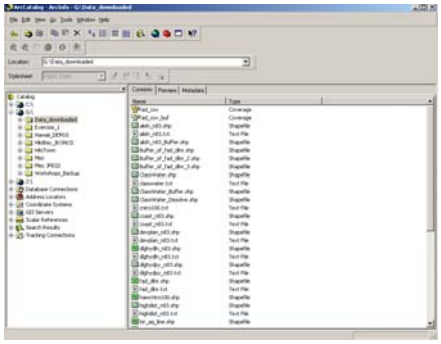
Workshop 1: Introduction to ArcGIS 9.1

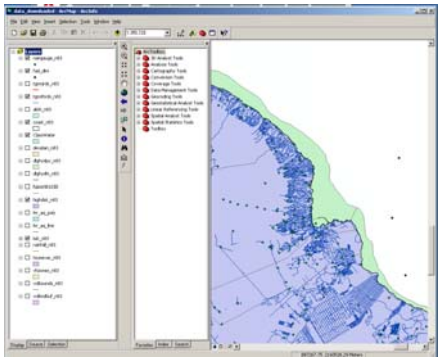
This exercise serves as an introduction to ArcGIS 9.1, and its two main applications: ArcMap and ArcCatalog. Environmental Systems Research Institute (ESRI) released version 9.1 in 2005. Unlike the previous release (ArcGIS 8), the new version integrates ArcToolbox into ArcMap and ArcCatalog. The new version provides access to a command prompt, scripting capabilities, and many other new tools. In ArcGIS 9.1, most tasks can be accomplished in multiple ways, with the use of the a pull-down menu, a toolbar, the Toolbox, the command prompt, or model builder. Within ArcGIS 9.1, three license levels (ArcView, ArcEditor, and ArcInfo) provide different levels of functionality and power. ArcGIS 9.1 maintains a similar interface to version 8.

ArcCatalog 9.1

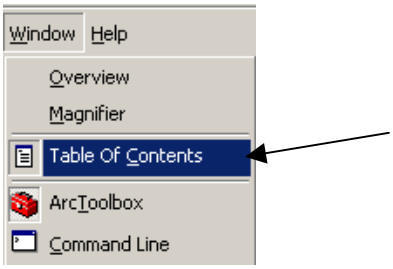


ArcCatalog serves as a file manager, allowing users to browse, manage, and document geographic data.

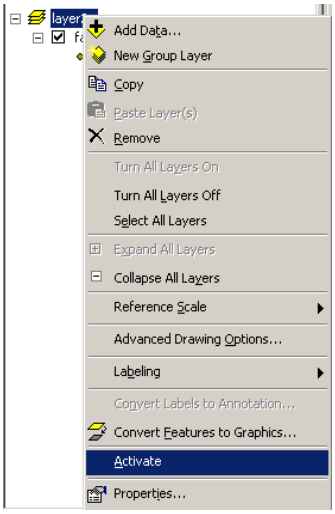
ArcMap 9.1



ArcMap allows users to explore, edit, query, analyze, symbolize, and layout data. ArcMap is typically the most widely used application.



The ArcMap interface can be configured in many ways, displaying a variety of windows and toolbars. Users often split the ArcMap window into three sections: the Table of Contents, the map display area, and the Toolbox. You can hide or display the Table of Contents by selecting the **[Table of Contents]** option in the **[Window]** menu. Similarly, ArcToolbox can be turned on and off from the **[Window]** menu, or by clicking on the ArcToolbox button in the standard toolbar.

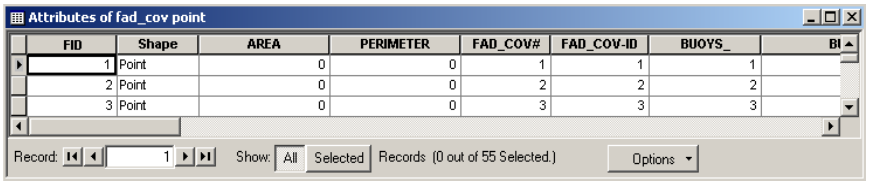


In ArcMap, the Table of Contents lists layers in the order drawn, with the top layers being drawn on top of the bottom ones. You can drag layers up or down to rearrange the order in which they are drawn.

Layers exist within data frames that can be viewed either (a) one at a time in the Data View, or (b) simultaneously in the Layout View. In the Data View mode, you can right-click on the data frame name and select **[Activate]** to make the layers within the data frame visible; ArcMap will not draw any layers from inactive data frames.

You can also group layers by right-clicking on the Data Frame name and selecting **[New Group Layer]** from the pull-down menu. Then to add, remove, and manage grouped layers, simply right-click on the group layer name and select the **[Properties]** menu.

Each data layer has an attribute table that contains descriptive information about its features (e.g., points, lines, polygons, etc.). Attribute tables store unique identifiers and attribute information, with each row describing one feature. The columns, or fields, consist of items automatically calculated by the software (e.g., area and perimeter), as well as items entered by or calculated by the user.



Overview

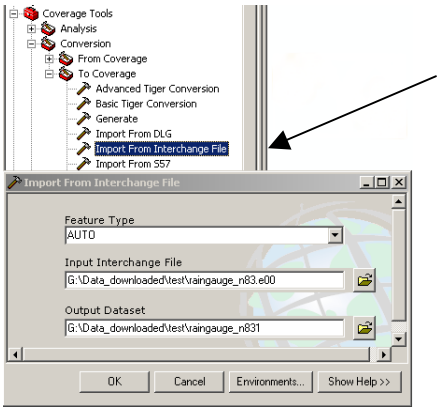
In this workshop, we will perform a series of tasks to illustrate some of the basic features of ArcGIS. Specifically, we will learn to extract subsets of data, represent data with different symbols, create and calculate new fields, query and sort data, create a graph, and produce a layout. We will explore ArcGIS in the context of a hypothetical research question: on the island of Hawaii, are there any contiguous forest tracts greater than 100 km^2, and if so where?

Getting Started

One of the best sources of GIS data in Hawaii is DBEDT's website:

http://www.state.hi.us/dbedt/gis/download.htm

From this site, you can preview layers, read metadata, and download ArcView shapefiles and Arc/Info coverages. The shapefiles are in

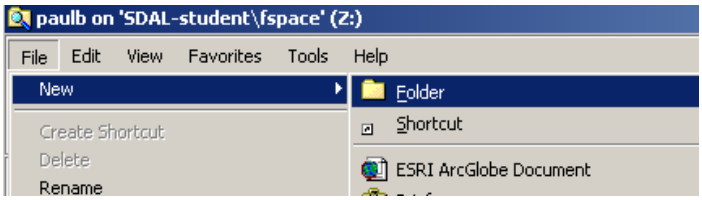


zip format, requiring decompression with WINZIP, while the Arc/Info files must be converted using the **[Import from Interchange File]** tool within ArcToolbox's Coverage Tools.

For this workshop, you will find the required shapefiles in the folder:

I:\ITER_GIS_Workshops_Fall2005\Workshop1\Data

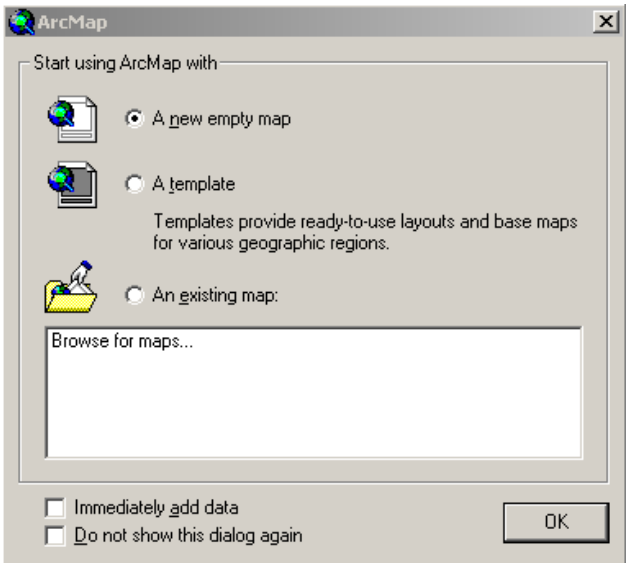
Before starting, you will need to create your own folder on your designated **(Z:)** drive. Double-click on the "My Computer" icon to launch the file manager. Then, with the **(Z:)** drive highlighted, pull down the **[File]** menu and select **[New] > [Folder].**

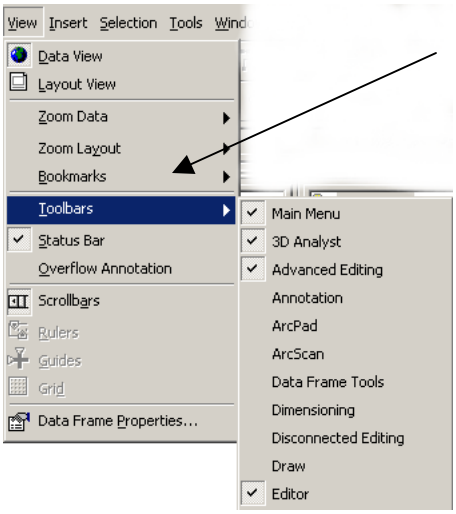


Click on the newly created folder icon 

and rename it to "gis_workshop1".

Next open ArcMap by double-clicking on the desktop icon, or by pressing the **[Start]** menu button > **[Programs]** > **[ArcGIS]** > **[ArcMap].** Choose to start ArcMap with **[A New Empty Map]** and click **[OK].**





ArcMap has many toolbars that can be accessed by pulling down the **[View]** menu, selecting **[Toolbars],** and then choosing the desired toolbar. The **[Tools]** and **[Standard]** toolbars, which open by default, contain many of ArcMap's most common tools and tasks.

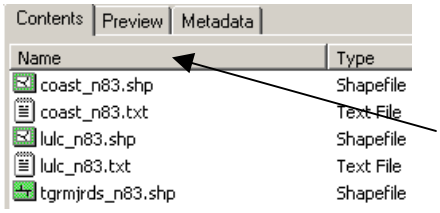
Tools Toolbar

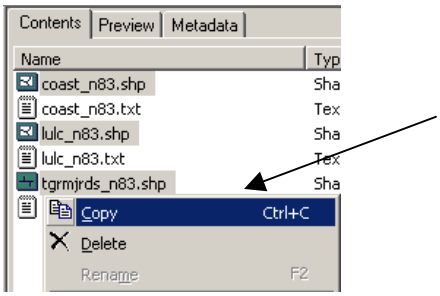
Standard Toolbar

Note the vertical bar on the left side of each toolbar. By clicking and dragging on this bar, you can move, dock, and reshape the toolbars as desired. When you hover over one of the toolbar buttons with the mouse, ArcMap displays the function of that button.

From the **[Standard]** toolbar, click the toolbox button  to open ArcToolbox. Next click on the ArcCatalog button  to open ArcCatalog. Alternatively, you can open ArcCatalog from the desktop icon or the **[Start]** menu. The **(I:)** and **(Z:)** drives should appear in the ArcCatalog directory tree, but if they do not, you can map them manually with the **[Connect to Folder]** button  .

Step 1: Adding Data

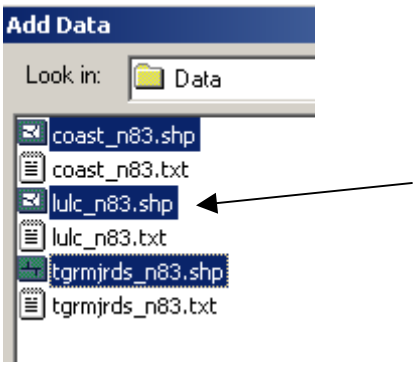




In ArcCatalog, expand the (I:) drive  by clicking on the "+" sign. Continue expanding the subfolders until you can see the contents of **I:\ITER_GIS_Workshops_Fall2005\Workshop1\Data** in the window on the right. Note that in ArcCatalog you can preview data or read metadata by hitting the tabs across the top of the window.

Now we are ready to begin. First we will use ArcCatalog to copy three shapefiles to our own directory. Highlight the three shapefiles (**coast_n83.shp, lulc_n83.shp, tgrmjrds_n83.shp**) simulataneuosly using Ctrl-Click. Then right-click on any of the highlighted files, and select **[Copy]** from the pull-down menu. Navigate to your "gis_workshop1" folder, and paste the three files anywhere in the empty right-side window. The three shapefiles should appear in your folder.

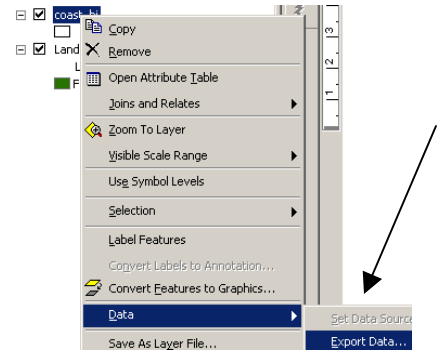
Click on the shapefile **lulc_n83.shp** in the directory tree, and experiment with the **[Contents]**, **[Preview],** and **[Metadata]** tabs. Using the **[Metadata]** > **[Spatial]** tab, can you determine the projected coordinate system for this file?



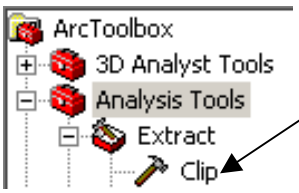
NAD_1983_UTM_Zone_4N, or North American Datum 1983, Universal Transverse Mercator, Zone 4N. Since all three layers are in the same projection, we can overlay them and they should line up accurately. Let us try this in ArcMap.

Return to your ArcMap window and click on the **[Add Data]** button  . Navigate to your folder, highlight all three shapefiles simultaneously, and press **[Add]**. The three layers should appear in the map display area. By clicking and dragging on the layer names, rearrange the layers in the Table of Contents in the following order: **tgrmjrds_n83** (major roads), **lulc_n83** (land use/land cover), and **coast_n83** (coast polygon). At this point, you ought to save your ArcMap document in your folder using the **[File]** menu > **[Save As]** option. Try to remember to save your work after every step!

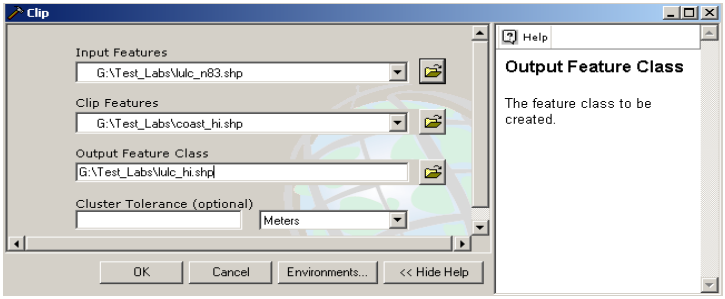
Step 2: Clipping



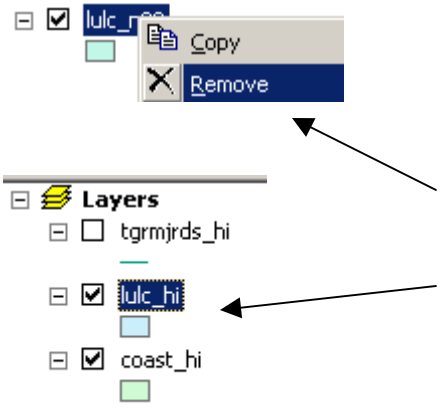
For this exercise, we will focus on the Big Island. Conveniently, we can use the Big Island coastline as the boundary for our study. Using the select tool  draw a box around the Big Island. ArcMap highlights every feature from all three layers. We can save the Big Island coastline as a new shapefile by right-clicking on the layer **coast_n83** in the Table of Contents, and selecting **[Data]** > **[Export]**. In the dialog box that appears, name the new layer "**coast_hi**" and select **[Yes]** to add the layer to the map. We can now use this layer as a "cookie-cutter" to extract subsets of the other two layers (land use and roads). Before continuing, go to the **[Selection]** menu and clear all selected features.



In ArcToolbox, expand the **[Analysis Tools]** and **[Extract]** folders, and then double-click on the **[Clip]** tool. Click on the **[Show Help>>]** button to see additional information about this tool and its input parameters. Using the browse button  , enter the layer **[lulc_n83.shp]** as your input feature, **[coast_hi.shp]** as the clip feature, **[lulc_hi.shp]** as the output feature, and press **[OK]**.



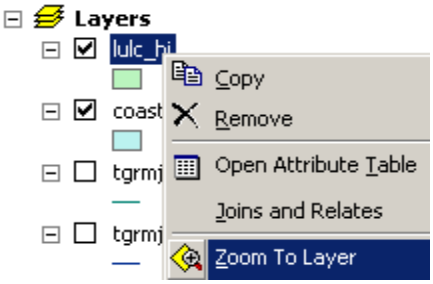
ArcMap automatically adds the new output shapefile **lulc_hi.shp** to



your map. Close the **[Clip]** window after the script finishes. Now perform the same operation on the road layer **[tgrmjrds_n83.shp]**, clipping out the Big Island's roads and naming the new feature class **[tgrmjrds_hi.shp].**

Let us clean up our view. Remove the three original layers **tgrmjrds_n83**, **lulc_83**, **coast_n83** by right-clicking on them, and selecting **[Remove].** Reorder the layers to match the adjacent list, and un-tick the box next to **tgrmjrds_hi**.

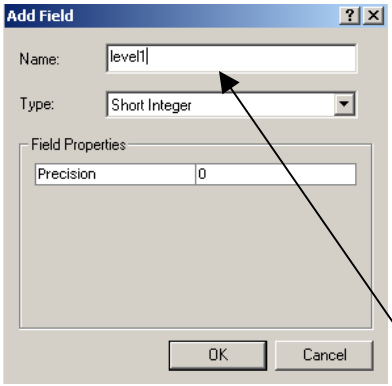
Let us focus more closely on Big Island land use. Right-click on the layer **[lulc_hi]** and select **[Zoom To Layer],** or press the full extent tool  . You should see a map similar to the one below.

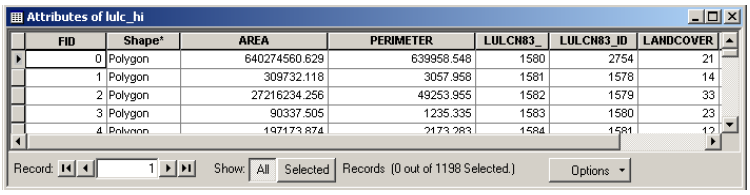


By default, ArcMap initially displays layers using random symbols, in this case a single solid color. In Step 4, we will modify the symbols using the **[Layer Properties]** window and **[Symbology]** tab, but first, we need to reclassify the land use codes.

Step 3: Reclassifying

Open the land use attribute table by right-clicking on the layer **lulc_hi** and selecting **[Open Attribute Table].**



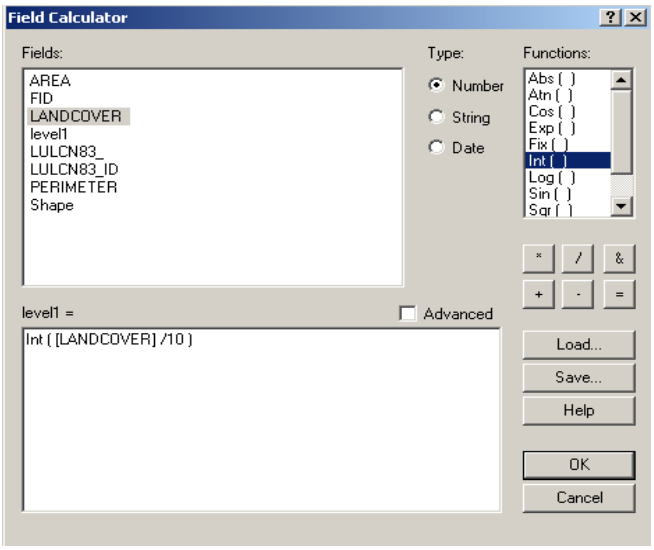


The field "**landcover**" contains Level II codes (see sidebar for complete list); however, for this exercise, we are concerned primarily with Level I codes. To reclassify our data, we can add and calculate a new field in the attribute table. Press the **[Options]** button at the bottom of the attribute table and select **[Add Field]**. Give the new field the name "LEVEL1" and press **[OK]**. Now we can calculate values for this field. It is possible to calculate fields outside of an edit session, but in this exercise, we will do it within an edit session. Open the editor toolbar by pulling down the **[View]**

menu, and selecting **[Toolbars]** > **[Editor]**. Then choose **[Start Editing]** from the toolbar. Within the attribute table, right-click on the field name "LEVEL1" and choose **[Calculate Values]**. Now we can insert a formula into the lower window of the **[Field Calculator]** to make the calculation.

Land Cover Codes:

Level I	Level II
1 Urban or Built-up Land	11 Residential
	12 Commercial and Services
	13 Industrial
	14 Transportation, Communications, Utility
	15 Industrial and Commercial Complexes
	16 Mixed Urban or Built-up Land
	17 Other Urban or Built-up Land
2 Agricultural Land	21 Cropland and Pasture
	22 Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
	23 Confined Feeding Operations
	24 Other Agricultural Land
3 Rangeland	31 Herbaceous Rangeland
	32 Shrub and Brush Rangeland
	33 Mixed Rangeland
4 Forest Land	41 Deciduous Forest Land
	42 Evergreen Forest Land
	43 Mixed Forest Land
5 Water	51 Streams and Canals
	52 Lakes
	53 Reservoirs
	54 Bays and Estuaries
6 Wetland	61 Forested Wetland
	62 Nonforested Wetland
7 Barren Land	71 Dry Salt Flats
	72 Beaches
	73 Sandy Areas Other than Beaches
	74 Bare Exposed Rock
	75 Strip Mines, Quarries, and Gravel Pits
	76 Transitional Areas
	77 Mixed Barren Land
8 Tundra	81 Shrub and Brush Tundra
	82 Herbaceous Tundra
	83 Bare Ground
	84 Wet Tundra
	85 Mixed Tundra
9 Perrenial Snow or Ice	91 Perrenial Snowfields
	92 Glaciers



To enter a formula, you can click on any of the fields, functions, or mathematical symbols in the upper part of the dialog box to make them appear into the lower box, or simply type the formula manually into the lower box. Note that for those with programming skills, you can tick the **[Advanced]** box and type in a Visual basic script. To convert from Level I to Level II codes, enter the following formula and press **[OK]**:

LEVEL1 = Int ([LANDCOVER] /10)

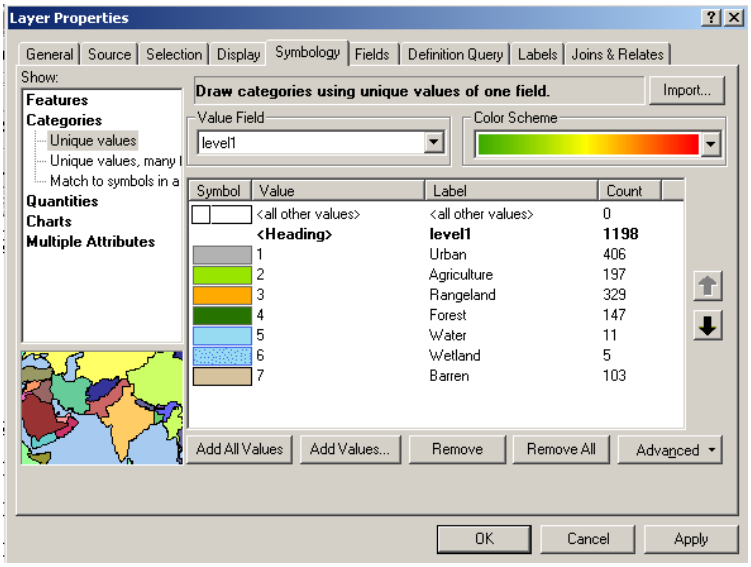
From the **[Editor]** toolbar, save your edits and stop editing. Following the steps above, add another new field "AREA_KM2" (area in km^2), setting the data type to float, and compute it using the following formula (Note: you must exit the editor to add a field):

AREA_KM2 = AREA / 1000000

From the **[Editor]** toolbar, save your edits and stop editing.

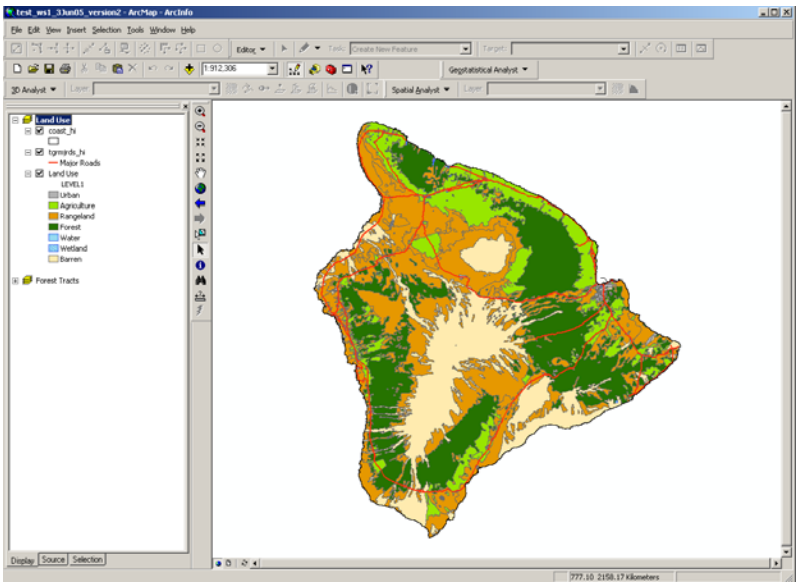
Step 4: Symbolizing

Now that we have reclassified our land use codes, we can choose some more useful symbols. Double-click on the layer name **[lulc_hi]** to open the **[Layer Properties]** window, and press the **[Symbology]** tab. From the list on the left, choose **[Categories]** > **[Unique Values]**. Select **[LEVEL1]** for the Value Field, and press the button **[Add All Values].** Arcmap adds each of the LEVEL I



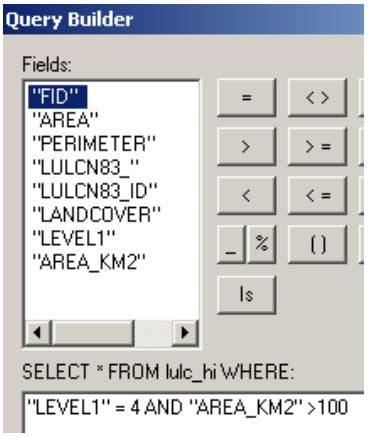
land use codes to the Table of Contents. Now we can select more appropriate labels (by single-clicking and typing within the label column) and colors (by double-clicking on the color symbol and making selections from the **[Symbol Selector]** menu). From the **[Symbol Selector]** menu, we can access a vast number of symbols with the **[More Symbols]** button. To view the number of polygons in each category, simply press on the "Count" header. After choosing appropriate colors, un-tick the **[All Other Values]** box and press **[OK].**

For the **coast_hi** layer, select the "hollow" symbol with a black outline, and for the **tgrmjrds_hi** layer, choose the "highway ramp" red symbol. Now place the layers in this order: coast, roads, and land use. Your map should resemble the one below.



Before moving to the next step, let us insert a new data frame using the **[Insert]** menu > **[Data Frame].** Now highlight the three layers in our original data frame, and copy and paste them into the new data frame, creating two identical data frames. Label the top one "**Land Use**" and the lower one "**Forest Tracts**". If we press the layout view button , notice that both data frames appear on the same page. We will rearrange this layout in Step 7, but for now, return to data view mode .

Step 5: Querying

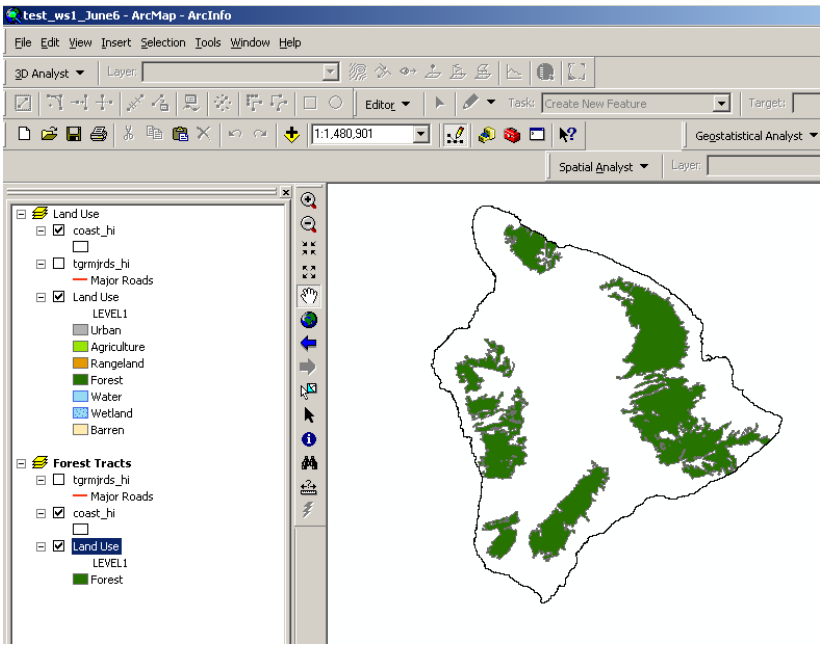


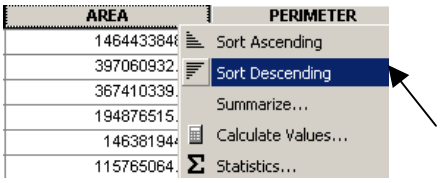
ArcMap accommodates SQL (structured query language) in a couple different situations. For instance, under the **[Selection]** menu > **[Select by Attributes]** option, ArcMap will select features that meet the requirements of your query. ArcMap then can zoom to your selection, compute statistics on it, or export it as a new shapefile.

Another way to use SQL is at the **[Layer Properties]** level. Right click on "**Forest Tracts**" data frame, and select **[Activate].** Open the **[Layer Properties]** window for the layer **lulc_hi**, and select the **[Definition Query]** tab. To answer our research question, we want to select all polygons with a land cover of forest and an area greater than 100 km^2. Press **[Query Builder]** and enter the following formula into the lower window of **[Query Builder]:**

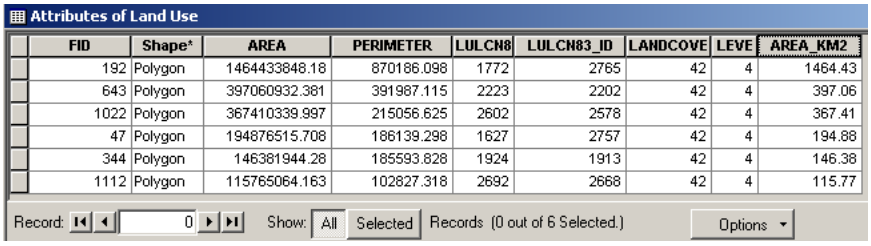
"LEVEL1" = 4 and "AREA_KM2" > 100.

Press **[OK]** twice to exit the **[Layer Properties]** window. Notice that ArcMap now displays only the polygons that meet our selection criteria.

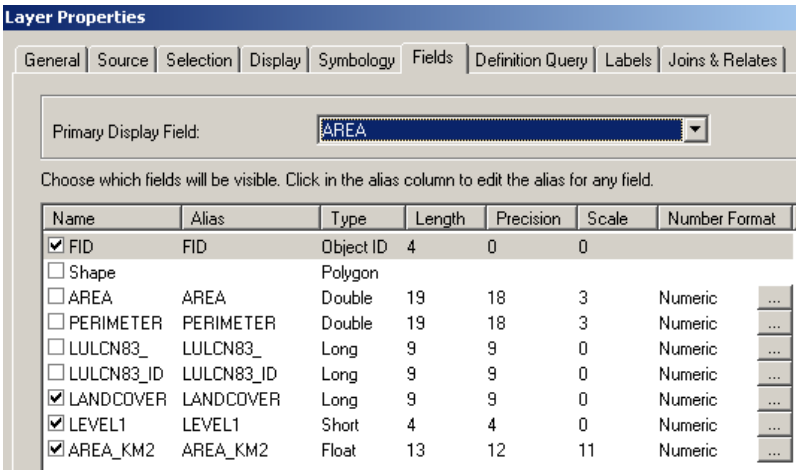




Similarly, when you open the attribute table for **lulc_hi**, notice that ArcMap shows only the 6 selected polygons. In the attribute table, right-click on the column header "AREA_KM2" and choose **[Sort Descending]** to view the records from largest to smallest.

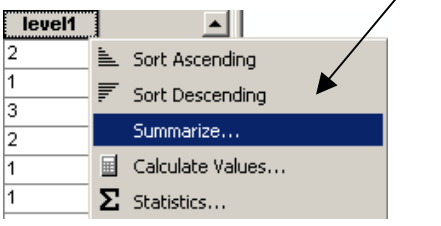


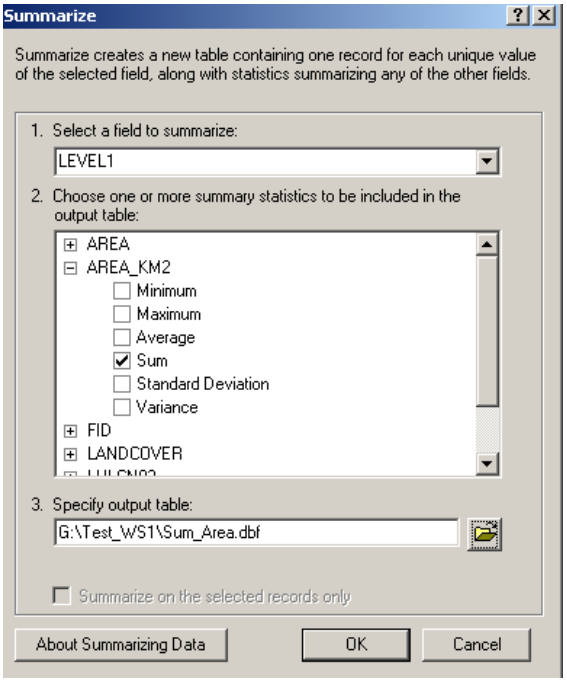
From the **[Fields]** tab within the **[Layer Properties]** window, you can choose which fields are visible in your table. This is especially useful when your table contains dozens of variables or when you want to add the table to a layout, as we will do in Step 7.



Step 6: Summarizing and Graphing

Let us do one more thing before we produce our layout: let us make a graph to include in the layout. We will make a plot of the total land area in each land cover classes. First, we must compute the total area in each class. To do this, activate the "**Land Use**" data frame, and open the attribute table for **lulc_hi**. Right-click on the variable name "LEVEL1" and select **[Summarize].** In the **[Summarize]** dialog box, (1) select "LEVEL1" as the field to summarize, (2) tick the box next to "SUM" under the field "AREA_KM2", and (3) enter your directory path and a filename such as "Sum_Area". Press **[OK]** and add the table to the map. The table will appear in the Table of Contents only.





Then from the **[Tools]** menu, select **[Graphs]** > **[Create]**. In **[Graph Wizard. Step 1 of 3.]**, choose a column graph and press **[Next].** In the second graph wizard, choose "Sum_Area" as the layer, and tick the box next to "Sum_AREA_KM2" as the field. In the last wizard, tick the box to label the X-axis and select "LEVEL1" as the field. Also tick the box to show the graph on the layout and press **[Finish].** From the layout page, you can right-click on the graph at any time, select **[Properties],** and then edit the graph's appearance (e.g., colors, title, etc.).

Step 7: Producing a Layout

The last step of this exercise is to produce a layout. Please save your work before going any further. If ArcToolbox is still open, close it to enlarge the map display area. Click on the layout button at the bottom of the ArcMap window. ArcMap automatically displays the two data frames and your graph in the layout. Rearrange the data frames and graph so that you can view them easily.

Now for each of the data frames, go to the **[Insert]** menu and add a title, north arrow, scale, and legend to the map. Within each data frame, you can adjust the size and location of the map by using the fixed zoom in button, the fixed zoom out button, the pan tool, and the mapscale 1:1,467,589. To adjust the frame size, click and drag on the borders or corners. You can move individual map elements (e.g., the north arrow or scale bar) by clicking and dragging, or edit them by right-clicking with the pointer

 and selecting **[Properties].** To rearrange the order of the map elements, right-click on them and choose to bring them forward or move them back. Note that any modifications made within the data view will be reflected in the layout.

Experiment with the various layout features, but do not spend too much time on this step. Our goal is to become familiar with the capabilities of ArcGIS, not produce the ultimate conference poster.

Try making some basic changes to the layout:

(1) rename and/or remove some of the labels and categories for the **lulc_hi** layer to reflect our query,
(2) add a table showing the 6 forest tracts over 100 km^2 (hint: use the **[Options**] tab in the attribute table),
(3) label the forest tracts by area using the **[Labels]** tab in the **[Layer Properties]** window,
(4) experiment with the **[Properties]** dialog box for the graph.

Everyone will have a slightly different layout. The next page shows one possible layout. When you are happy with your layout, save it and exit ArcGIS. Congratulations and welcome to ArcGIS 9.1!

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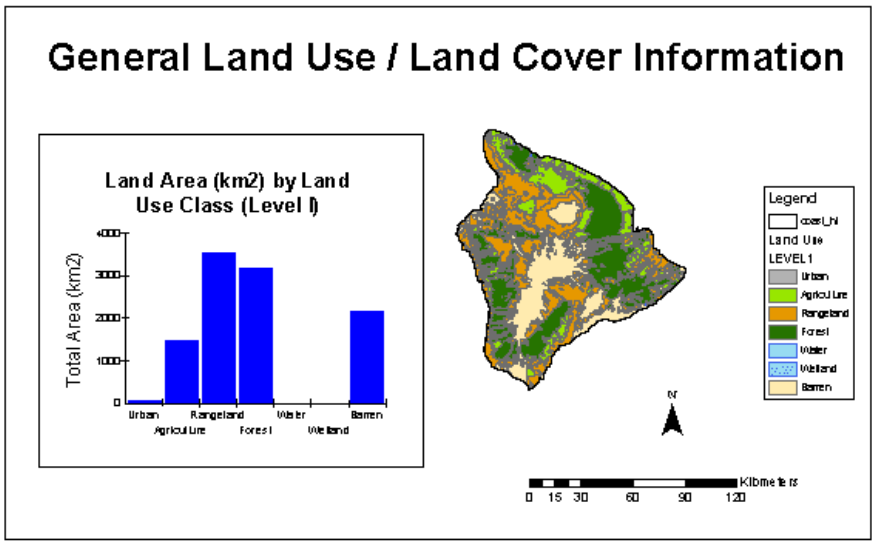
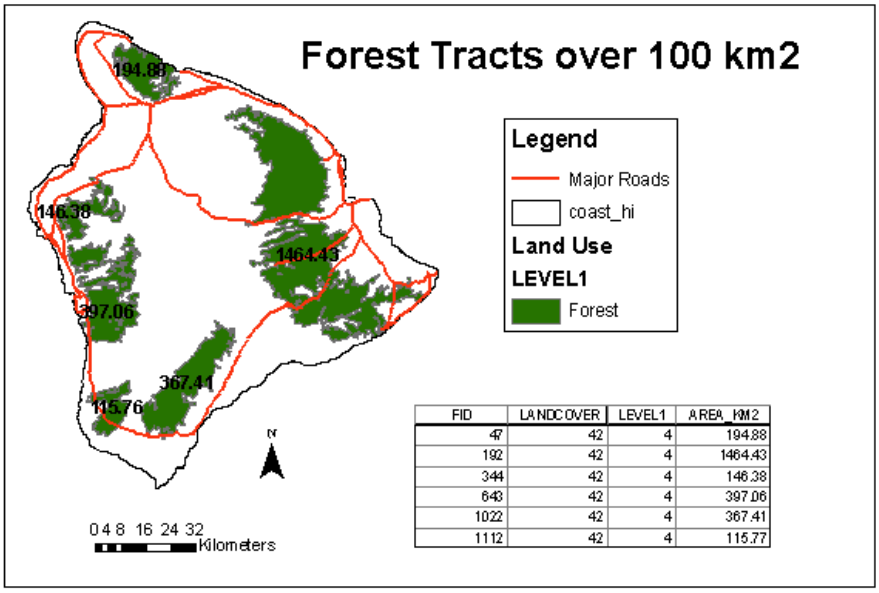
ESRI website on Hawaii projections and coordinate systems:
http://caromap.esri.com/Hawaii/datproj.htm





FID	LANDCOVER	LEVEL1	AREA_KM2
47	42	4	194.88
192	42	4	1464.43
344	42	4	146.38
643	42	4	397.06
1022	42	4	367.41
1112	42	4	115.77