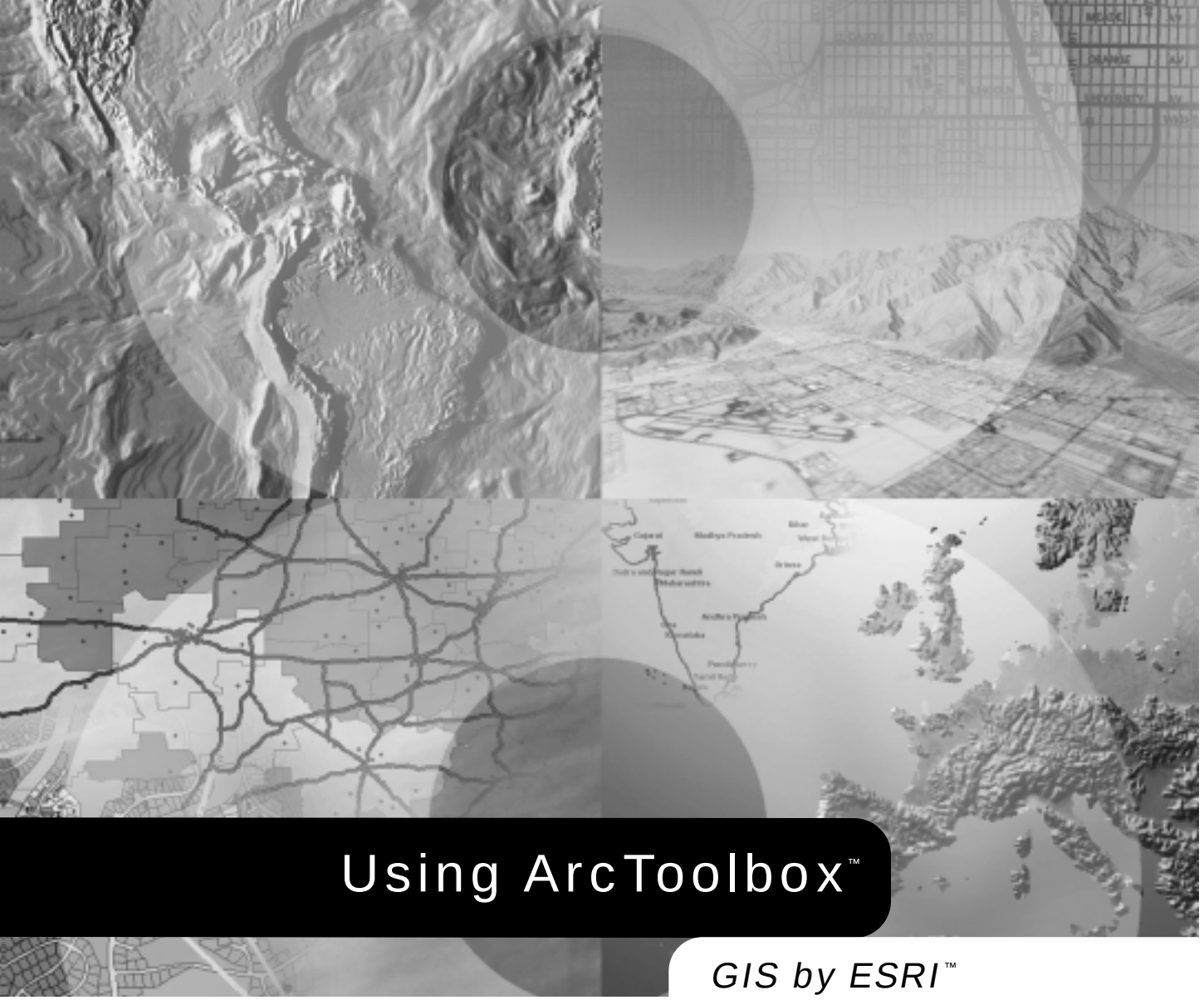

Using ArcToolbox™

GIS by ESRI™

CONTRIBUTING WRITERS

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Quick-start tutorial

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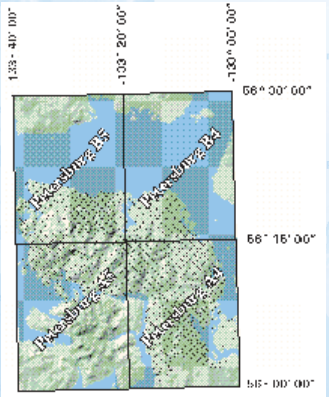
Conducting a GIS processing project is easier than ever with the powerful tools in ArcToolbox. When used in conjunction with ArcCatalog—the application for browsing, storing, organizing, and distributing data—ArcToolbox lets you meet the geoprocessing needs of your project quickly and efficiently.



In this tutorial, you'll use ArcToolbox and ArcCatalog to conduct a logging study for a portion of the Tongass National Forest in southeastern Alaska. By performing overlays, buffers, and other geoprocessing tasks with ArcToolbox, you'll calculate the dollar value of trees in areas suitable for logging. You'll use ArcCatalog to organize and manage your data, as well as to immediately preview the results for each step.

The study area is shown here. You will conduct the study for the PetersburgB4 and PetersburgB5 15-minute quadrangles. You will use base coverages and grids for forest stands, rivers, roads, and old growth to complete the study. This data has been provided with the software. Additionally, several of the coverages you would normally derive in the course of this project are provided to eliminate repetitive processing steps.

When conducting your analysis, you must keep certain study criteria in mind. First, harvest areas must be 100 meters from all roads and fish spawning streams. Second, areas must not include old growth forest.

You'll use several datasets throughout the course of the project. The following table provides descriptions of these datasets.

Coverage	Description
Oldgrowgrid	Grid of old growth forest stands
Overlay3	Overlay of buffered roads and streams, forest stands, and old growth forest
Road	Major roads
Roadbuf	Major roads buffered 100 meters
Standb5	Forest stands for PetersburgB5 in Universal Transverse Mercator (UTM)
Standddb4	Forest stands for PetersburgB4 in decimal degrees
Stream	Streams

The data you'll need for this tutorial is included on the ArcToolbox installation disk. The datasets were provided courtesy of the USDA Forest Service, Tongass National Forest, Ketchikan Area. They have been simplified by ESRI. The Forest Service cannot assure the reliability or suitability of this information. Original data was compiled from various sources, and spatial information may not meet National Map Accuracy Standards. This information may be updated, corrected, or otherwise modified without notice.

All exercises in the tutorial are processed locally, rather than being sent to a Geoprocessing Server for remote processing. It is recommended that you do not use the Geoprocessing Server for this tutorial if you have ArcInfo Workstation installed locally. If you need to use a Geoprocessing Server, see 'Using a Geoprocessing Server' in Chapter 3 before you start the tutorial.

This tutorial is designed to let you explore the capabilities of ArcToolbox and ArcCatalog at your own pace and without the need for additional assistance. You'll need about one hour of focused time to complete the six exercises in the tutorial. However, you can also perform the exercises one at a time if you wish.

Exercise 1: Organizing your data in ArcCatalog

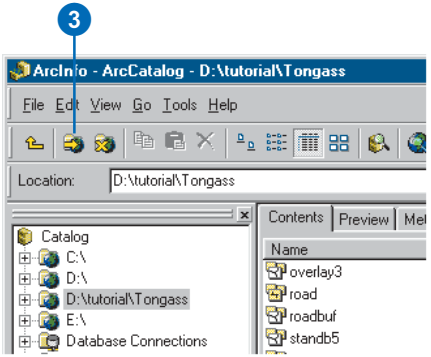
Before you begin your geoprocessing and analysis work, you must first find and organize the data that you'll need. You should organize your data in such a way that you'll be able to find it quickly and efficiently. This will be done using ArcCatalog.

Copying and connecting to data

You'll begin by copying the tutorial data provided with the ArcToolbox software to a folder on a local disk. You will work with a copy of the data locally if the data was installed on a connected disk, in order to maintain the integrity of the original data. Once it has been copied, you will then create a connection to the folder containing the data in ArcCatalog.

1. Start ArcCatalog by either double-clicking a shortcut installed on your desktop or using the Programs list in your Start menu.
2. Copy the ArcToolbox tutorial data from the directory where it is installed to your own tutorial workspace. In the examples shown here, the data has been copied to local drive D:\ and placed in a folder called "tutorial".

   In ArcCatalog, data is accessed through folder connections. When you look in a folder connection, you can quickly see the folders and data sources it contains. You'll now begin organizing your tutorial data by creating a folder connection to it.
3. Click the Connect To Folder button and navigate to the data folder. Click OK to establish a folder connection.



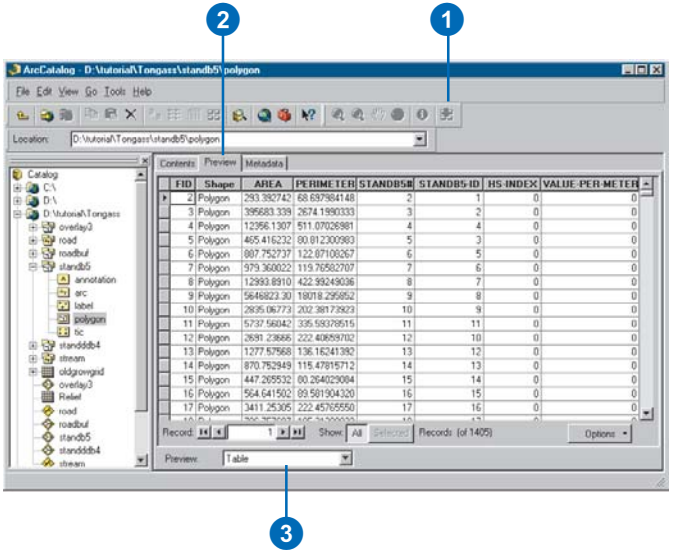
Your new folder connection—D:\tutorial\Tongass—is now listed in the ArcCatalog tree. You will now be able to access all of the data needed for your project through that connection.

Exploring your data

Before you begin your analysis, you should explore the datasets provided for the project. This will help you get a better feel for ArcCatalog and the tutorial data.

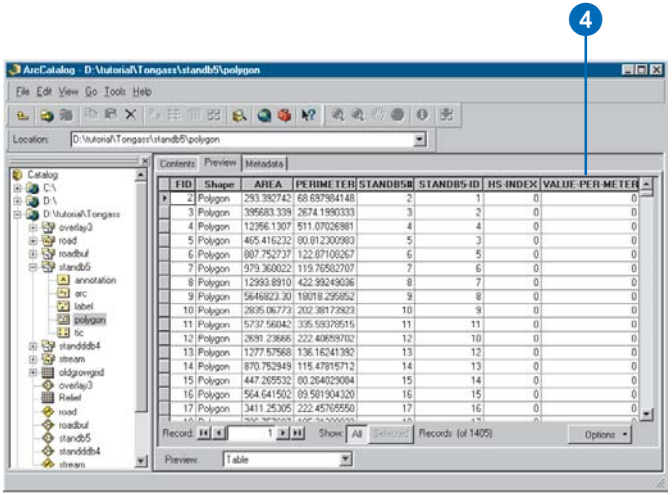
1. Click the Thumbnails button on the Standard toolbar to display previously created thumbnail images of the datasets in your Tongass folder.

   Layers have been created for all the coverages. The Standb5 coverage is in a UTM projection, while Standddb4 is in unprojected decimal degrees. All other coverages and grids have been merged and are in UTM projection.



2. Click the plus sign next to the D:\tutorial\Tongass connection to see the *datasets* contained in the folder. Click the Preview tab and click each dataset in the tree.
3. Double-click the Standb5 coverage to open it. Click the polygon *feature class*. Click the Preview dropdown arrow and click Table to see the feature attribute table contents. The VALUE-PER-METER field stores the value of the timber in each forest stand as a density—dollars per meter squared.

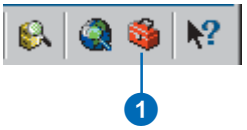
   Polygons with a value-per-meter attribute of zero are nonforested areas such as lakes and grasslands. Because the purpose of this project is to calculate the value of trees in areas suitable for logging, you will exclude the nonforested areas from the timber harvest. You will then compute the value of the timber in the remaining area using this attribute.
4. Right-click the VALUE-PER-METER field to open a context menu. Sort the table into ascending and then descending order. What is the lowest nonzero value per meter? What is the greatest?



Starting ArcToolbox

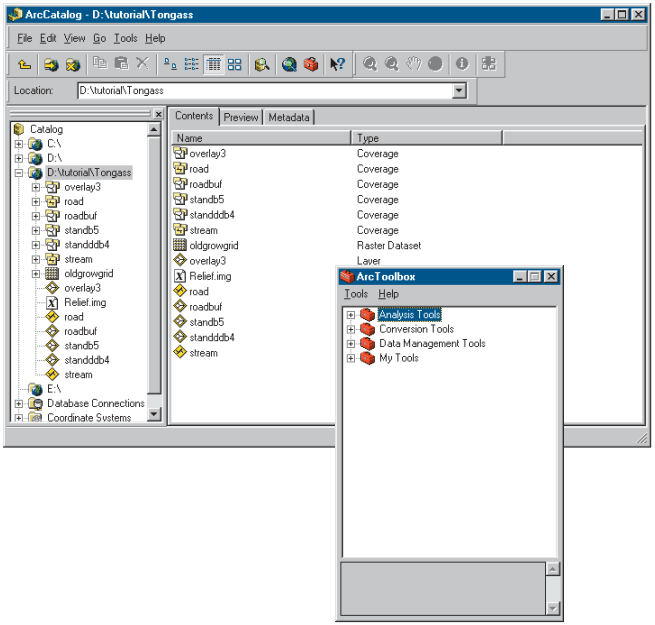
In the remaining sections of the tutorial, you'll conduct your geoprocessing work using ArcToolbox. You'll still need to use ArcCatalog to manage and examine your datasets. Keep both applications open for the remainder of the tutorial.

1. Click the Launch ArcToolbox button on the ArcCatalog toolbar to start ArcToolbox.



You can also start ArcToolbox as you would any other application—from the Start menu or from a shortcut on your desktop.

2. Both the ArcCatalog and ArcToolbox windows should now be open. Size and arrange the two applications on your screen so that both are visible.



You are now ready to start the first part of the tutorial: processing the forest stands. You'll be introduced to several ArcToolbox *tools* and *wizards* and will use these for your analysis.

Exercise 2: Processing the forest stands

In the first exercise, you prepared for the latter exercises by organizing your data. Now you are ready to begin processing your data. Two forest stand coverages—Standddb4 and Standb5—currently cover the entire study area. Before you can begin your study, these coverages must be merged.

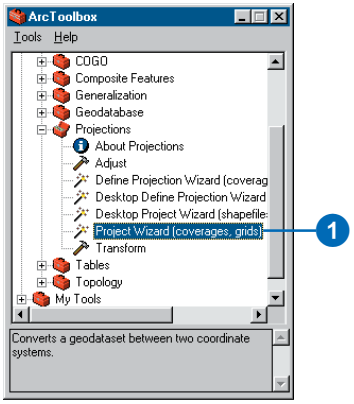
As noted in Exercise 1, the Standb5 coverage is projected in a UTM coordinate system, while the Standddb4 coverage is in unprojected decimal degrees. In order for you to conduct a meaningful analysis of these areas, the coverages must share the same coordinate system. For this reason, you will project Standddb4 to match the coordinate system of Standb5. Once this is done, the topology will have to be rebuilt as it is lost when a coverage is projected.

Projecting a coverage

ArcToolbox software's Project Wizard lets you easily project a coverage to another coordinate system. You can use the Project Wizard to manually define the output projection (you supply all the projection parameters), or you can have the wizard use the projection information stored in an existing coverage. For this study, you'll use the wizard to project the Standddb4 coverage to match the coordinate system of Standb5.

1. Double-click the Project Wizard (coverages, grids) in the Projections toolset of Data Management Tools.

   The first panel of the Project Wizard (coverages, grids) should now be open. You will use the projection information in Standb5 to project Standddb4.



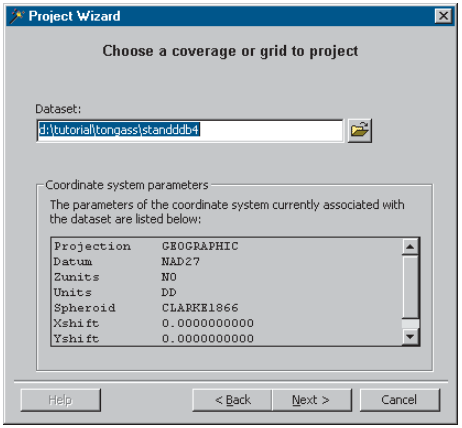
2. Click the option to Project my data to match existing data. Click Next.

   This panel is used to specify your input coverage. ArcToolbox gives you several options for setting input and output dataset names. You can type the full pathname to the dataset into the text box. You can also click and drag a dataset, or datasets, from the ArcCatalog tree or Contents tab and drop it on the text box. Alternatively, you can click the Browse button to open the ArcCatalog browser and navigate to your dataset.

   ArcToolbox has a feature called sticky paths. This means that it remembers the path to the last dataset you specified and will assume that the same path applies when you type only a dataset name into another tool or wizard. It also remembers output dataset paths.

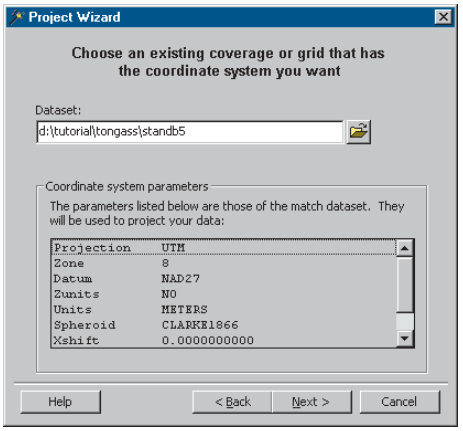
Tutorial instructions will simply ask you to type coverage names and their paths into the appropriate text boxes. However, feel free to use any of the techniques just described to make the entry.

3. Type "D:\tutorial\Tongass\Standddb4" in the Dataset text box. Click Next.



Use the next panel of the wizard to specify the name of the coverage whose projection information will be used to define the output projection. You will use Standb5 to define it. Notice that in both this and the previous panel, the wizard displays the projection information for the coverage you have selected.

4. Type "D:\tutorial\Tongass\Standb5" in the Dataset text box. Click Next.



The next panel appears, where you will specify the output coverage name. You will call the output coverage "Standb4" and store it in your Tongass folder.

5. Type "D:\tutorial\Tongass\Standb4" for the output dataset. Click Next. A summary page appears. Once you have reviewed the summary, click Finish.

   A message appears to tell you that the wizard is processing your request. This message appears in all tools and wizards when a process is active. When the tool or wizard is finished, the message disappears, indicating that the process is complete.

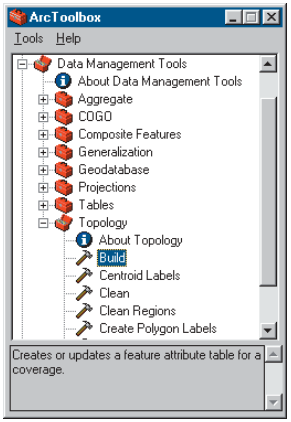
   Your new coverage should now appear in your Tongass folder.

6. Click the Standb4 coverage in the Catalog tree and click the Preview tab. Switch to Geography on the Preview dropdown list to see your new coverage.

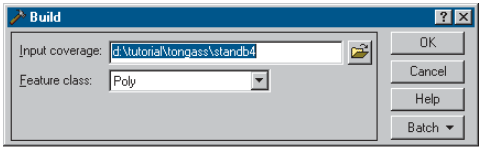
Building topology

If you double-click the Standb4 coverage in the ArcCatalog tree, you'll note that the coverage doesn't contain a polygon feature class. This is because changing a coverage's projection removes its topology. You must now rebuild polygon topology for your new coverage using the Build tool before going any further with your analysis.

1. Double-click the Build tool in the Topology toolset of Data Management Tools.



2. Type "D:\tutorial\Tongass\standb4" in the Input coverage text box.



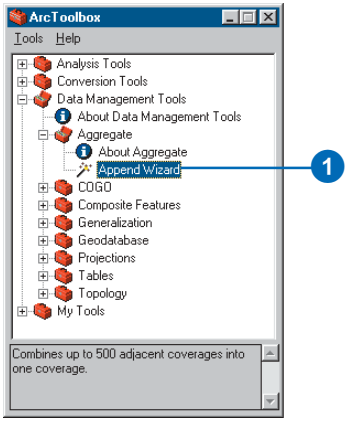
3. Change the Feature class to Poly. Click Yes on the subsequent message box to confirm Poly as the desired feature class. Click OK.

The Standb4 and Standb5 coverages are now in the same projection (UTM), and your new coverage has polygon topology. The next step is to merge the coverages together so that the data can be used as one dataset that matches the extents of the other coverages in the study.

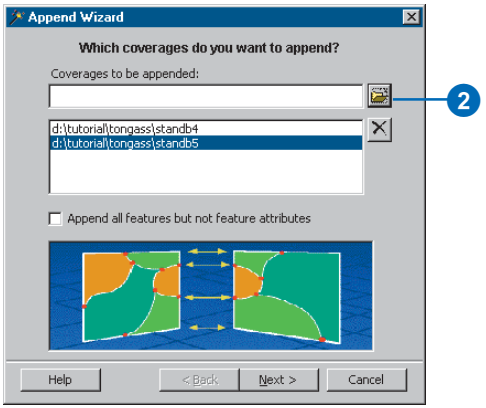
Merging datasets

You can use the Append Wizard to merge the two coverages.

1. Double-click Append Wizard in the Aggregate toolset of Data Management Tools.



The Append Wizard joins multiple coverages together when you type their names in the Coverages to be appended text box. The easiest way to do this is to use the browser and select all of the datasets at once. Simply click the coverage, then hold down the Ctrl or Shift key while clicking the other coverages to select them all.



2. Click the Browse button and navigate to the D:\tutorial\Tongass folder. Select Standb4 and Standb5 and click the Open button.

   Your coverages should now be listed on the wizard. If you made a mistake, you can remove a coverage by selecting it and clicking the Delete button next to the list.

3. Click Next.

   The next panel of the wizard appears. You will use it to specify the feature classes that will be merged.

4. Click Poly in the Feature classes list.

5. Click Next.

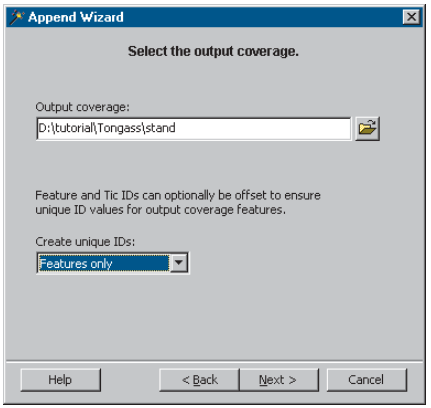
   This panel is used to specify the name of an optional clip coverage. You will not use a clip coverage in this tutorial.

6. Click Next.

   Use the next panel to specify the output coverage name and to offset the feature IDs. Unique feature IDs within the output coverage are necessary in order to maintain a relationship between the new features and the originals.

7. Type "D:\tutorial\Tongass\stand" in the Output coverage text box. Click the Create unique IDs dropdown arrow and click Features only. Click Next.

8. Review the summary panel and click Finish.



Your forest stand data is now ready to be used with the other Tongass datasets in the next exercise. By analyzing the forest stand data along with the coverages you'll create in the upcoming tasks, you will determine which areas are suitable for harvest and how valuable those areas are.

Exercise 3: Processing the streams and roads

In the last exercise, you processed the forest stands; now you will process the streams and roads data to eliminate the areas that do not meet the first of the specified criteria: harvest areas must be at least 100 meters from all fish spawning streams and roads.

To process the streams, you will first select and extract stream segments flagged as fish spawning grounds and place them in a new coverage named Fish. You will then generate a 100-meter buffer around each segment.

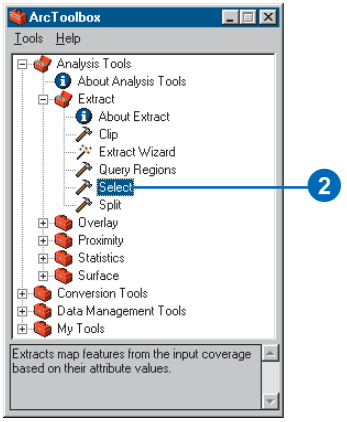
To meet the second part of the criterium—harvest areas must be at least 100 meters from roads—you would have to create a similar buffer. However, this step has already been completed for you to avoid repetition; the extracted roads are represented by the Roadbuf coverage.

Extracting features

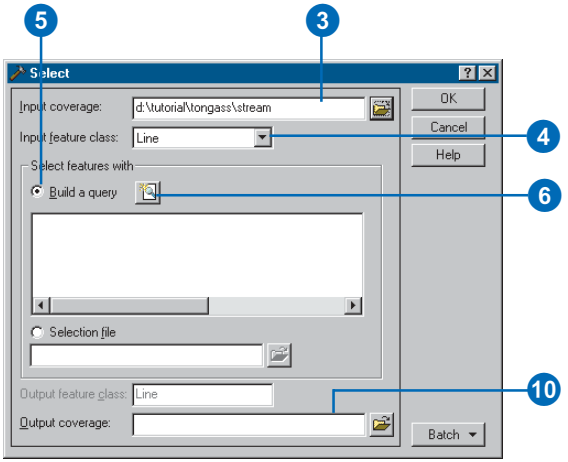
Using the Select tool, you will extract streams that are flagged as fish spawning areas to a new coverage. But first, you should examine the stream coverage in ArcCatalog to see how many streams are in the study area.

1. Click the Stream coverage in the ArcCatalog tree and click the Preview tab to examine the coverage.
2. Double-click the Select tool in the Extract toolset of Analysis Tools.

   You will now specify the coverage and feature class that you are processing, the logical expression that identifies the features (there is a button that opens a query builder), and the output coverage and feature class.



3. Type "D:\tutorial\Tongass\stream" in the Input coverage text box.
4. Click the Input feature class dropdown arrow and click Line.

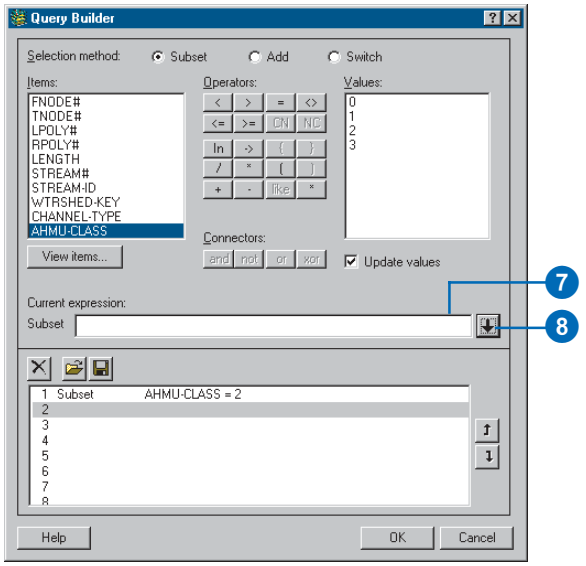


5. Click the first option to Build a query if it is not already selected.
6. Click the Query Builder button to open the Query Builder dialog box.

   You'll use the Query Builder to create the logical expression that identifies the features you want to select. You can type the expression directly into the text box or build the expression by clicking the fields, operators, connectors, and values. You must choose the selection method before creating the expression, as it affects the expression's logic. Once a suitable expression is created, you can add it to the tool's expression list.

   The default selection method is subset. If you are familiar with the ArcInfo TABLES™ module, subset is the same as using the RESELECT keyword when you create a selection expression.
7. Type the expression "AHMU-CLASS = 2" in the Current expression text box. Keep the default selection method.

   The item AHMU-CLASS is used to classify the stream types. All spawning streams have a value of 2. The expression tells the Select tool to extract only those streams with a value of 2—that is, the fish spawning streams.
8. Click the down arrow button next to the Current expression text box to add the expression to the list.



9. Click OK to close the Query Builder.

   Call your new coverage Fish and save it in your Tongass folder.
10. Type "D:\tutorial\Tongass\Fish" in the Output coverage text box on the Select tool. Click OK.

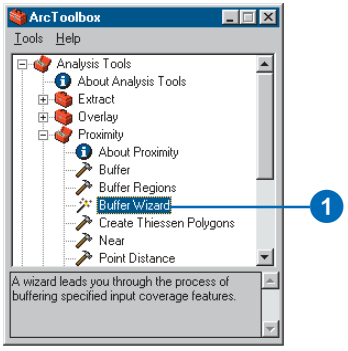
    A message appears when the processing is complete asking whether you want to see the output tool messages. Click Yes and review the number of input and output lines.

    You can now view your new Fish coverage in ArcCatalog.

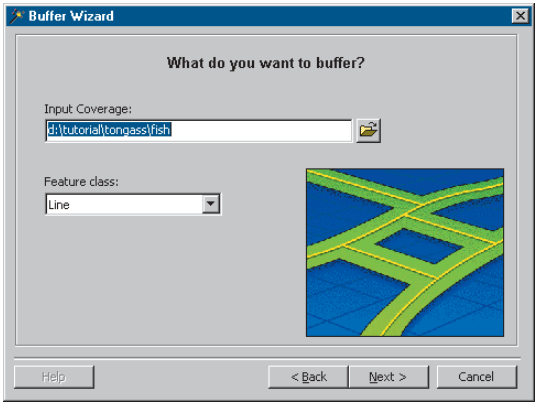
Creating a buffer

Now that you've created a coverage representing the fish spawning streams, you can build a 100-meter buffer around them using the Buffer Wizard. You'll end up with a new coverage called Fishbuf.

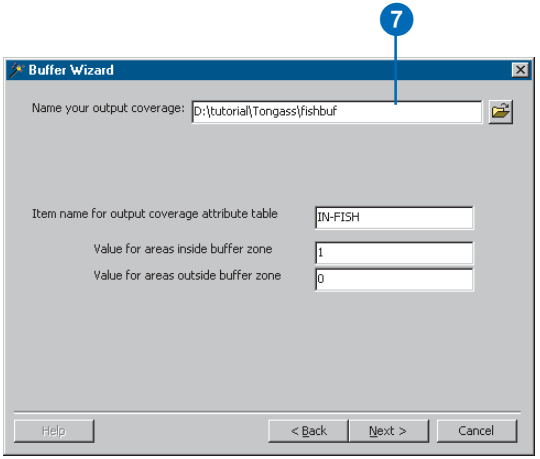
1. Double-click Buffer Wizard in the Proximity toolset of Analysis Tools.



2. Click Next after reading the introductory panel. You want the output coverage to contain polygons, not regions, so accept the default buffer type and click Next.

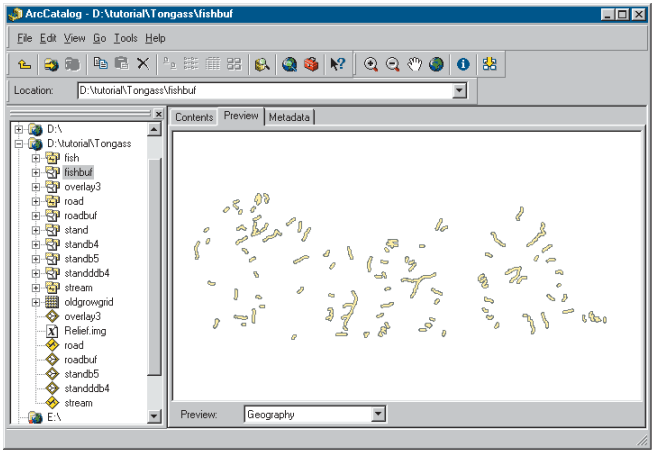


3. Type "D:\tutorial\Tongass\Fish" as the coverage you want to buffer. Click Next.
4. Accept the Single buffer with Specified distance option and click Next.
5. Type "100" as the buffer distance in meters and click Next.
6. Click Both sides with round ends for the buffer style. Click Next.
7. Type "D:\tutorial\Tongass\Fishbuf" as the output coverage.



You must now set the inside and outside values for the output coverage. Inside and outside values are used to determine which areas are inside or outside the buffer area.

8. Type “IN-FISH” as the item name. Type “1” for the inside value and “0” for the outside value. Click Next when finished.
9. After reviewing your choices on the last panel, click Finish to run the wizard.
10. View your Fishbuf coverage in ArcCatalog.
11. Examine the polygon attribute table for Fishbuf. Note the IN-FISH field and its values. Records with an IN-FISH value of 0 indicate a polygon that is not within 100 meters of a stream, while records with a value of 1 are within that distance. This item and its values will be important in a latter step that determines what areas are available for forest harvesting.



As mentioned earlier, one of the timber value criteria requires a 100-meter buffer on major roads. To make this buffer, you would follow the same process you just followed to create the Fishbuf coverage.

However, to eliminate a repetitive step, the Roadbuf coverage was created for you. It is in your Tongass directory; use ArcCatalog to examine it. Pay particular attention to the IN-ROAD polygon attribute.

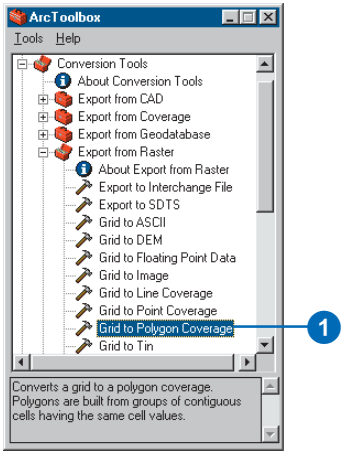
In the next exercise, you’ll create an old growth forest coverage. This coverage, along with the Stand, Fishbuf, and Roadbuf coverages, will be used to generate the final results.

Exercise 4: Converting data

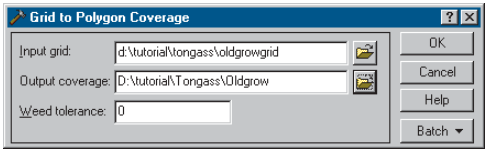
In the previous exercises, you processed forest stands, streams, and roads to help in your study. Now, you'll convert the *grid* of old growth forest areas into a coverage that will be used in an overlay with the forest stands. This grid was created exclusively for this tutorial; it was not provided by the Forest Service.

You'll use the Grid to Polygon Coverage tool to complete the conversion.

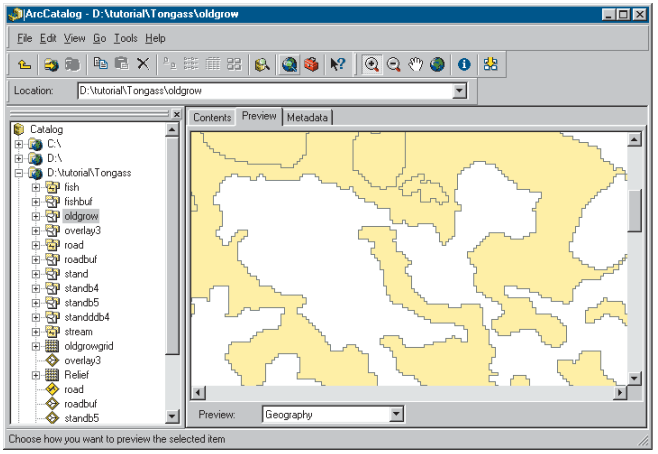
1. Double-click Grid to Polygon Coverage in the Export from Raster toolset in Conversion Tools.



2. Type "D:\tutorial\Tongass\oldgrowgrid" in the Input grid text box. Type "D:\tutorial\Tongass\Oldgrow" in the Output coverage text box. Click OK.

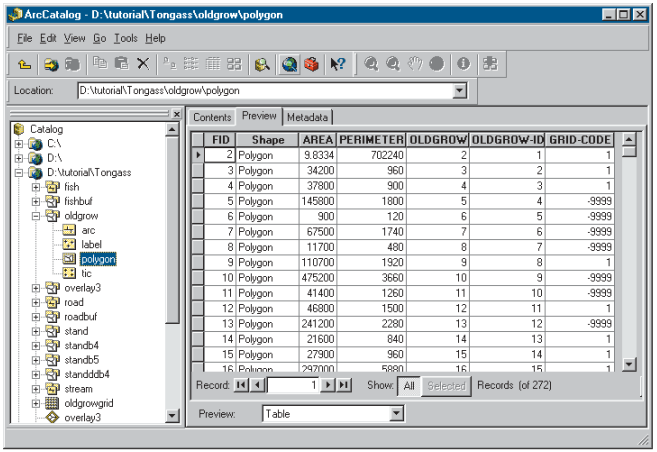


When the tool is finished processing the request, you should see your new coverage, Oldgrow, in the ArcCatalog tree.



3. Click the Preview tab in ArcCatalog to view the Oldgrow coverage in Preview view. Zooming in reveals the common stair-step effect found in vector data that has been converted from raster data.
4. Examine the attributes for the coverage's polygon feature class. Areas of old growth have a GRID-CODE value of 1. All other areas were "Nodata" in the grid and have a value of -9999. When inadequate information is available for a cell location of a grid, the location can

be assigned a value of Nodata. Nodata and "0" are not the same; "0" is a valid value. Because Nodata represents inadequate information, Nodata cells cannot be used in calculating the statistics in a grid's statistics (STA) table.



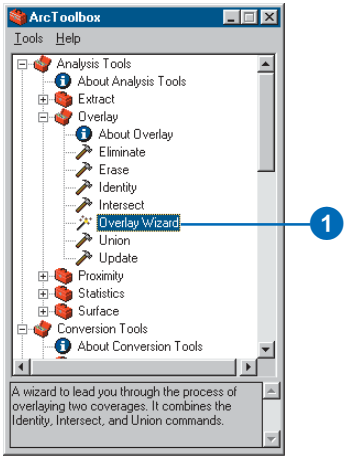
You now have all the coverages you need for your analysis. In the next exercise, you'll overlay them to create a final coverage for the study.

Exercise 5: Creating the analysis coverage

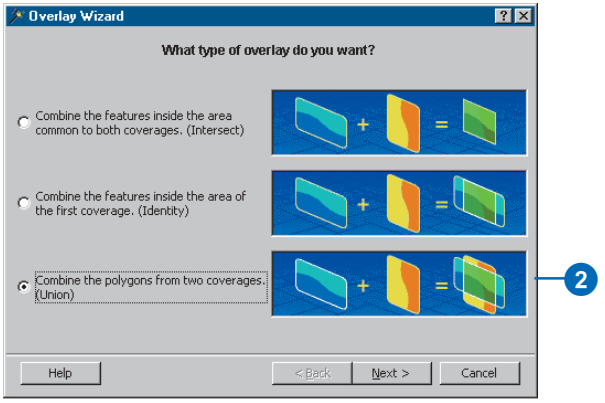
Now that you have organized, processed, and converted your data, you are ready to create the final analysis coverage. To create the final analysis coverage, it is necessary to overlay the Stand, Fishbuf, Roadbuf, and Oldgrow coverages. This would normally require you to perform two union overlays—Roadbuf with Fishbuf, and Stand with Oldgrow—and then intersect the two resulting coverages to create the final analysis coverage.

However, to avoid repetitive tasks, you will only perform one union overlay—Roadbuf with Fishbuf—so that you can experience the Overlay wizard. The final coverage required for the analysis has been created for you and is named Overlay3. You will examine the Overlay3 coverage at the end of this section.

1. Double-click Overlay Wizard in the Overlay toolset in Analysis Tools.

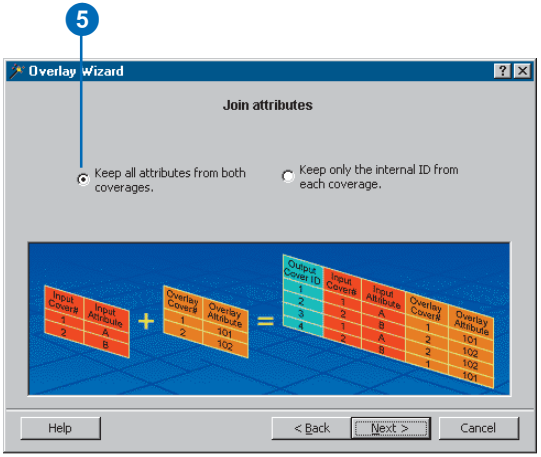


2. Click the third option to Combine the polygons from two coverages, then click Next.



3. Type "D:\tutorial\Tongass\Fishbuf" as the input coverage. Click Next.
4. Type "D:\tutorial\Tongass\Roadbuf" as the overlay coverage. Click Next.

5. Click the option to Keep all attributes from both coverages, as they are needed to determine what areas are outside of the road and stream buffers. Click Next.

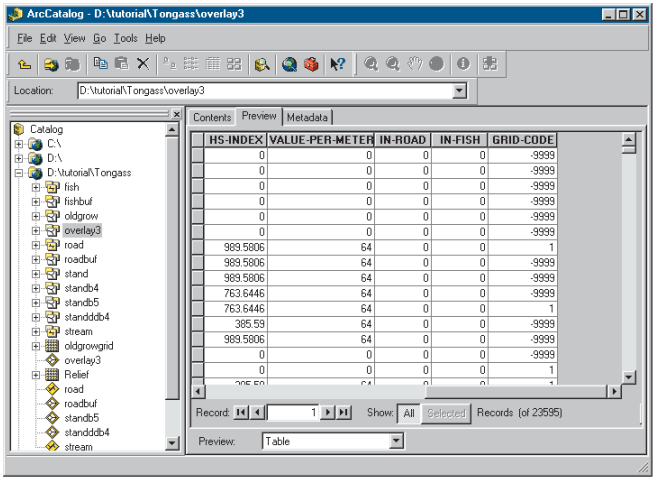


6. Type "D:\tutorial\Tongass\Overlay1" as the name of the output coverage. You want to use the default fuzzy tolerance, so click Next.

7. Review the summary panel to ensure all input is correct. Click Finish when you are done.

   As mentioned, the final overlay coverage, Overlay3, was created for you. Overlay3 was created using the same procedure you just followed. All of the extra fields resulting from the series of overlays (Cover#, Cover-ID) were deleted using ArcCatalog as they are not required for this analysis. The items created in the buffered coverages and the converted grid will be used to determine what areas are harvestable.

8. View the Overlay3 coverage in the Catalog. Examine the attribute values of the polygon attribute table. You should see the items you created when you buffered the roads and streams as well as the item created in the grid conversion.



You should now have a clear understanding of the steps that were needed to arrive at this point. ArcToolbox broke down complex tasks into easy-to-follow tools and wizards, and ArcCatalog allowed you to immediately preview your results.

With all of the geoprocessing work complete, you are ready for Exercise 6: Computing the timber value.

Exercise 6: Computing the timber value

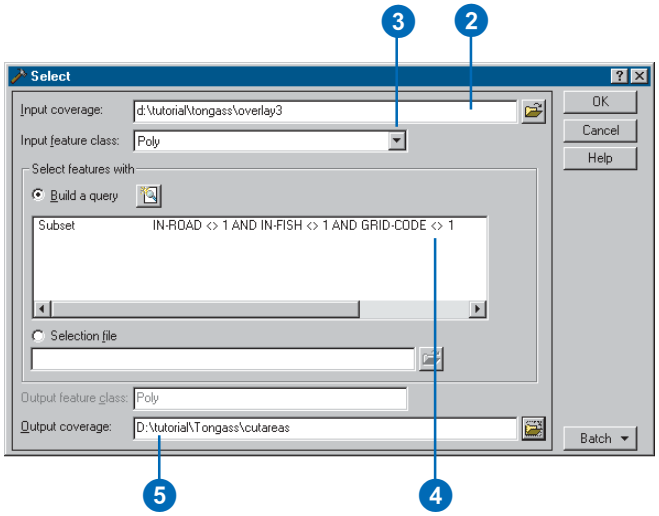
The first five exercises focused on geoprocessing tasks. In this exercise, you will build on these tasks by computing the value of the trees in harvestable areas. These are areas that are not old growth and are 100 meters away from fish spawning streams and major roads. You will use the Select tool to extract the polygons that meet these criteria into a new coverage called Cutareas. The Statistics tool will then weight the VALUE-PER-METER field by the area of each polygon and sum the results.

Remember that value-per-meter is a density expressing the value of the original stands in terms of dollars per square meter. Because this value is a density, it still applies even though the original stand polygons have been divided into many smaller polygons through the sequence of overlays that you have performed.

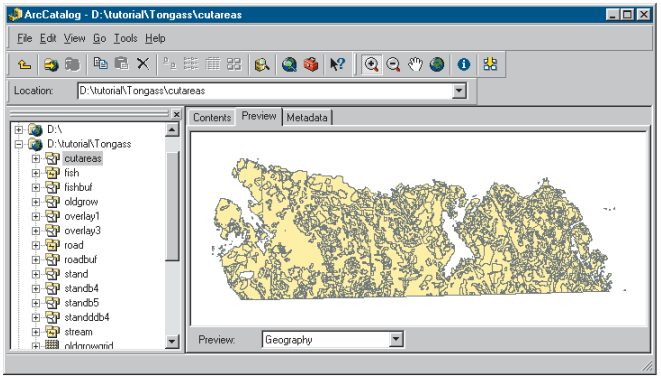
Extracting the polygons

You will begin by extracting the polygons that meet all of the criteria.

1. Double-click the Select tool in the Extract toolset of Analysis Tools.
2. Type "D:\tutorial\Tongass\Overlay3" in the Input coverage text box.
3. Click the Input feature class dropdown arrow and click Poly.
4. Click the Query Builder button to open the Query Builder dialog box. Create a logical expression to select all polygons that have a value not equal to 1 for the IN-ROAD, IN-FISH, and GRID-CODE items. The item that stores the old growth flag was given the name GRID-CODE. Remember that you can type the expression directly into the text box or build it by clicking the fields, operators, connectors, and values. Keep the default selection method of subset.



5. Type "D:\tutorial\Tongass\Cutareas" in the Output coverage text box. Click OK.



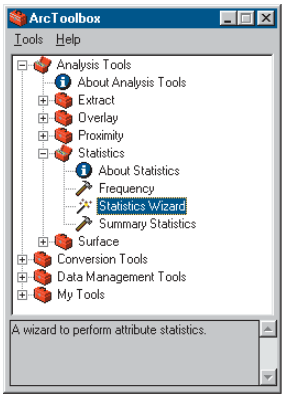
6. Examine the Cutareas coverage in ArcCatalog.

Visually, your new coverage is not much different from your Overlay3 coverage. However, in the new coverage, polygons that can't be harvested now have all their attributes set to 0. This includes the VALUE-PER-METER field. You can easily verify this by opening the Cutareas polygon attribute table and sorting it on cutareas-id. Those polygons with an ID of 0—there are quite a few—didn't meet your criteria.

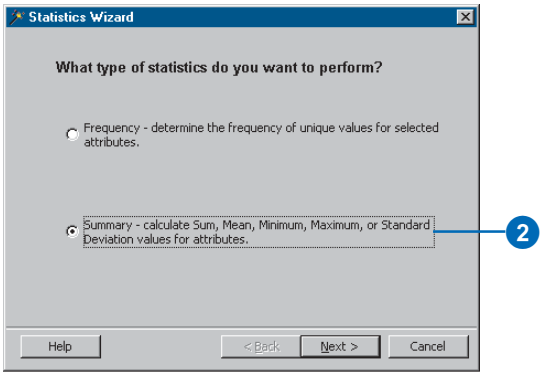
Generating statistics to show timber value

The last part of this tutorial involves using the Statistics Wizard to compute the dollar value of the trees in each polygon and to get a sum of all the values. The wizard will do this by multiplying the polygon areas (which are in square meters) by the VALUE-PER-METER values (which are in dollars per square meter). The result will be written to one record in an INFO™ file.

1. Double-click Statistics Wizard in the Statistics toolset of Analysis Tools.

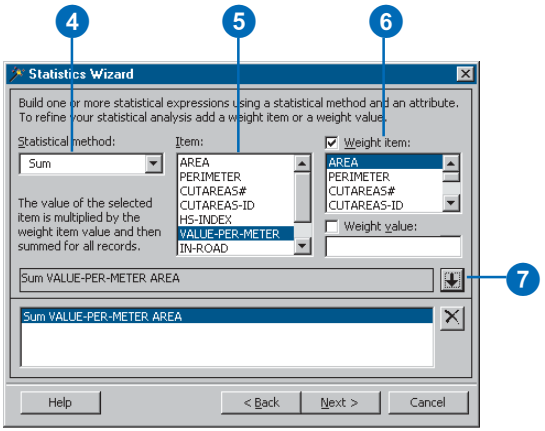


2. Click the second option to sum the contents of the value-per-meter item. Click Next.



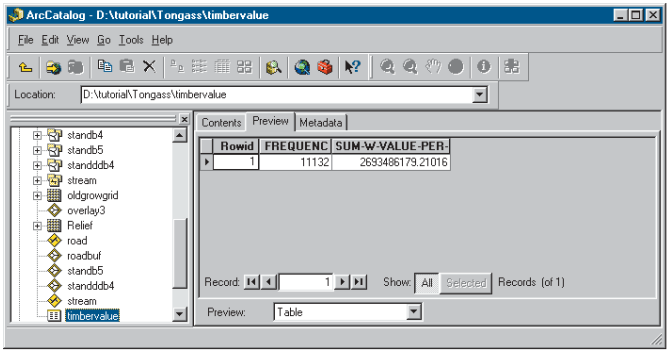
3. Type "D:\tutorial\Tongass\cutareas.pat" as the input table. Click Next.

4. Click the Statistical method dropdown arrow and click Sum.
5. Click VALUE-PER-METER in the Item list.
6. Check Weight item and click AREA in the list.



7. Click the down arrow button to add the expression to the list. Click Next.
8. Click Calculate statistics for all records. Click Next.
9. Type "D:\tutorial\Tongass\timbervalue" as the output table name. Click Next. Click Finish after reviewing the summary.

10. Examine your new timbervalue table in ArcCatalog using Preview view. What is the total value of all harvestable timber in the study area? If your number is about $2.7 billion, then you didn't make a mistake. Trees are worth a lot of money! Of course, this is the value of almost 110 square miles of forest.



This tutorial introduced you to the extensive capabilities of ArcToolbox and ArcCatalog. Using both applications, you quickly and easily performed a number of GIS operations and observed the results. You can now use these applications to perform your own analyses.

You have yet to uncover many features of ArcToolbox. In the next few chapters, you will review all the features that make ArcToolbox a user-friendly and complete GIS application for your daily needs.