to suit specific needs, such as changing its color (Fig. 2.9). For example, the Expressway symbol could be given a different color and line width.

Many symbols come with ArcMap in addition to the basic ones that appear in the Symbol Selector. The user can load additional symbol sets and modify them to suit specific applications, or create entirely new symbols and symbol sets.
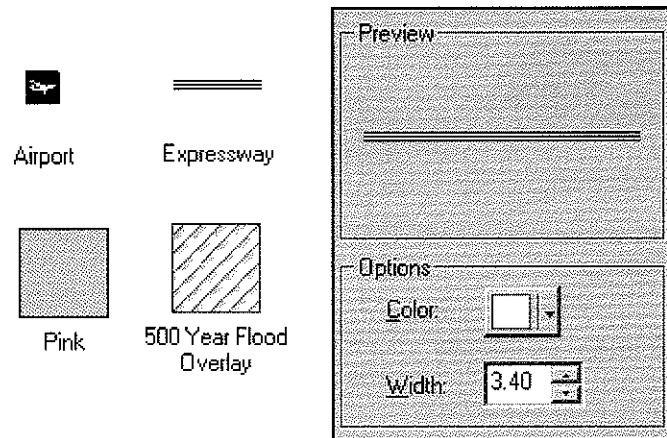
Fig. 2.9. Examples of symbols: a marker for airports, a line symbol for expressways, a pink solid fill symbol, and a 500 Year Flood patterned fill symbol. Once a symbol is chosen in the Symbol Selector, you can modify its properties.

The Help system

ArcGIS includes extensive help files with a wealth of important information. Help is requested from the Help entry on the main menu bar. On the left are three tabs allowing the user to search for information, and the right shows the current entry on display (Fig. 2.10). Four search methods are available. The Contents tab shows an organized outline of material, much like a library of books. To view the contents of a book, click the plus sign to expand the entry. The Index tab contains a wealth of frequently used entries. Typing a word in the box on top causes the window to jump through the index to the matching word. The Search tab allows the user to enter a word or phrase and search the entire Help text. Finally, the Favorites tab can be used to save entries that are frequently consulted.
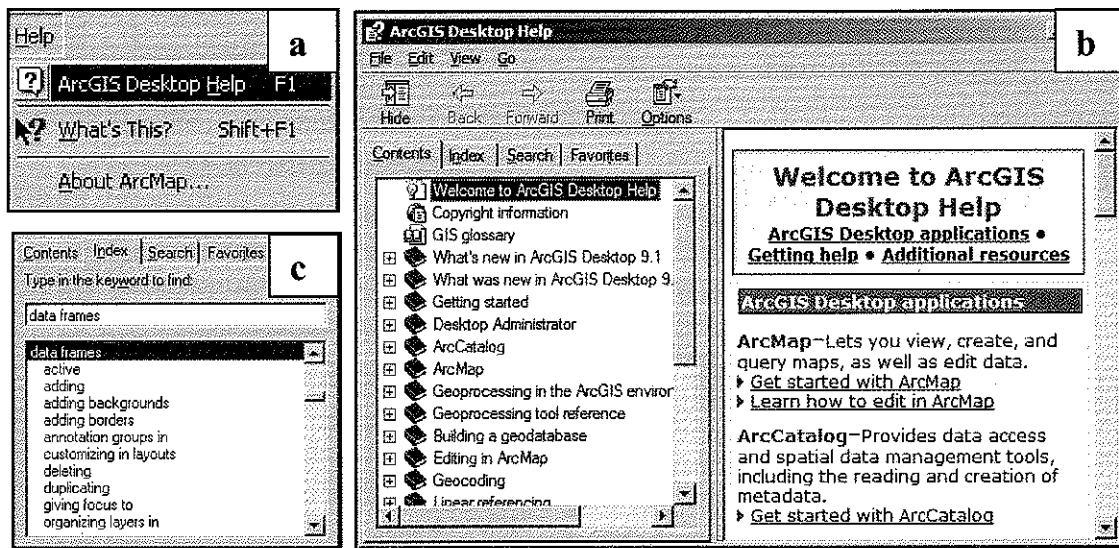

Fig. 2.10. ArcGIS Desktop help: (a) getting help, (b) the Help window showing the Contents tab, (c) the Index tab

Map scale concepts

What is map scale?

Map scale is a measure of the size at which features in a map are represented. The scale is expressed as a fraction, or ratio, of the size of objects on the page to the size of the objects on the ground in real life. Because it is expressed as a ratio, it is valid for any unit of measure. So for a common U.S. Geological Survey topographic map which has a scale of 1:24,000, one inch on the map represents 24,000 inches on the ground (or one meter represents 24,000 meters on the ground, and so on). Imagine a map made to the scale of 1:100,000. You can use the map scale and a ruler to

$$\frac{1}{100,000} = \frac{2.5 \text{ cm}}{x \text{ cm}}$$

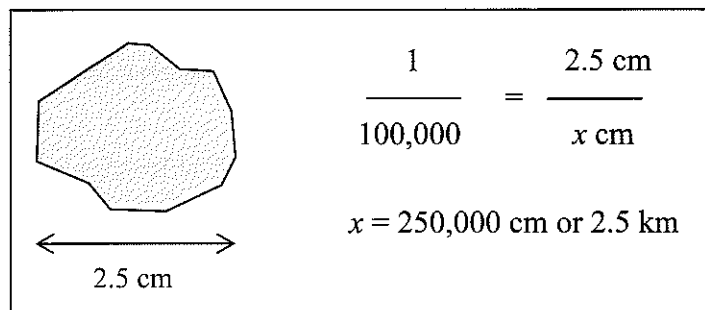$$x = 250,000 \text{ cm or 2.5 km}$$

2.5 cm

Fig. 2.11. Solving for the actual size of a lake

determine the true distance of any feature on the map, such as the width of a lake (Fig. 2.11). Measure the lake with a ruler, and then set up a proportion such that the map scale equals the measured width over the actual width (x). Then solve for x. Keep in mind that the actual width and the measured width will have the same units. You can convert these units if need be.

Often people or publications refer to large-scale maps and small-scale maps. A large-scale map is one in which the *ratio* is large (i.e., the denominator is small). Thus a 1:24,000 scale map is larger scale than a 1:100,000 scale map. Large-scale maps show a relatively small area, such as a quadrangle, whereas small-scale maps show bigger areas such as states or countries.

Scale with GIS data

When data are stored in shapefiles or other spatial data formats, they do not have a scale, technically speaking, because only the coordinates are stored. They acquire a scale once they are drawn on the screen or on a piece of paper. ArcMap has a scale box on the main toolbar that reports the current scale of the map on the screen (Fig. 2.12), and it updates every time the zoom scale changes. Likewise, you can determine the scale of a map to be printed or set a specific scale to print to.

However, the concept of scale does apply to GIS data, in the sense that most data layers have an intrinsic scale at which they were created. The map in Figure 2.13 shows congressional districts in pink and the state outlines in thick black lines. Notice how the state boundaries are more angular and less detailed than the districts because they were digitized at a smaller scale. Thus, although it is possible to take small-scale data and zoom in to large scales, the accuracy and detail of the data will suffer. The original scale of a map or data set is thus an important attribute, and it should be included when creating metadata for layers.

Fig. 2.12. The scale box in ArcMap shows the current scale of the map on the screen.
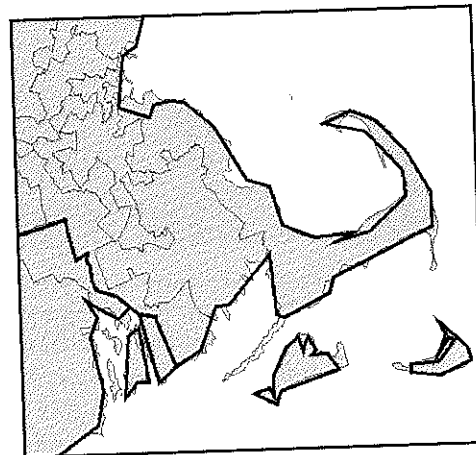
Fig. 2.13. These two layers showing Massachusetts originated from maps with different scales.

One should exercise caution in using data at scales very different from the original. When selecting or creating data, it is also important to use data that are appropriately scaled for the analysis. Zooming into a data set may give a false impression that the data are more precise than they actually are. A pipeline digitized from a 1:100,000 scale map, for example, has an uncertainty of about 170 feet in its actual location due just to the thickness of the line on the paper. Displaying the pipeline on a city map at 1:60,000 might look fine, but zooming in to 1:2000 would not help at all should you desire to locate the pipeline by digging.

From looking at Figure 2.13, one might conclude that it is desirable to always obtain and use data at the largest possible scale. However, large-scale data require many more data points per unit area, increasing data storage space and slowing the drawing of layers. Every application has an optimal scale, and little is gained by using information at a higher scale than needed.

Reference scale

Data frames have a property called the **reference scale,** which stipulates the scale for which the layers are designed to be displayed (Fig. 2.14a). When placing symbols and labels on the map, you naturally give the symbols their most aesthetically pleasing size relative to the current map scale. However, because symbols normally remain the same size as the scale changes, at some zoom levels they appear too large, while at others they appear too small (Fig. 2.14b).
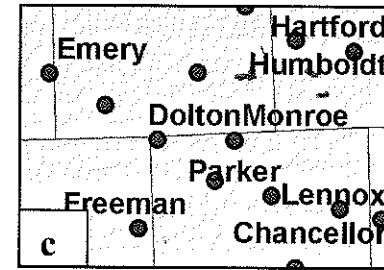

a

The reference scale

Fig. 2.14. (a) The reference scale sets the proportional size of the features and their text. (b) If the reference scale is not set, the symbols will always appear the same size. (c) If the reference scale is set, then zooming in or out changes the size of the text and symbols in proportion to the features.

If the reference scale is set, then the symbols will get larger or smaller as the zoom scale changes, just as the features do (Fig. 2.14c). You can set the reference scale, clear it, and automatically zoom to it.

b
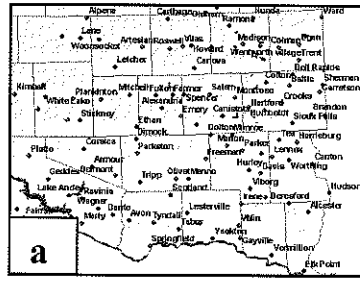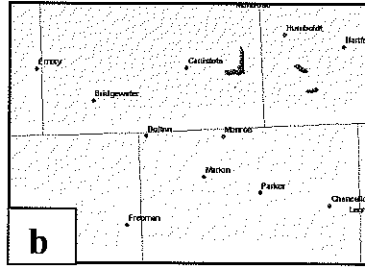
Zoom in—reference scale not set

c

Zoom in—reference scale set

> **TIP:** Be sure to understand the difference between the terms *map scale, reference scale,* and *visible scale range.* Map scale determines the ratio of features on the map to features on the ground. The reference scale controls the sizing of symbols and text when zooming from one map scale to another. The visible scale range determines the range of scales at which a layer will appear.

Labeling concepts

Labeling involves taking an attribute of a feature, such as its name, and placing it on the map close by. ArcMap provides three basic types of labeling. You can place **interactive labels** one at a time, or automatically label many features using **dynamic labeling,** or take precise control of labeling by using **annotation.**

Interactive labels

Interactive labels are constructed by the user one at a time, and they can be used to label map features or provide titles and supporting text for a map layout. One labeling method involves placing text interactively on the map in one of three ways: as a plain text graphic, as a callout box, or splined along a line. A callout places text in a box with a pointer to indicate the feature of interest. Splining causes labels to follow along a feature such as a road or creek. Alternately, you can label a feature using the value from a field in its attribute table. All interactive labels remain on the map as graphic elements, unless you decide to select and delete them.

More complex text can be constructed using the wrapped text tools. The text is placed inside a shape defined by the user, and rudimentary control of margins and columns is provided, as well as background and border options. If the wrapped text box changes shape, the text inside is automatically reformatted to fit.

Dynamic labels

Dynamic labels are created from an attribute and are actively managed by ArcMap as you turn layers on and off, zoom in and out, etc. Every time you redraw the map, ArcMap redraws the labels. It optimizes the display by omitting overlapping labels. Thus the number of labels displayed can vary, depending on the zoom scale and label size.

Creating dynamic labels involves specifying the label field in the Layer Properties menu, setting options for how they appear, and turning them on (Fig. 2.15). Choices include the following:

> ➤ Setting options that control the size, font, and color of the labels.

> ➤ Setting priorities for where they are placed.

> ➤ Adopting guidelines to resolve overlap conflicts between labels.

Fig. 2.15. Set the labeling properties of dynamic labels using the Labels tab in the Layer Properties window.

> ➤ Specifying different classes of labels. For example, large cities could have a bigger label and take priority over smaller cities.

> ➤ Using the data frame properties to control which layers have priority over others, such as always labeling states before cities.

> ➤ Specifying that labels be displayed only at a range of scales, just as for layers.

The **Placement Properties** help to manage the overlap and optimization of the labels to give the best possible result. Points, lines, and polygons have different placement options.

Point label overlaps are resolved by offsetting the label from the point, while putting as many labels as possible in the preferred location.

Line labels can be placed several ways: they can be placed horizontally or vertically at the middle or ends of the line. You can also spline text along a linear feature, placing it inside, above, or below the line (Fig. 2.16).
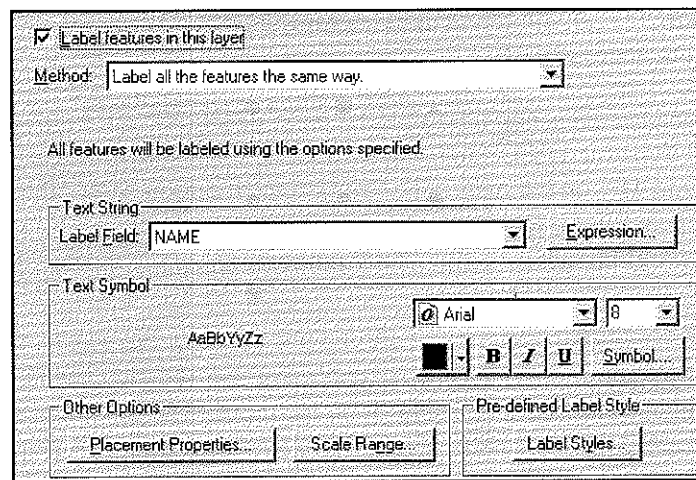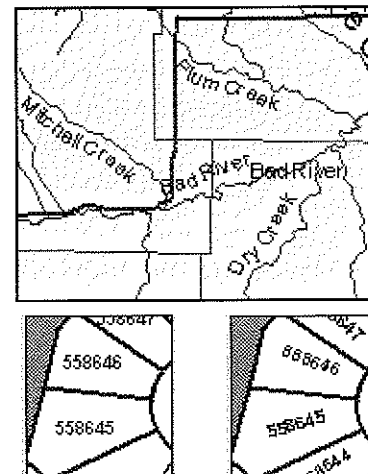
Fig. 2.16. Line labels may be splined along features such as these creeks. Polygon labels may be horizontal or straight with the long edges.

Polygon labels may be forced to be horizontal, or the software can try to place them at the same angle as the polygon's longest boundaries to maximize the fit (Fig. 2.16). In addition, the user can request to omit labels that would extend beyond the borders of the polygon.

Duplicate label options are used in situations such as one street composed of many blocks. You can control whether a label is placed for every block, or only one per street.

Finally, the **Conflict Detection** options can handle priorities for different layers. **Label weights** control which layers take priority; for example, states might have a higher priority than cities and be preferentially labeled in case of a conflict between the two. **Feature weights** specify the layers whose features cannot be overlapped by labels. For example, labels from cities should probably not obliterate markers for Superfund sites. Finally, label **buffers** prevent new labels from encroaching on the edges of existing labels.

Because the actual labels placed vary, depending on scale and symbol size, printing maps based on dynamic labels can bring surprises. What shows on the screen does not necessarily appear the same way on the map. The Print Preview option shows the printed map and labels as they will appear. For many purposes a few extra or missing labels do not matter. If they do, however, converting labels to annotation provides greater control over label placement.

Annotation

Annotation provides precise control of each label. Ordinary dynamic labels can be converted to annotation. The labels that fit on the map are automatically placed, and the overlapping labels are directed to an overflow window. From this window you can work with the labels individually to place them exactly as needed. Annotation always appears in the same place and at the same size regardless of printing or zooming changes. Annotation may be stored in three ways.

➤ You can store it in the map as simple text.

➤ You can store it as a feature class in a geodatabase and use it in other map documents.

➤ You can store it in the same geodatabase as the features linked to it—of course the features must then be in a geodatabase and not in a shapefile or coverage. Feature-linked annotation is automatically created, moved, and deleted as the features are edited, but it is only available to ArcEditor or ArcInfo users, not to ArcView users.

Summary

➢ ArcMap provides a fully customizable graphical user interface (GUI) composed of menu bars, toolbars, windows, and context menus.

➢ Map documents store references to layers and information about them, such as how to draw them. The actual data exists outside the document and may be used by many people.

➢ Map documents may store either absolute or relative pathnames for data files. Absolute pathnames work better when the data will always be in the same place for every user. Relative pathnames are best if the data will be moved about.

➢ The Table of Contents lists the available data layers and provides control for the order of drawing, and through context menus it gives access to properties and commands associated with each layer.

➢ Data frames contain layers to be drawn together, and they also have properties including the coordinate system and the reference scale.

➢ Data layers have multiple properties covering issues such as the source data, the projection, display, labeling, symbols, and more.

➢ Map scale is the ratio of size in the map to size on the ground. The original scale of a geographic data set determines the scale of its usefulness.

➢ The display scale controls the range of scales at which a layer appears. The reference scale of a data frame can be used to control the scaling of symbols and labels.

➢ Labels can be placed dynamically or as permanent annotation. Annotation may be stored as text in the map, as a feature class in a geodatabase, or as feature-linked annotation in the same geodatabase as the features.

> **VERY IMPORTANT TIP:** Pathnames, including the names of map documents and spatial data sets, should not contain spaces or unusual characters such as #, @, &, *, etc. Use the underscore character _ to create spaces in names if needed. Although ArcCatalog and ArcMap allow spaces in names, the spaces create problems for certain functions. Thus, it is wise to avoid them entirely.

> **TIP:** Be sure to understand the difference between the terms *map scale, reference scale,* and *visible scale range.* Map scale determines the ratio of features on the map to features on the ground. The reference scale controls the sizing of symbols and text when zooming from one map scale to another. The visible scale range determines the range of scales at which a layer will appear.

Chapter Review Questions

You may need to consult the Skills Reference section to answer some of these questions.

1. Describe the difference between a data layer and a data frame.

2. What is a map document, and what types of information are stored in it?

3. How does ArcMap decide which layers to draw first?

4. Mary creates a map document and e-mails it to a colleague in another state. He calls and tells her the document opens but no map appears. Explain what is wrong.

5. What does it mean if a layer's check box is dimmed?

6. Why can different labels appear each time you zoom or pan a layer with labels?

7. What is the difference between the scale range and the reference scale?

8. You measure a football field (100 yards long) on a detailed map and find that it is 0.5 inches long. What is the scale of the map?

9. Describe the difference between dynamic labeling and annotation.

10. What characters should be avoided when naming GIS files, folders, and map documents?

Mastering the Skills

Teaching Tutorial

The following examples provide step-by-step instructions for doing basic tasks and solving basic problems in ArcGIS. The steps you need to do are highlighted with an arrow ➔; follow them carefully. Click on the video number in the VideoIndex to view a demonstration of the steps.

➔ Start ArcMap, if necessary. Navigate to the mgisdata\MapDocuments folder and open the map document ex_2.mxd.

➔ Choose Save As from the File menu and save your own copy of the map document under a new name such as ex_2mine.mxd. Save it frequently as you work.

> **TIP:** The names of map documents, spatial data sets, and folders should not contain spaces or unusual characters such as #, @, &, *, etc. Use the underscore character _ to create spaces in names if needed. Although ArcCatalog and ArcMap allow spaces in names, the spaces can create problems for certain advanced functions. Thus, it is wise to avoid them entirely.

Working with the map display

First, let's briefly review some of the techniques for zooming and panning that we learned in Chapter 1.

1➔ Use the Zoom In tool to draw a box around the lower part of the large lake in central South Dakota (Fig. 2.17).

1➔ Hover the cursor over the lake for a moment until its name appears.
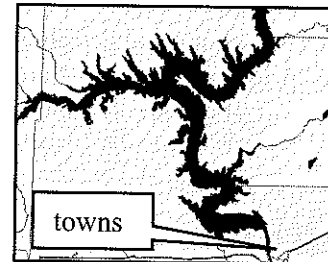
1. What is the name of this lake?
   _____

Fig. 2.17. Zoom to this lake

2. What is the function called that causes the lake name to appear? _____

1➔ Use the Pan tool to drag the two small towns near the bottom part of the lake to the center of the view.

1➔ Use the Fixed Zoom In tool to zoom in. Keep clicking the tool until the schools appear on the map.

3. At approximately what scale do the schools appear? _____

1➔ Click the Fixed Zoom Out tool ONCE to zoom back out.

4. What is the scale now? _____ Make a guess what the minimum scale for the school display is set to. _____

2➜ Right-click the Schools layer in the Table of Contents and choose Properties from the context menu.

2➜ Click the General tab and read the minimum display scale.

5. What is the minimum display scale of the Schools layer? _____

2➜ Click the button to Show Layer at All Scales and click OK.

2➜ Use the Full Extent button to zoom to all of South Dakota again.

Now the schools are displayed for the entire state.

TIP: You can also set/clear the range scale by right-clicking the layer name in the Table of Contents and choosing Visible Scale Range.

3➜ Use the Previous Extent button to return to the close-up of the Pierre area.

Now notice a curious thing: north of the two towns (Pierre and Ft. Pierre), two schools show up in the middle of Lake Oahe. This seems very odd, unless they mean schools of fish.

3➜ Click on the Identify button and click on each school in turn.

6. What are the schools' names? _____

Each school's name is followed by the term "historical", so probably these schools were built and used prior to the dam that created Lake Oahe.

4➜ Close the Identify Results menu.

4➜ Use the Forward Extent button to return to the display of the state.

4➜ Click the Find button. Fill out the dialog box to search for **Meadowbrook** in the NAME field of the Schools layer.

4➜ When it finds the school, right-click on the school name and choose Zoom To.

4➜ Right-click the school name again and choose Flash to locate it. You may need to move the Find dialog box to see the feature flash. Repeat if needed.

7. To what urban area does Meadowbrook School belong? _____

5➜ Close the Find dialog box.

5➜ Choose View > Bookmarks > Rapid City from the main menu bar.

5➜ Click the Measure tool and use it to determine the length of Rapid Creek inside the urban area of Rapid City (inside the blue boundary).

5➜ Instead of the default meters, click on the Choose Units button and set the units to miles. Measure again.

8. What is the length of Rapid Creek inside Rapid City, in miles? _____

6➜ Click the Measure Feature button on the Measure tool.

6➜ Change the area units to acres.

6➔ Click on the Rapid City urban area shown as the blue polygon.

9. What is the area of Rapid City, in acres? _____

Using data frames

Now we will learn some things about data frames. First we will examine the map in Layout view, rename the existing data frame, and add a new one.

7➔ Close the Measure tool, and then click the Layout view icon in the lower left of the display area to switch from Data view to Layout view.

7➔ Click on the Layers data frame name; then click again and type in a new name for it, **Rapid City**. Click Enter.

7➔ Click the minus sign in the box next to the data frame name to collapse the list of data layers in it.

7➔ Choose Insert > Data Frame from the main menu bar.

7➔ Rename the new frame **South Dakota**.

The new data frame appears with a set size in the middle of the page. It is highlighted with blue handles, indicating it is the active frame. The active frame is also shown in boldface type in the Table of Contents. Next, resize both frames so they do not overlap each other on the page.

8➔ Place the cursor inside the South Dakota frame; then click and drag it to the lower right, slightly off the page.

8➔ Click once inside the Rapid City frame to make it the active frame. Place the cursor over the lower left or right corner, and click and drag to resize the frame to occupy only the top half of the page.

8➔ Move and resize the South Dakota frame until the page appears similar to the one shown in Figure 2.18.

9➔ Make sure that the South Dakota frame is the active frame.

9➔ Click the Add Data button. Navigate to the mgisdata\Sdakota\southdakota geodatabase and choose the state feature class. It appears in the data frame.

9➔ Switch back to Data view by clicking the world icon (Fig. 2.19), or choose View > Data view in the main menu bar.

Fig. 2.18. Layout view
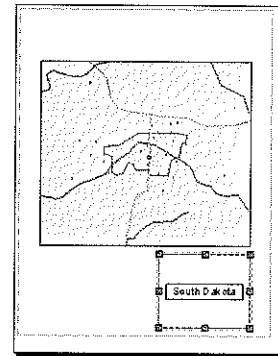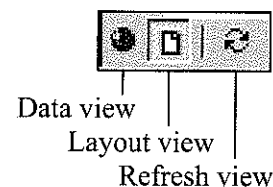
Data view
Layout view
Refresh view

Fig. 2.19. View buttons

You will use this data frame to create a location map for Rapid City. First, however, notice that the state appears elongated in the east-west direction. This elongation provides evidence that the data layer is stored in geographic data units, that is, latitude-longitude. Let us examine the coordinate system in a little more detail.

10➔ Right-click the state layer name in the Table of Contents and choose Properties; then click the Source tab to see the projection information.

10. What is the coordinate system of this data set? _____

By default, the data frame adopts the coordinate system of the first data set loaded into it. Any other data sets loaded now would be drawn in this same coordinate system, no matter what other coordinate system they may have.

10➔ Look at the map units display at the bottom of the ArcMap window and verify that the units are shown in degrees of longitude and latitude. `99°19'44.11"W  44°25'23.86"N`

The map units displayed have also defaulted to the units of the first coordinate system—degrees. These display units can be changed.

Although data are commonly stored in a geographic coordinate system (GCS) with units of degrees, the distortion inherent in a GCS makes it a poor choice for a map, and professional cartographers avoid using GCS in maps for this reason. We will now set the map projection of the frame. Afterward, the GCS units are projected on the fly to whatever coordinate system is chosen for the data frame.

11➔ Close the Layer Properties window.

11➔ Right-click the South Dakota frame name, and choose Properties from the context menu.

11➔ Click the Coordinate System tab, and verify that the frame coordinate system is the same as the state coordinate system.

11➔ In the box showing the coordinate system tree, click the following links to find the coordinate system desired: Predefined > Projected Coordinate Systems > State Plane > NAD 1983 > NAD_1983_StatePlane_South_Dakota_North_FIPS_4001. Click OK.

Now that the data frame has this coordinate system, any other data layer loaded into the frame will be reprojected to match it. Next, you will set up an **extent rectangle** to show the location of Rapid City in this frame. This trick is another data frame property.

12➔ Open the South Dakota frame Properties window, and choose the Extent Rectangles tab.

12➔ Click the Rapid City frame in the list to the left, and click the double arrow to place it in the list to the right.

12➔ Click the Frame button and choose the border by clicking on the drop-down list next to the sample. Select the 4.0 Point line symbol. Click OK in both boxes.

12➔ Use the Zoom In tool to zoom in as far as possible to the state without cropping any of it.

12➔ Switch to Layout view to verify that the border is shown. Extent rectangles only appear in Layout view.

Labeling features interactively

We need to add a few labels to this map. We can do this easily using the text tool in the Drawing toolbar.

13➔ Make sure that South Dakota is the active frame and return to Data view.

13➜ Click the New Text tool on the Drawing toolbar. The black triangle indicates that more versions of this tool are accessible by clicking the drop-down arrow.

13➜ Click inside the state; then type the name **South Dakota**. Press Enter.

13➜ Click once on the text to select it.

Notice the blue dashed line that appears around the text, indicating that it is currently selected and will be affected by changes in its font or other properties.

13➜ Use the drawing toolbar buttons to set the font size to 28 and make the text Bold. Click and drag the text to center it inside the state.

TIP: To delete text, click the black arrow on the Drawing toolbar, click the text to select it, and press the Delete key. You can also use the black arrow to draw a box around many text boxes, or hold down the Ctrl-key to select multiple text boxes for deletion.

14➜ Use Add Data to add the feature class urbanarea from southdakota.mdb to the South Dakota frame. If necessary, use Find to locate Rapid City.

14➜ Click the drop-down arrow on the Text tool and choose the Callout text button. Click on Rapid City and drag slightly to the lower right to create the label.

14➜ Type in the name **Rapid City** and press Enter. Select the new label. Adjust its location and pointer end if necessary (Fig. 2.20). Also adjust the South Dakota label if needed so that both can be clearly seen. (Make sure the Select Elements tool is selected on the drawing toolbar to move the labels.)

14➜ Turn off the urbanarea layer by clicking its check box.

14➜ Switch to Layout view to see the changes.

Fig. 2.20. Labeling the state

14➜ Use the Layout Zoom In tool to zoom in to the South Dakota frame.

Notice that the South Dakota label has run over the edge of the state, and the Rapid City label is so enlarged that the pointer is not even visible. This happens because the font sizes remain the same with respect to the screen, but the state became smaller when you switched to Layout view. Setting the frame's reference scale will fix the label sizes so they remain the same relative to the state size.

15➜ Go back to Data view.

15➜ Right-click the South Dakota frame and choose Reference Scale > Set Reference Scale from the menu.

15➜ Switch to Layout view again. This time the labels are scaled down along with the state.

The multiline text tools are useful for placing paragraphs on a map document. Several different shapes can be chosen, including rectangles, circles, and polygons. The size and shape of the text boxes can be adjusted, and the text inside will automatically be wrapped to fit.

16➜ Click the Zoom Whole Page button on the Layout toolbar.

16➜ Click the New Rectangle Text button on the Drawing toolbar and click and drag to create a rectangle in the empty part of the page, and then release the mouse button. A dotted box with "Text" inside it will appear.

16➜ Double-click in the text box to open its Properties, and click the Text tab. Enter a paragraph in the box, saying whatever you like, without pressing Enter.

16➜ Click the Frame tab and choose a border for the text.

16➜ Click the Columns and Margins tab. Leave the margins as is, but set the number of columns to 2. Click OK to close the text Properties box.

16➜ Adjust the rectangle size by clicking and dragging its corners. Change the font or other properties of the text using the Drawing toolbar or by double-clicking on the text again to edit its properties.

16➜ While the text box is still selected, press the Delete key to get rid of it.

Next we will change symbols and create labels for the schools in Rapid City.

17➜ Return to Data view. It will show the South Dakota frame since that was the most recent active view.

17➜ To switch frames while in Data view, right-click the Rapid City frame name and choose Activate from the context menu.

17➜ Click the plus sign next to the Rapid City frame to expand its contents again.

17➜ Click the Schools symbol to launch the Symbol Selector. Choose the symbol School 2, click on the color box and select a red color from the palette, and change the symbol size to 16 pts. Click OK.

First we will demonstrate using the labeling tool to label features individually. Later we will create dynamic labels.

18➜ Choose the Label tool from the text tool set. This tool uses the display field set in the layer properties to label the features clicked. The Label Tool Options window appears.
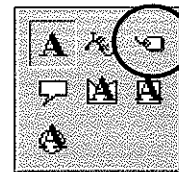
18➜ Keep the default options to automatically find the best label placement and to use the label properties set for the layer.

18➜ Click inside the blue area and watch the Rapid City label appear. Use the drawing toolbar to change its font size to 14 and move it to a better location, if needed.

TIP: To delete a newly added label, press the Delete key while the label is still selected.

18➜ Click somewhere on the orange background (Pennington County).

No label appears when you click the county. It is likely that the "best label placement" for the label is the middle point of the county, which does not show up in this view. Hence no label appears. Adjust the label placement options to solve this problem.

19➜ Change the labeling option to Place label at position clicked. (If you have already closed the Label Tool Options menu, click the Label tool again to open it.)

19➜ Click the orange background again, and the county label will appear. Adjust its font to 24 points and move it to a better location if desired.

19➜ Click on a section of Rapid Creek to label it. Adjust the size, font, or location if needed.

19➜ Click on the major highway running east-west near the top of the map.

Notice that when you click the highway, only an empty label box appears. You might need to set the display field for the layer.

20➜ Close the Label Tool Options window.

20➜ Open the Major Roads layer properties and click the Labels tab. The Label field is currently set to DESCRIP. Close the Properties window.

20➜ Use the Identify tool to click the highway now. Notice that its DESCRIP field is blank, which explains the labeling problem. SIGN1 looks like a better field for labeling. Close the Identify Results window.

20➜ Open the Label tab in the Properties window again, and change the Label field to SIGN1. Click OK to close the Properties window.

20➜ Click the Label tool again, set it to place labels at the position clicked, and click on the highway to create a new label.

TIP: If you still have trouble making a label appear, be sure to click exactly on top of the highway symbol. The Map Tips option is turned on for this layer, so it may help to wait until the tip appears, and then click to place the label.

20➜ In the Label Tool Options menu, change the second option to Choose a Style.

20➜ Click the Interstate Highway symbol from the list that appears. Label the highway again.

20➜ Choose the U.S. Route symbol and label the smaller road heading south from town.

20➜ Close the Label Tool Options window.

TIP: Simple labels, text boxes, and graphics are collectively termed Elements. To Select All Elements or Unselect All Elements, use the functions in the Edit pull-down menu on the main menu bar.

Creating dynamic labels and annotation

These labels we have created are simple graphics placed on the screen. Now you will learn how to create dynamic labels for features based on one of their attribute fields and convert them to annotation.

21➜ Right-click the Schools layer and choose Properties from the context menu; then click the Labels tab.

21➜ Check the Label features box. Verify that NAME is the Label Field.

21➜ Increase the size of the text to 12 pt. and make the style Bold. Click OK.

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Notice that some of the schools may not have labels because they overlapped with names of other schools. The Labeling toolbar offers several convenient functions for working with labels, including viewing unplaced labels.

22➜ Right-click the gray menu area at the top of the window, and choose the Labeling toolbar from the list.

22➜ Click the View Unplaced Labels button to show the missing labels, which appear red. (If you don't see any unplaced labels, click the Fixed Zoom Out tool once or twice until they appear.)

22➜ Zoom into the northeast part of the city between Rapid Creek and the interstate. Notice how more school labels appear now that we have more space.

22➜ Use the button to return to the previous zoom extent.

Now let's experiment with some label placement options.

23➜ Open the Layer Properties for Schools to the Labels tab and click the Placement Properties button.

23➜ Click the Placement tab, if necessary. Notice the graphic indicating the placement preferences.

23➜ Click Change Location and find the Prefer Top Center, all allowed icon (Fig. 2.21). Click it to select it and click OK.
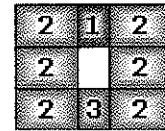
Prefer Top Center, all allowed

Fig. 2.21.

The matrix in Figure 2.21 represents a set of rules for placing the labels. The white space in the center represents the point itself. The most preferred label location is the top center, designated with a 1. The boxes labeled 2 are second in priority, and the 3's show the least desirable location. A zero in a box would indicate that labels must never be placed there.

23➜ Click the Conflict Detection tab, and set the buffer distance to 0.25 (units are a fraction of the label height). This option will suppress labels within this distance of each other for a cleaner-looking map. Click OK.

23➜ Change the font size to 10. Click OK. See the changes.

> **TIP:** Turn labels on and off for a layer by right-clicking the layer name in the Table of Contents and choosing the Label Features option. If the menu choice is checked, the labels are on, and choosing it will turn them off. If unchecked, choosing it will turn them on.

Before we convert the labels to annotation for the finishing touches, let's label Rapid Creek again with a symbol which angles along the creek.

24➜ Select and delete the previous label(s) for Rapid Creek.

24➜ Open the Layer Properties for the Rivers layer and click the Labels tab.

24➜ Check the box to turn on the labels.

24➜ Change the font symbol to dark blue italic. Leave the other options as they are.

24➜ Click the Placement Properties button and click the Placement tab.

24➔ Fill out the boxes as shown in Figure 2.22 to place labels parallel to the lines and above or below them, with a 10-meter offset, at the best location, and removing duplicate labels. Click OK and OK.

Now we will convert the text to annotation for the final touches. In order to try out the entire process, the schools should have several unplaced labels.

25➔ Click the Fixed Zoom Out button until at least two of the schools show as unplaced labels.

25➔ Right-click the Rapid City data frame and choose Convert Labels to Annotation.

Annotation is created for an entire data frame rather than for single layers. Notice that both Schools and Rivers are listed for conversion, since both of them currently have dynamic labels. We only want to create annotation for Schools, and so we must turn off the labels for Rivers.
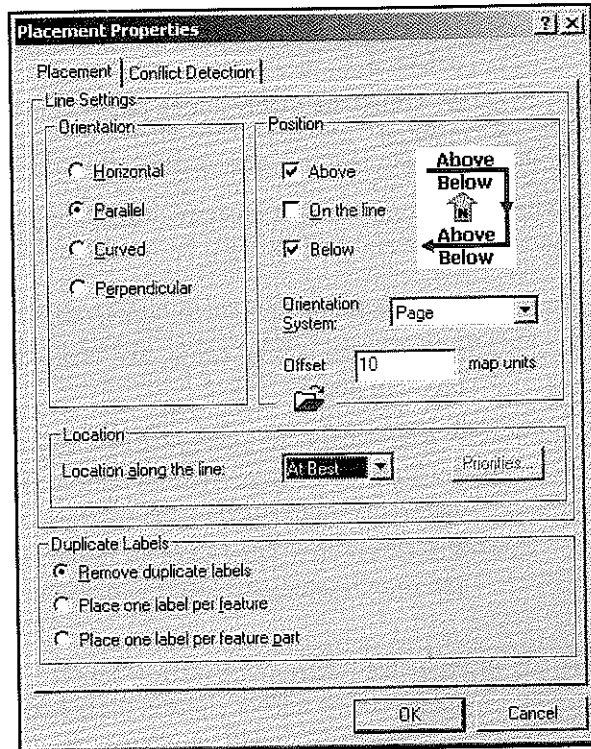
Fig. 2.22. Label placement options for lines

26➔ Cancel the Convert Labels to Annotation window, right-click the Rivers layer, and uncheck Label Features.

26➔ Open the Convert Labels to Annotation window again and fill the button to create annotation in the map.

26➔ Choose to create annotation only for the features in the current extent. We don't want to label every school in the state.

26➔ Keep the box checked to convert unplaced labels to unplaced annotation. These labels will be put in an overflow window for individual placement later.

26➔ Click Convert to create the annotation.

View the new annotation. It looks similar to the dynamic labels, but the labels are now individually adjustable. If you had unplaced labels, they were put in an overflow window (Fig. 2.23). We can place these labels manually.

27➔ In the overflow window, right-click the first label and choose Flash Feature. Repeat if needed until you see the school flash. (You may need to move the overflow window to see the flash.)
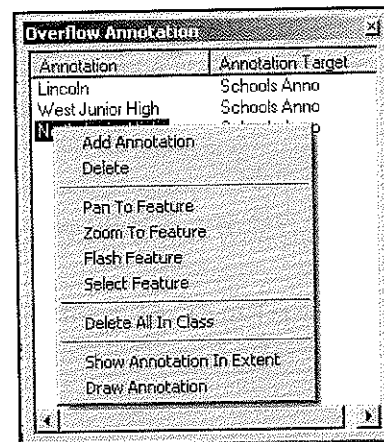
Fig. 2.23. Manually placing overflow annotation

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27➔ Right-click the school name again and choose Add Annotation. The label is added to the map. The light blue dashed line around the name indicates that it is currently selected.

27➔ Adjust the newly added position to fit. Select and move other school names if needed.

One benefit of annotation is customizing the label. Look at the long name for the South Dakota School of Mines and Technology. It would look better to call it by its nickname, SD Mines.

28➔ If the South Dakota School of Mines is in the overflow window, add it to the map.

28➔ Select the school name, and then double-click inside the dashed box. A text dialog box will appear.

28➔ Replace the text with **SD Mines**.

28➔ Click the Change Symbol button, and change the color of the text to blue, to distinguish the college from the K–12 schools. Click OK and OK.

28➔ Find the new label (it is far to the left). Put the cursor inside the label; then click and drag it to a good location near the school.

➔ Place the remaining overflow labels. To help fit the annotation, adjust the location of other schools and/or shorten the school names.

TIP: If you are not sure which school is which, use the Identify tool to learn its name. Click on the black arrow in the Drawing toolbar to continue moving the annotation.

Now that these labels are annotation, they will be scaled in size as the map scale changes.

29➔ Use the Zoom In tool to zoom into a section of the city with only a few schools. Although the school symbols remain small, the text becomes large.

Next we will set the reference scale so that both symbols and text are scaled.

29➔ Use Previous Extent to return to normal.

29➔ Right-click the Rapid City frame name and choose Reference Scale > Set Reference Scale from the context menu.

29➔ Zoom in again, and notice how this time the symbols increase in size as well.

29➔ Return to the previous extent.

TIP: To set an exact reference scale such as 1:24,000, right-click the data frame name, choose Properties, click the General tab, and type a specific reference scale in the appropriate box.

Some annotation properties can be modified, such as placing a scale range to show it only at certain scales. It can also be removed from the map if no longer needed.

30➔ Open the Rapid City data frame properties and choose the Annotation Groups tab.

30➔ Click the Schools Anno group and choose Properties.

30➔ Set the option to not show the annotation when zoomed out beyond 1:125,000. Click OK.

TIP: To remove annotation, click the Annotation Group name to select it, and click the Remove Group button.

Annotation stored in the map is saved by saving the map document. When creating annotation you can choose instead to save it as a feature class in a geodatabase, in which case more than one map document can use it. However, the Editor is then required to modify the annotation.

30➔ Click OK to close the Frame Properties window, and click File > Save As from the main menu bar.

30➔ Navigate to the mgisdata\MapDocuments folder for the location, and name the document *ex2_schools*. (It is not necessary to enter the .mxd extension.) Click Save. We'll use this document again in Chapter 9 to create a layout.

Labeling classes with different label styles

As a final example, we will create labels for subsets of features in a layer. We will label large towns with large text and smaller towns with small text (Fig. 2.24). This technique requires creating two classes of labels, setting an expression which defines each class (population < or > 10000), and setting the symbol properties for each class.
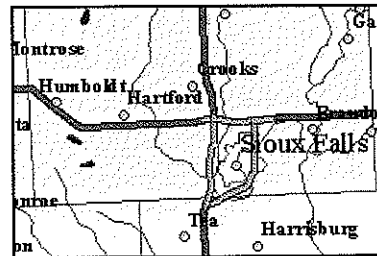
➔ Open the original ex_2.mxd document.

Fig. 2.24. Town labels

31➔ Zoom into the greater Sioux Falls area as shown in Figure 2.24. Sioux Falls is in southeastern South Dakota at the intersection of Interstates I90 and I29.

31➔ Open the Labels tab of the Layer Properties for Towns.

31➔ Check the Label Features box.

31➔ Choose the method to Define classes.

31➔ The current class is Default. Uncheck the Label Features in this class box. Since we will be creating new classes, we don't want the default class displayed.

31➔ Click Add to add a new class.

31➔ Name the new class *Cities* and click OK.

The new class is created, and now all of the buttons and properties in this menu refer to the Cities class. Next we need to define the members of the class using a selection expression and set the symbol properties (Fig. 2.25).

32➔ Click the SQL Query button and enter the expression [POP100] >= 10000.

32➔ Click Verify to check the expression for errors. (If an expression is incorrect, then no labels may appear.) Click OK and OK.

32➔ Check the box to Label Features in the Class.

32➔ Make sure AREANAME is the label field.

32➔ Click the Symbol button and choose Country 1 as the symbol for Cities. Click OK.

Now the Cities label class is completely defined. (You could edit other properties for label placement and scale range, but we won't do so at this time.) You can always go back to edit them later. We now create the other class, Villages.

33➔ Click the Add button and name the new class *Villages*. Click OK.

33➔ Repeat the steps for the Villages class just as for Cities, but for the labels choose the symbol Capital and make it Bold, and enter the SQL expression [POP100] <= 10000. Verify it and click OK and OK.

33➔ When finished setting the properties for both classes, click OK to close the property sheet and enact the changes.
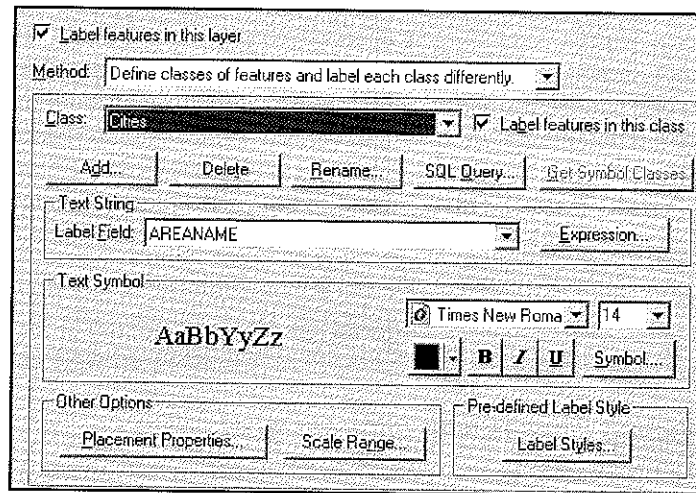
Fig. 2.25. Labeling properties window

TIP: To go back and edit properties for a label class later, access the class by clicking the Class drop-down button in the property sheet and choose the class to edit.

Notice on the map now that Sioux Falls appears in large type and the other towns appear in small type. You can add as many label classes to a layer as desired. Like other dynamic labels, these class labels can be converted to annotation and will retain their different sizes in the conversion.

Using the Label Manager

A map with many labeled layers can be cumbersome to adjust if one must keep opening label properties for each layer. The Label Manager facilitates the control of labeled layers and makes it easier to modify the properties of multiple layers.

34➔ Click the Label Manager button on the Labeling toolbar.

The Label Manager (Fig. 2.26) lists all the label classes from all the layers. Notice the two label classes you just added for the Towns layer: Cities and Villages. Imagine that you want to temporarily turn off the Villages labels.

34➔ Uncheck the Villages label class but leave Cities checked and click Apply. The village labels disappear.

　
34➔ Click the Cities label class in the Towns layer to highlight it. Notice the label properties appear in the window, similar to the way they appear in the Labels tab of the Layer Properties menu. You can use the Label Manager to edit the label properties of your label classes.

34➔ Change the Cities font color to green.

34➔ Click OK when you are done editing the labeling properties.
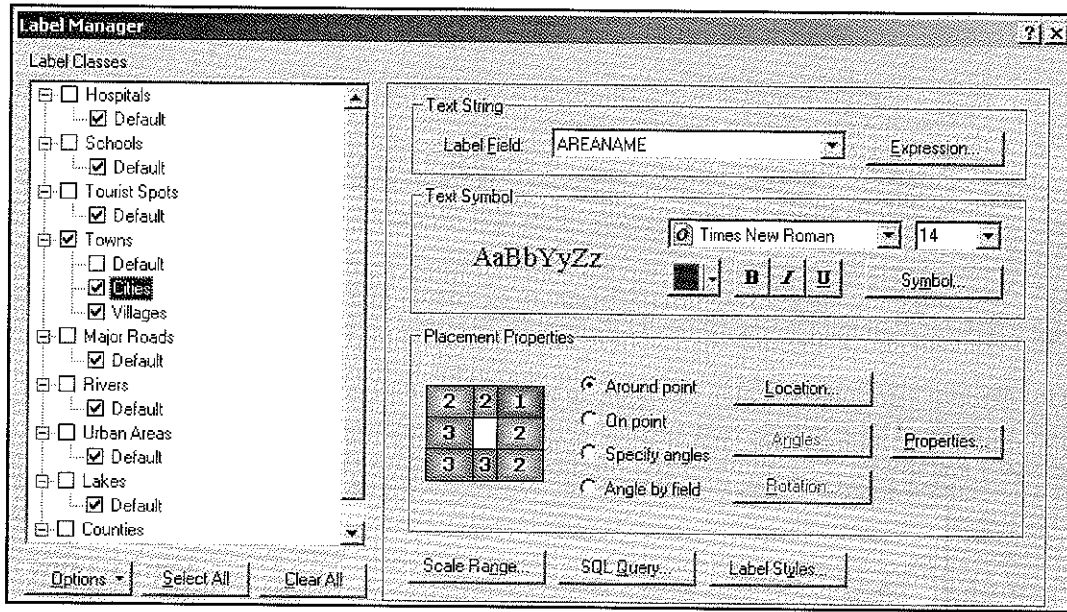
Fig. 2.26. The Label Manager

Creating a quick printout

Map documents are printed by creating a map layout in Layout view, setting up the map page, and printing. Chapter 9 covers this process in detail, but we'll do a quick one now using a predefined template.

35➔ Click the Layout View button to change to layout view.

35➔ Click the Change Layout button on the Layout toolbar.

35➔ Click on the General tab and examine the layout choices. As you click each name in turn, a thumbnail view shows what the layout looks like.

35➔ Choose the LetterPortrait.mxt template. Click Finish.

35➔ Click on the Full Extent button to view all of South Dakota again.

36➔ Click on the Select Elements tool. Click on the data frame and resize it to look like Figure 2.27.
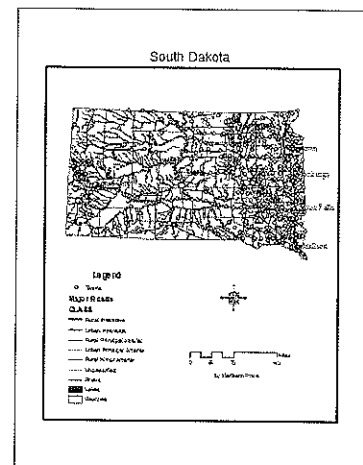
Fig. 2.27. A quick layout

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36➜ Use the Zoom In or Pan tools to adjust the placement of the map inside the data frame, if needed.

36➜ Click on the Select Elements tool again. Move and resize the legend, north arrow, and scale bar if needed to get an attractive map layout.

37➜ Double-click on the map title, enter a title in the box, and click OK.

37➜ Double-click on the text under the scale bar, enter by Your Name and click OK.

38➜ To print, choose File > Print from the main menu bar. Notice the preview showing how the map fits on the printer page.

38➜ Click OK to print it (or Cancel if you don't want it printed).

38➜ Return to Data View.

TIP: To change the page layout to Landscape or to change printers, click the Setup button in the Print window. See the Chapter 9 Skills Reference "Setting up the map page" for details.

TIP: Choose File > Export map to create an image file of a layout in a picture format such as JPEG or PDF. These images may be placed in word processing or presentation documents. See the Skills Reference "Exporting a map" in this chapter for instructions.

Using symbols and styles

Data layers may be represented with a variety of different symbols. The symbol properties of a layer control how it is displayed. To demonstrate, we will examine different ways of symbolizing town features. The towns of South Dakota in the map are currently drawn using a single symbol, a pink circle. First we will learn to change the characteristics of this symbol. Chapter 4 explains how to create and edit symbols.

39➜ Right-click the Towns layer and uncheck the Label Features option so the town labels are no longer being displayed.

39➜ Right-click the symbol for Towns in the Table of Contents. (Make sure to click the symbol, not the name.) Choose a different color from the palette.

39➜ Left-click the Towns symbol in the Table of Contents. This action launches the Symbol Selector, which has more options for changing the symbol.

39➜ Choose a different symbol from the palette. Experiment with changing its color and size. Then click OK to make the changes take effect.

➜ Examine the new symbols in the map. If they are unsatisfactory, open the Symbol Selector again and fiddle with the symbol some more.

ArcMap has many other symbol sets that come with it, and new symbols can be created as needed. Let's look at some of the other standard symbols available.

40➜ Click on the Towns symbol again to open the Symbol Selector.

40➜ Scroll down to the bottom of the symbol palette and note that the very last symbol is called Dam Lock.

40➜ Click on the More Symbols button.

The menu shows a long list of different **styles,** which are groups of related symbols used for a specific purpose. Notice that the first two, *yourname* and *ESRI,* are already checked, meaning that they are being displayed in the palette. You will now choose the Civic style and add it.

40➔ Click on the Civic symbol style, and scroll down to view the new symbols added to the bottom of the palette, finishing with various symbols for trees. Notice that the symbols are in alphabetical order by name.

40➔ Choose any symbol from the Civic list to display the towns.

Experiment with choosing different styles and symbols for line and polygon features.

➔ Click the symbol for the rivers and choose several different line styles from the default styles and/or add additional styles.

➔ Click the Counties layer symbol and choose several different shade styles.

This is the end of the Tutorial.

➔ Exit ArcMap. Do NOT save changes.

Exercises

Use ArcMap and the data in mgisdata\Sdakota\southdakota.mdb to answer the questions.

TIP: To submit certain answers to your instructor, you must capture an image from the screen and place it in an answer document. Whenever a question has the statement **Capture** at the end, capture the answer by making sure the ArcMap window is active, and simultaneously press the Alt and PrintScrn keys on the keyboard. This action places the active window on the Clipboard, and it can then be pasted into a Word or PowerPoint document. For help, ask your instructor.

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1. Find the Mount Rushmore Memorial in the interest feature class and zoom into it. Then answer the following questions.

In which county is it?

What is the name of the river running north of it?

What is the name of the closest town?

How far from the town is the memorial, in miles?

What are the names of the two tourist spots to the immediate northwest of the memorial?

2. Create a road map of South Dakota with the following characteristics:

➢ Show only the roads and counties. Make the outline of the counties medium grey so they are less prominent.

➢ Change the symbols of the roads to look like this legend. Use the Expressway symbol for the interstates and a thick single line for the others. Use a different color for each one. **Capture** the map.

CLASS
═ Rural Interstate
═ Urban Interstate
▬ Rural Principal Arterial
▬ Urban Principal Arterial
▬ Rural Minor Arterial

3. Locate Spink County and zoom into it so that the entire county is visible. Set up the map so that it displays the schools with purple school symbols, and the county outlines are thick black lines.

4. Next, use simple labels to label each of the towns in Spink County. Use a boldface type, and be sure to adjust the labels for best readability. **Capture** your map.

5. Turn off the schools and create labels for the rivers in Spink County, using italic blue text that follows along the river. Also label the two lakes. **Capture** your map.

6. What is the driving distance across South Dakota along Interstate 90, in miles? In kilometers?

7. Set up labels for the towns in South Dakota such that cities with more than 25,000 people are labeled in 14-pt. bold text, towns with more than 5000 people are labeled with 10 pt. bold text, and hamlets with less than or equal to 5000 people are labeled with 8 pt. italic text. Set the scale range on the hamlets so they do not show when zoomed out beyond 1:2 million. **Capture** a map of the entire state showing the labels, and **capture** another one showing the southeast corner of the state with the hamlet labels.

TIP: To select the towns, set up a double expression that looks like [POP100] > 5000 AND [POP100] < 25000. The field name must be repeated for the expression to work correctly.

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8. Add another data frame to the map that contains the lower 48 states with a light blue symbol, and rivers and lakes with a dark blue symbol. Group the lakes and rivers as a single layer named Hydrology. Place South Dakota on the map in dark purple, and label it with a callout label.

9. Make a layout with the two frames. Put on the title South Dakota and put your name below it. Print the map to turn in.

10. Create a labeled school map of Sioux Falls, just as you did for Rapid City, using annotation to get the best label placement possible. Label it with your name in one corner. **Capture** your map.
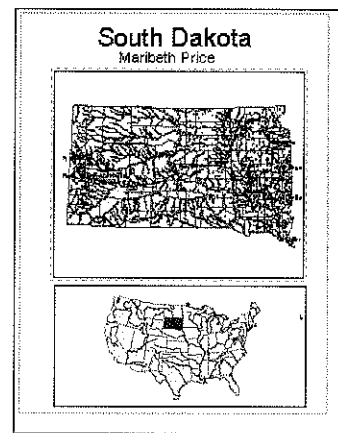
Challenge Problem

Create a United States map layout showing the conterminous states as well as Alaska and Hawaii. Use three different data frames, and include at least three different feature classes of your choice, using the same ones for all three frames. You don't need to include a legend. (**Hint:** Right-click a layer and notice that you can copy and paste layers between frames.)

Skills Reference

Starting ArcMap

ArcMap can be started several ways.

Fig. 2.28. Program icons

1. Click the Start button on the Start Menu bar of the computer and navigate to Programs > ArcGIS > ArcMap, and click it to start.

2. Find the ArcMap icon on the desktop and double-click it (Fig. 2.28).

3. Click the appropriate button in ArcCatalog (Fig. 2.28).

4. As ArcMap starts, it displays a dialog screen (Fig. 2.29). Choose to start with a new empty map, open a map template, or open an existing map.

5. To open existing maps, click Browse for maps to search for a map on the disk, or click one of the recently used maps shown in the list.
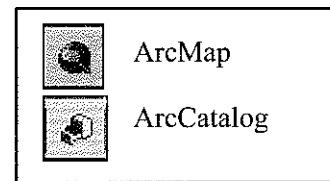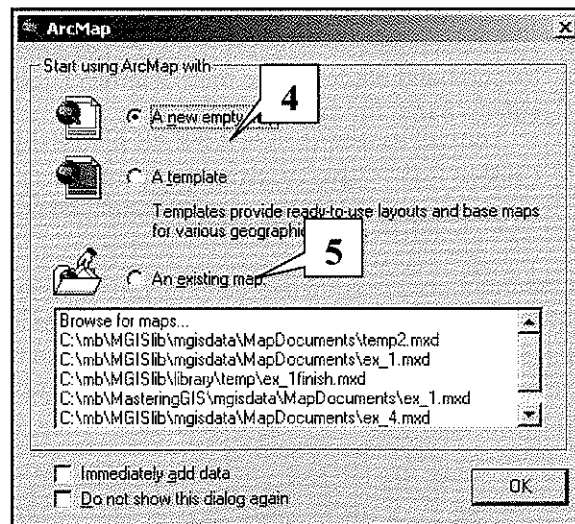
Fig. 2.29. ArcMap start-up dialog   95

Managing toolbars

1. To move a toolbar to another location on the GUI, click and hold on its handle (a shadowed line on its left edge) and drag it to the desired position (Fig. 2.30). This is a docked toolbar.

2. To move a toolbar off the GUI entirely, use the handle to drag it off the GUI. It then becomes a floating toolbar. It can be docked again by dragging it to a location on the GUI.

Fig. 2.30. Handle

3. To open a toolbar that is not present, right-click on a toolbar or empty space and choose the desired toolbar from the alphabetical list.
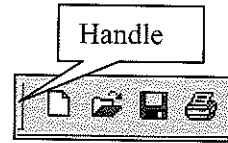
4. To close a toolbar, click on the X box in its upper right corner, OR right-click on a toolbar or empty space and choose the toolbar to close from the list.

Adding data

1. Click the Add Data button on the main toolbar OR choose File > Add Data from the main menu bar.

2. Use the Add Data dialog box to navigate to the folder containing the data to open.

3. Click on the data layer to select it. Select multiple layers by holding down the Control or Shift key while clicking additional data sets.

4. Click Add. The data will be added to the active data frame.

TIP: If the disk or directory containing the data does not appear in the list, you probably need to add a connection to it using the Add Connection button, as described in Chapter 1.

Saving an ArcMap document

1. Click on the Save button, OR choose File > Save from the menu bar.

2. If the document has not previously been saved, a dialog box appears for the user to select a location and name for the map document. Navigate to the directory to save it to, and then enter a name for the document.

3. Choose File > Save As from the menu bar to save the map document under a new name, leaving any previously saved version unchanged. Specify the location and name as for step 2.

TIP: The names of map documents, spatial data sets, and folders should not contain spaces or unusual characters such as #, @, &, *, etc. Use the underscore character _ to create spaces in names if needed. Although ArcCatalog and ArcMap allow spaces in names, the spaces can create problems for certain advanced functions. Thus, it is wise to avoid them entirely.

Opening an ArcMap document

1. Click the Open button OR Choose File > Open from the main menu bar.

2. Use the dialog box to navigate to the directory containing the file.

3. Click on the file to select it and choose Open.

4. If the currently open map has unsaved changes, you will be prompted to save them before opening the new document. ArcMap can only open one map document at a time.

5. To create a new, empty map document, click the New Map File button, OR choose File > New from the main menu bar.

Controlling display with the Table of Contents

1. To **turn a layer on or off,** click inside the check box.

> **TIP:** If the check box is dimmed, then the current map scale is outside the display range set for the layer. Try zooming to another scale, or reset the scale range in the layer properties.

2. To **change the draw order,** click and hold on the layer name and drag it higher or lower in the list. A black bar indicates where the layer will be placed. Release the mouse button to finish.

> **TIP:** If the layers don't seem to go anywhere when you drag them, and the black line does not appear, check to make sure that the Display tab in the lower right corner of the Contents box is clicked. You cannot move layers when the Source tab is clicked.

3. **Hide the legend** for a data layer by clicking the minus sign in the box next to the layer. Click the plus sign to expand it again.

Setting Map Tips

1. Right-click the name of the layer in the Table of Contents and choose Properties from the context menu.

2. Click the Fields tab and set the Primary display field for the text to appear in the tip.

3. Click the Display tab and check the box to Show Map Tips.

> **TIP:** If the Show Map Tips box is dimmed, then you must create a spatial index for the layer using ArcCatalog.

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Grouping layers for display

Grouped layers can be turned on and off with one mouse click.

1. Click the first layer in the group to highlight it, and then click the other members of the group while holding down the Ctrl-key. When you are done, all the group layers should be highlighted in blue.

2. Right-click a member of the group and choose Group (Fig. 2.31).

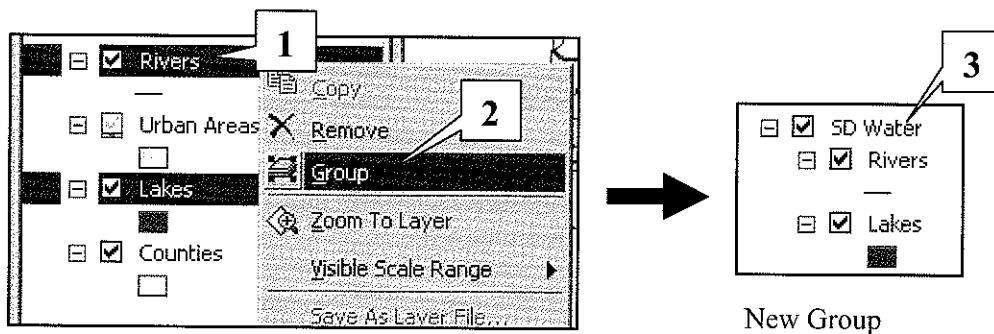3. Click on the New Group Layer name once to highlight it; then click on it again to type in a name for it. Press Enter to finish.

Fig. 2.31. Creating a group layer

Groups have joint properties such as setting scale ranges for the entire group at once. You can also add group members directly from the disk without needing to add them to the map document first. All layers in a group must be in the same data frame.

4. Right-click on the Group name and choose Properties from the context menu.

5. Click the General tab to set scale ranges for the group.

6. Click the Group tab and click Add to add more members to the group from the disk. Use Remove to remove members from the group. The Properties button is used to specify different properties for individual group members.

7. Click the Display tab to set transparency, brightness, or contrast for the group.

Using the Zoom/Pan tools and other zooming techniques

1. To zoom in to an area, click the Zoom In tool. Position the cursor to the upper left of the area to zoom to; then click and drag a box to encompass the area desired. Release the mouse button to finish.

2. To zoom out, click the Zoom Out tool and click once at the center zoom point. Draw a large box to zoom out slightly, or a small box to zoom out a great deal.

3. To zoom in by a fixed amount while remaining centered within the current extent, click the Fixed Zoom In tool.

4. To zoom out by a fixed amount while remaining centered within the current extent, click the Fixed Zoom Out tool.

5. To move the map, click the Pan tool, click on the map, and drag it to the desired area.

6. Click the Previous Extent button to return to the extent just before the current one.

7. Click the Next Extent button to return to the extent after the current one (this button is dimmed unless the Previous Extent button has been clicked).

8. Click the Full Extent button to view the full area of all the layers in the data frame.

9. To set a **bookmark,** zoom to the desired area and click View > Bookmarks > Create. Type in a name for the bookmark.

10. To zoom to an existing bookmark, click View > Bookmarks and choose the desired bookmark (Fig. 2.32).

11. To delete an existing bookmark, choose View > Bookmarks > Manage. Select the bookmark name by clicking on it, and click the Delete button.

12. To zoom to the reference scale, right-click the frame name and choose Zoom to Reference Scale from the menu.
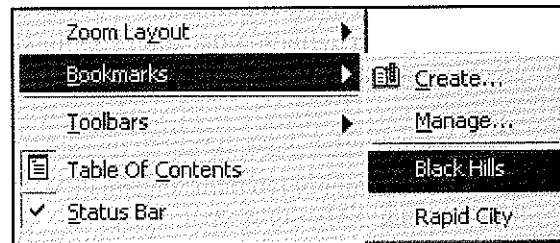
Fig. 2.32. Zooming to a bookmark

Identifying features

1. Click on the Identify tool.

2. Click on the feature to identify.

3. Clicking the identified feature in the dialog box will cause it to flash briefly (Fig. 2.33).

Sometimes you may have difficulty getting the right feature identified. Identify has some options to help: selecting the feature from the top layer, from the selectable layers, from all the layers, or from a requested layer.

4. In the Identify Results box, click the drop-down list at the top and select the option or layer desired.

5. If All Layers is the option selected, a list of features appears in the Results box, all of which were present at the point clicked. Click on a layer to view the attribute for that feature. Click on a different layer to see its attributes.
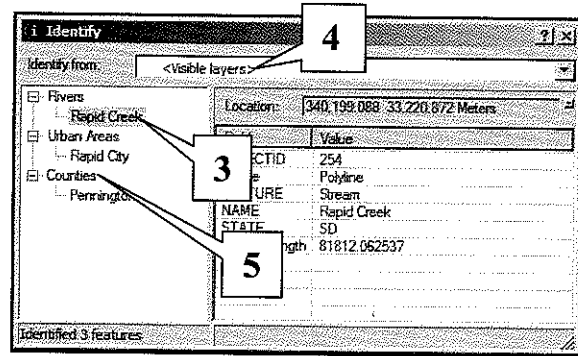
Fig. 2.33. Using Identify

Measuring features

1. Click the Measure tool. By default it measures distances.

2. Click on the map to start the line. Click along the path to be measured. Double-click to end the line. Both the total length and the length of the last segment are shown (Fig. 2.34).

3. Click the Measure Area button to measure a polygon area. Click to create vertices for the polygon and double-click when finished.

Fig. 2.34. The Measure tool

4. Click the Measure Feature button, and click on a feature to get its length, or area and perimeter.

5. Use the Choose Units button to set the units for length and area.

6. Use the Snap to Features button to make the cursor coincide with a feature when it gets close to it. This option is useful for precise measurements between or along features.

7. Use the Show Total button to keep a running count of all features measured.

8. Use the Clear/Reset Results button to clear running totals and reset the measurements.
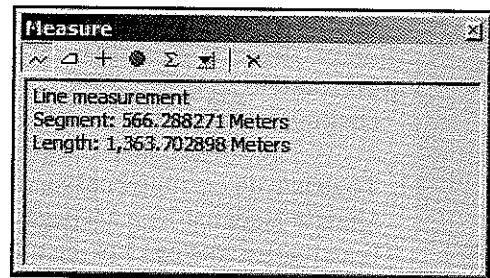
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Finding features by searching attributes

1. Click the Find tool and type the text to search for in the first box (Fig. 2.35).

2. Choose the layer or set of layers to be searched.

3. Check the box for an exact match or for features that are only similar to or contain the string.

4. Choose to search all fields, a specific field, or the primary display field.

5. Click Find to begin the search. Records that match the search will be listed at the bottom of the Find box.

6. Right-click one of the found records to display a context menu with options for flashing, zooming to, identifying, bookmarking, or selecting the found feature (Fig. 2.36).
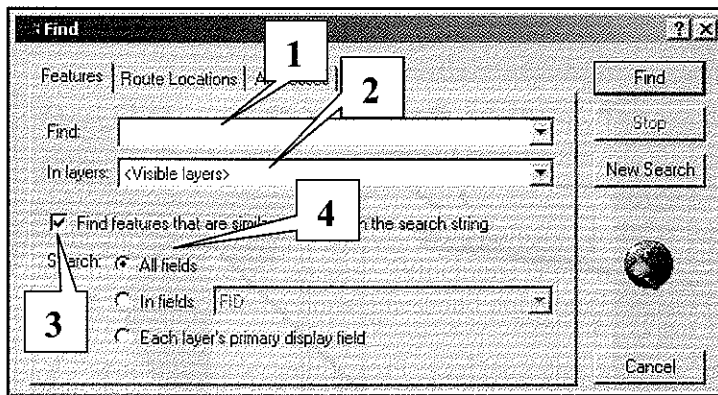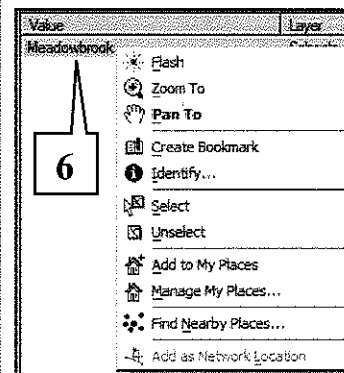

Fig. 2.35. Finding features

Fig. 2.36. The Find list

Setting data frame and layer properties

1. Right-click the frame or layer name and choose Properties from the context menu.

2. Click the tab containing the properties to set.

3. Enter the appropriate information and settings.

Defining symbols for a layer

You can set symbols a number of ways in ArcMap. Here are a few of the most common ways—all of these assume that all features in the layer are being drawn with the same symbol.

Changing the color of the current symbol

1. Right-click on the layer symbol in the Table of Contents, and choose a color from the palette that appears.

Changing properties of the current symbol

1. Click on the layer symbol in the Table of Contents to open the Symbol Selector window (Fig. 2.37).

2. Choose a symbol from the scroll box.

3. Modify the symbol's color, size, thickness, outline, or other attributes by setting the options provided. Make additional changes using the Properties button.

4. To load additional symbols in the scroll box, click the More Symbols button and choose from the list of categories.

Fig. 2.37. Symbol Selector

5. Use the drop-down Category box to change which categories are currently visible in the box.

6. Click OK when finished modifying the symbol.
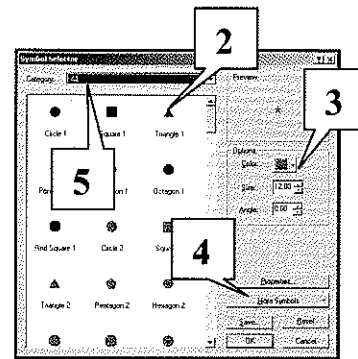
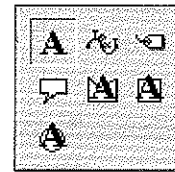*Labeling features interactively*

1. Look for one of the labeling tools on the drawing toolbar. Click on the black arrow for a drop-down menu to choose one of the tools.

Adding text to the map

1. Click the Add Text tool.

2. Click the desired location on the map and enter the text. Press Enter when finished.

3. Newly entered text is always selected, as shown by the dashed blue box around it. At this point you can change its font, size, or color using the menus on the Drawing toolbar. Or use the cursor to click and drag it to a new location.

TIP: To delete text, click the black arrow on the Drawing toolbar, click the text to select it, and press the Delete key. You can also use the black arrow to draw a box around many text boxes, or hold down the Ctrl-key to select multiple text boxes for deletion.

TIP: To delete all graphic elements including text, choose Edit > Select All Elements from the main menu bar, and press the Delete key. Be careful! This option also deletes any annotation saved in the map document.

Labeling a feature with its attribute

1. If needed, right-click the layer name, choose Properties, and click the Fields tab. Set the Primary Display Field to the desired attribute to appear in the label. Click OK.

2. Choose the Label tool from the labeling drop-down button. The Label Tool Options window will appear.

3. Choose whether to find the best placement (e.g., the center of a feature) or to place the label where you click. Also choose whether to use the symbol properties already set for the layer or to choose a new symbol style now. Click the X box to close the window.

4. Click on the feature to be labeled. ArcMap will label the topmost layer clicked, if more than one layer is present.

> **TIP:** The text symbol is set for the layer using the Layer Properties. Modify the default symbols by right-clicking the layer name, choosing Properties, clicking the Labels tab, and setting the text symbol.

Splining text from an attribute along a line

Splining text makes it follow along a linear feature such as a road or stream.

1. Set the font size and style options desired using the Drawing toolbar.

2. Choose the Spline Text tool from the labeling drop-down button.

3. Click vertices to define the line along which the text will appear. Double-click to end the line.

4. Type the text in the box and press Enter.

5. Use the Drawing toolbar to modify the position or font characteristics as needed.

Adding a callout label

A callout places text in a box with a pointer to the feature of interest.

1. Choose the Callout Text box tool from the labeling drop-down button.

2. Click on the feature to be labeled, hold, and drag to define the direction and length of the callout pointer.

3. Enter the text into the box and press Enter.

4. Click and drag on the text box to change its location, if desired. Click and drag on the blue dot to change the location of the pointer. Use the tools on the Drawing toolbar to modify the callout's font, style, size, etc.

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Creating wrapped text boxes

1. Choose one of the wrapped text tools: the New Polygon text, the New Rectangle text, or the New Circle text.

2. For the circle or rectangle text tool, click and drag to draw the circle/box, releasing the mouse when it reaches the desired size and shape. For the polygon tool, click on each vertex to define the desired shape, and double-click when finished.

3. Click in the empty shape to open the text Properties box (Fig. 2.38). Type in the text to be displayed. Do not use the Enter key unless you wish to enforce a new line within the text.

4. Set the symbol, spacing, or other options if needed.

5. Use the other tabs to change the margins, columns, frame border, size, position, or area background of the text box as needed.

6. Click OK to place the text.

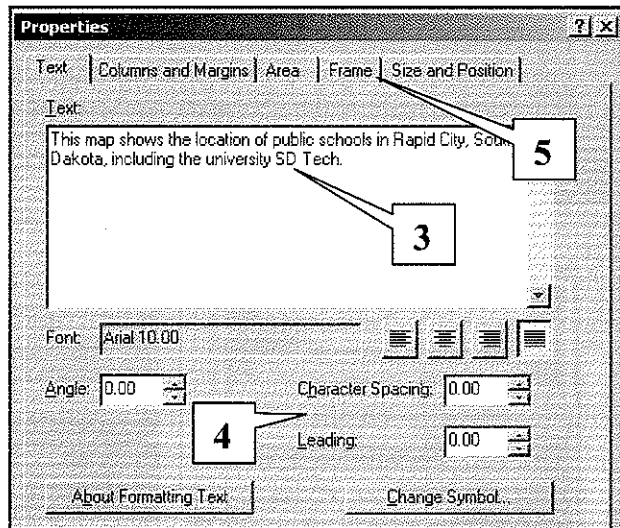7. To modify the text later, double-click to open its properties box.

Fig. 2.38. Wrapped text properties window

Setting the reference scale

1. Use the Pan/Zoom or Bookmark tools to zoom to the desired scale.

2. Right-click the data frame name in the Table of Contents and choose Reference Scale > Set Reference Scale.

TIP: To set an exact scale value such as 1:24,000, right-click the data frame name, open the data frame Properties, click the General tab, and type a specific reference scale in the appropriate box.

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3. To remove the reference scale, right-click the data frame name in the Table of Contents and choose Reference Scale > Clear Reference Scale.

4. To zoom to the reference scale, right-click the data frame name and choose Reference Scale > Zoom to Reference Scale.

TIP: Annotation, once created, retains its original reference scale set when it was created, even if the reference scale of the data frame is changed later.

Labeling features using dynamic labels

1. Right-click the layer name in the Table of Contents and choose Properties from the menu.

2. Click the Labels tab.

3. Check the Label Features box (Fig. 2.39).

4. Make sure the method is set to label all the features the same way.

5. Choose the Label Field. Click the Expression button to enter a VBA (Visual Basic for Applications) script.

6. Edit the font settings, or select a predefined text symbol by clicking the Symbol button and choosing a predefined symbol style.
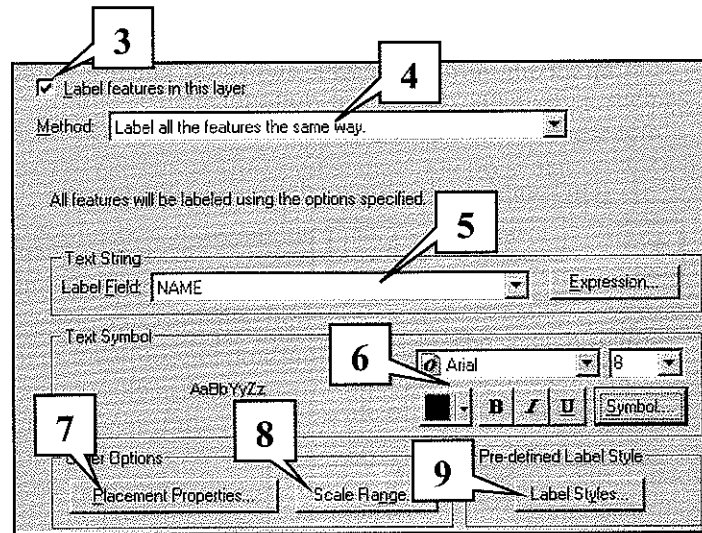
Fig. 2.39. The Label Properties window settings

7. For detailed control of label placement, click the Placement Properties button.

8. Set the scale range if desired, by using the label's scale range, or typing in new values. If the map scale is outside the specified range, the labels will not be drawn.

9. Select a label style, if desired. A label style includes BOTH a text symbol and predefined label placement options.

10. Click OK to place the labels.

TIP: Turn labels on and off for a layer by right-clicking the layer name in the Table of Contents and choosing the Label Features option. If the menu choice is checked, the labels are on, and choosing it will turn them off. If it is unchecked, choosing it will turn them on.

Converting dynamic labels to map annotation

These directions show how to create annotation stored as text graphics in a map. Consult the Help files for information on creating annotation as a geodatabase feature class.

1. Use the Layer Properties to create dynamic labels for all the desired layers. Take care in setting the properties, weights, and so on, because these will control the labels that appear.

2. Annotation will be created for all layers in the data frame with dynamic labels turned on. Turn off any dynamic labels for layers not to be converted.

3. Right-click the data frame name and choose Convert Labels to Annotation. The dialog box will appear (Fig. 2.40).
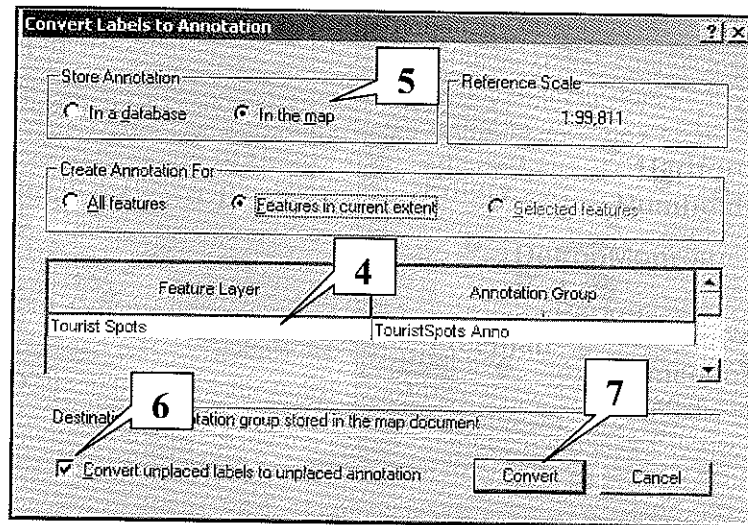
4. Examine which layers will be converted to ensure they are the desired ones.

5. Choose to create annotation in the map.

6. Check the box to Convert unplaced labels if you want to place overlapping labels interactively.

Fig. 2.40. Creating and placing annotation

7. Click Convert to create the annotation.

Unplaced labels will be placed in an overflow window if you checked that option. The next step is to place these labels interactively.

8. Right-click a label in the overflow list and choose a method to locate it (flash, pan, zoom, etc.).

9. Choose Add Annotation to add the label to the map. Click and drag it to adjust its location if necessary.
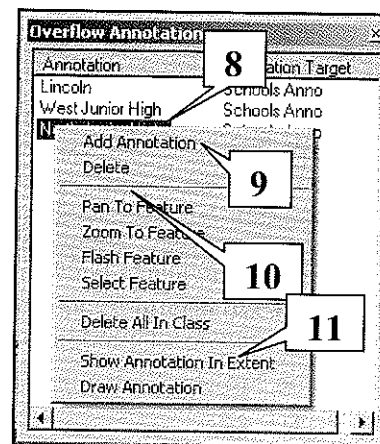
10. If you decide not to place the label, delete it from the list using Delete.

11. Use Show Annotation In Extent to list only the labels in the current view. Place all of these before zooming to another location—it saves time.

Creating a map from a template

A map template is a set of data frames, titles, styles, and other map elements which are already formatted and ready to receive the data in the data frame(s). Use a map template to quickly create a map using a standard format. You can also save your own map as a template to create a similar map again.

1. Click the Change Layout button in the Layout toolbar.

2. Click one of the tabs to see a choice of templates (Fig. 2.41). Templates you have created will be stored in the My Templates tab.

3. Click on a template to see a preview of it.

4. Use the Browse button to navigate to another directory containing more templates saved elsewhere.
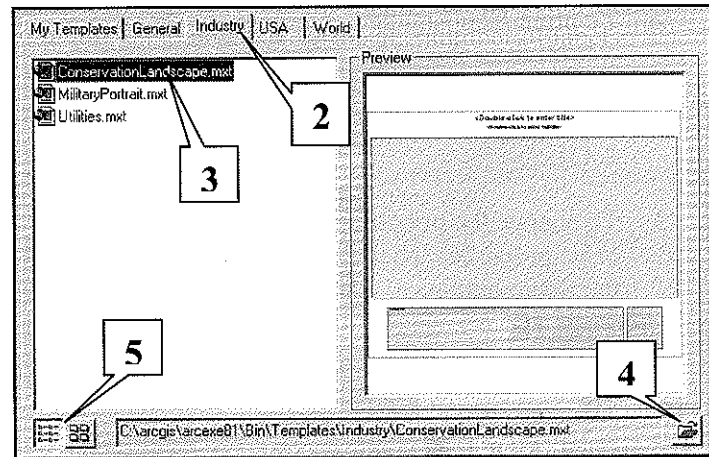
Fig. 2.41. Choosing a map template

5. Click the Thumbnail button to see icons of all the templates; click the List button to go back to the original list view.

6. Click the desired template and choose Next or Finish.

TIP: If the template has more than one data frame, it will prompt the user to assign the data frames in the map document to the data frames in the template.

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7. If the data frames need assigning, click each of the frames in the list on the left (Fig. 2.42).

8. Use the Move Up and Move Down buttons to put them in the same order as the numbered frames in the new layout.

9. Click Finish.

10. Finally, change any titles or other map elements in the template which need to be customized.
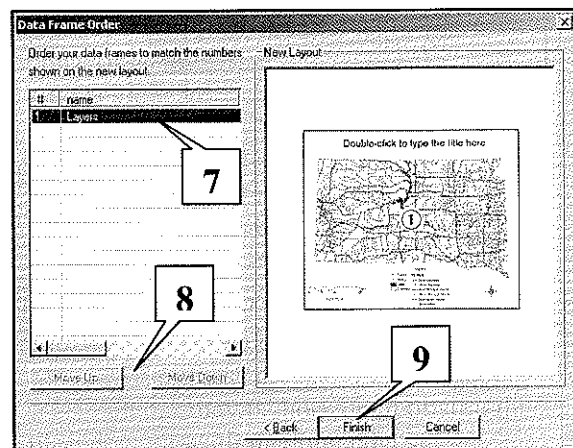
Fig. 2.42. Assigning map frames to the template

Printing a map

1. To preview a map to see how it will look on paper, chose File > Print Preview from the main menu bar.

2. To print, Choose File > Print from the main menu. The Print window appears (Fig. 2.43).

3. To change the printer or its properties, click the Setup button.

4. Set the number of copies to print.

Fig. 2.43. The Print window

5. Choose the desired tiling options if the map is larger than the printer paper.

6. Preview the layout placement on the page. Click OK.

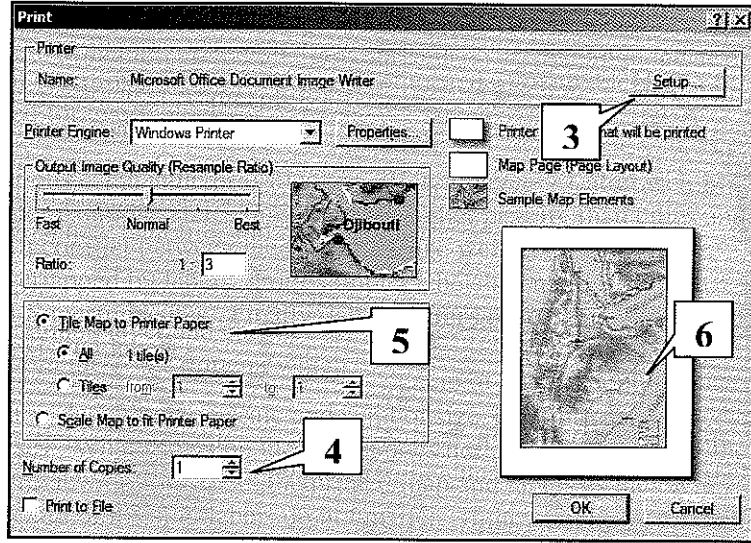## Exporting a map as a picture file

You can export a map as an image file to put it on a Web page or inside another document, or as a PDF to share it with others.

1. Choose File > Export Map from the main menu.

2. Navigate to the folder to save the picture file (Fig. 2.44). Choose the type of file and enter a name for it.

3. Click the gray arrow for more export options, such as the resolution. If planning to enlarge the map before printing, increasing the default resolution may be necessary.

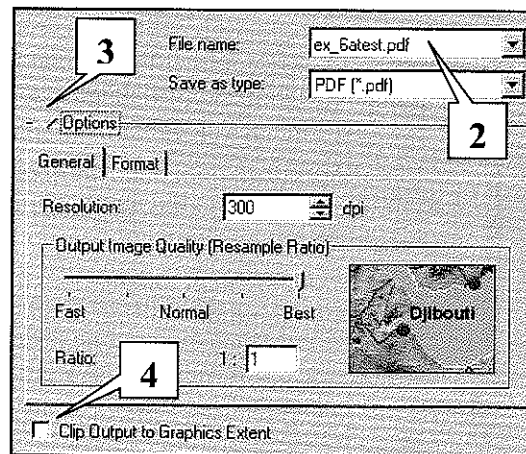4. To avoid having a white border around the picture, check the box to Clip Output to Graphics Extent.

Fig. 2.44. Exporting a map as a picture

5. Click Save.