First Look at ArcMap

Shapefiles

We have already used Shapefiles in last week's exploration of ESRI datasets we had on our local machines. Let's take a closer look at this popular and commonly used GIS format.

The first thing that you'll notice is that shapefiles are not a single file but as many as eight and at least three files (*.shp, *.shx, and *.dbf) all of which have the same high-level qualifier but different file-type suffixes. For instance, let's take a look at files in the directory *?*[†]*:\Courses\GIS in Geology\Week #2\datasets\counties*:

COUNTIES.DBF
COUNTIES.SBN
COUNTIES.SBX
COUNTIES.SHP
COUNTIES.SHX

ESRI provides a quite involved discussion of the format and contents of shapefiles in their whitepaper. Below is a brief description of each file's content:

*.aih	Required if part 2 of the Attribute Index of the active fields in a Table or a Theme's Attribute Table is comprised of this file. It's automatically created whenever you "Link tables" and also when you "Create Index" for a field.
*.ain	Required if part 1 of the Attribute Index of the active fields in a Table or a Theme's Attribute Table is comprised of this file.
*.avl	Optional legend for the shapefile can be stored in this file.
*.dbf	dBase file attribute table for the shapefile "theme"
*.prj	Projection information (not used by ArcView 3.x)
*.sbn	Required if part 1 of the Spatial Index of the features is comprised of this file.
*.sbx	Required if part 2 of the Spatial Index of the features is comprised of this file
*.shp	Feature Geometry for each shape
*.shx	Index of Feature Geometry

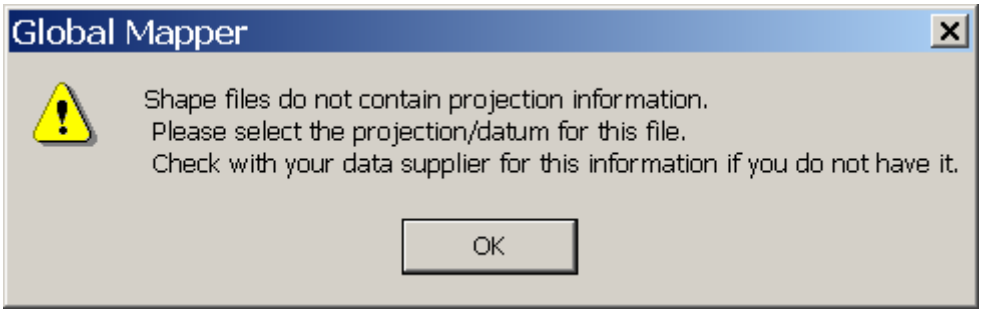
One of the most common mistakes by first-time shapefile users is not appreciating that, when copying a shapefile to a new location, all of the ancillary files must be copies as well. When copying a shapefile make sure get all files with the same high-level qualifier as the shapefile.

[†] Because the drive letter assigned to geocopter will differ from machine to machine, I have replaced it with "?".

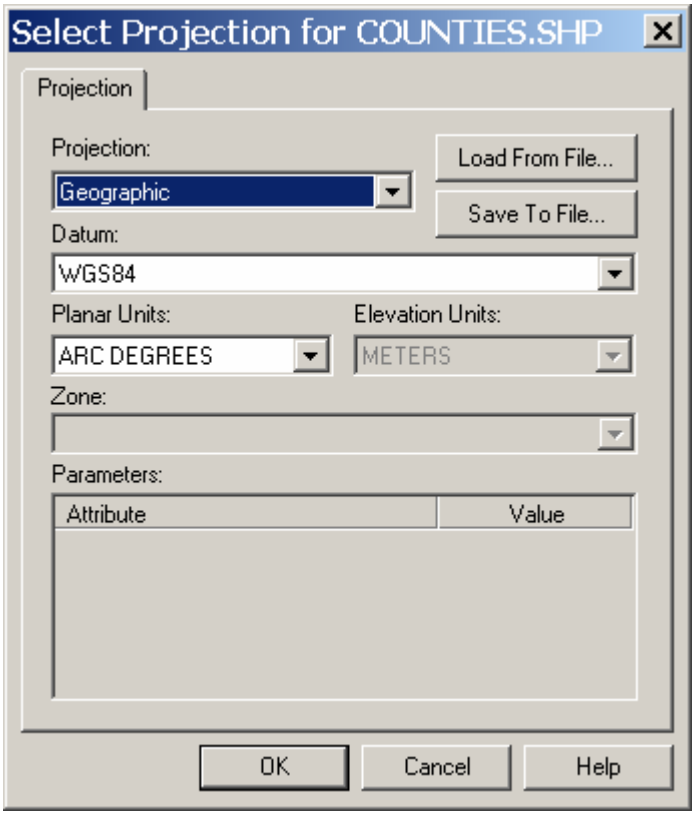
Global Mapper as Rosetta Stone

One of the most useful and powerful features of Global Mapper is that it will read virtually any GIS data no matter its format. Although ArcMap can do the same thing (and more) the process is quite involved and time consuming whereas in Global Mapper it's simply a matter of pointing and clicking. A second wonderful capability of Global Mapper is it's ability to export either raster or vector GIS data into any one of the more commonly used formats (including ESRI's). Let's give it a try.

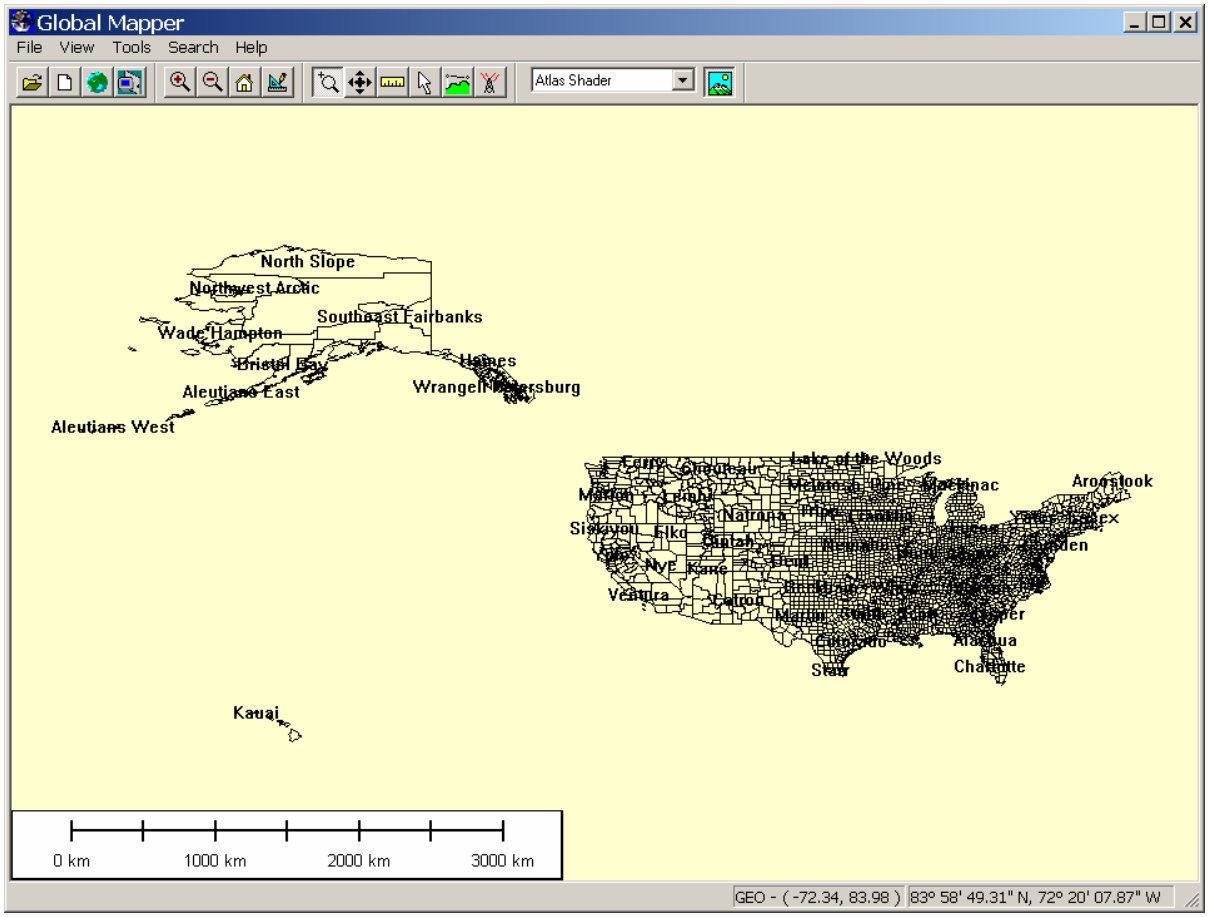
Start Global Mapper, and click  , navigate to *?:\Courses\GIS in Geology\Week #2\datasets\counties* and open the counties shapefile. You should see the following pop up warning that there is no projection data supplied for the counties shapefile.



Press "OK" and this dialog box will appear:

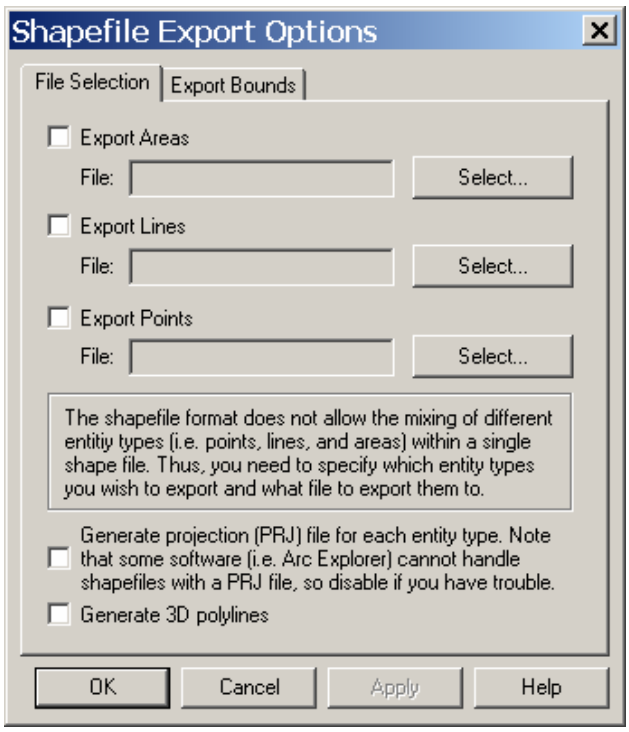


Note that Global Mapper is clever enough to guess that the dataset is in geographic coordinates (latitude and longitude). Press “OK” again and you should see the image below.

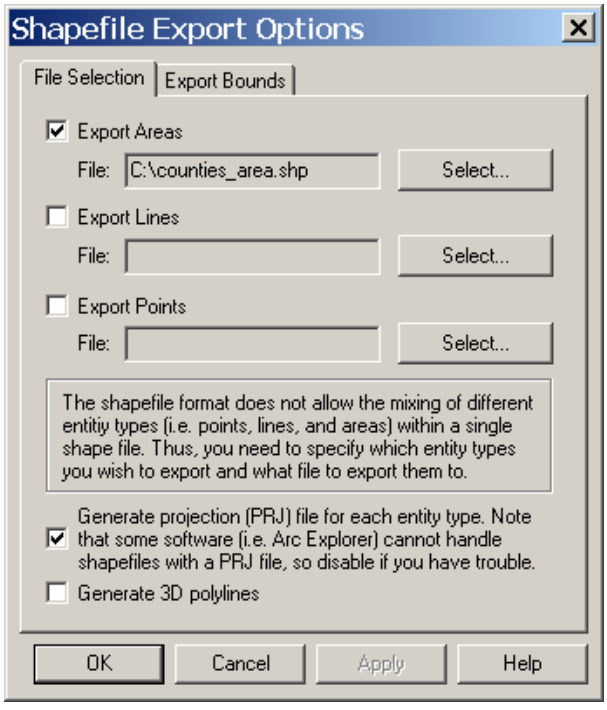


As was mentioned last week, the actual displaying of GIS data in Global Mapper is rather limited… for that we use ArcMap.

This particular dataset is already a shapefile so it could be read directly by ArcMap but let’s export to a shapefile anyhow and add projection data. Select File>Export Vector Data>Export Shapefile and the dialog box shown below will appear (if you haven’t disabled it already, a small information box may appear before the dialog box):



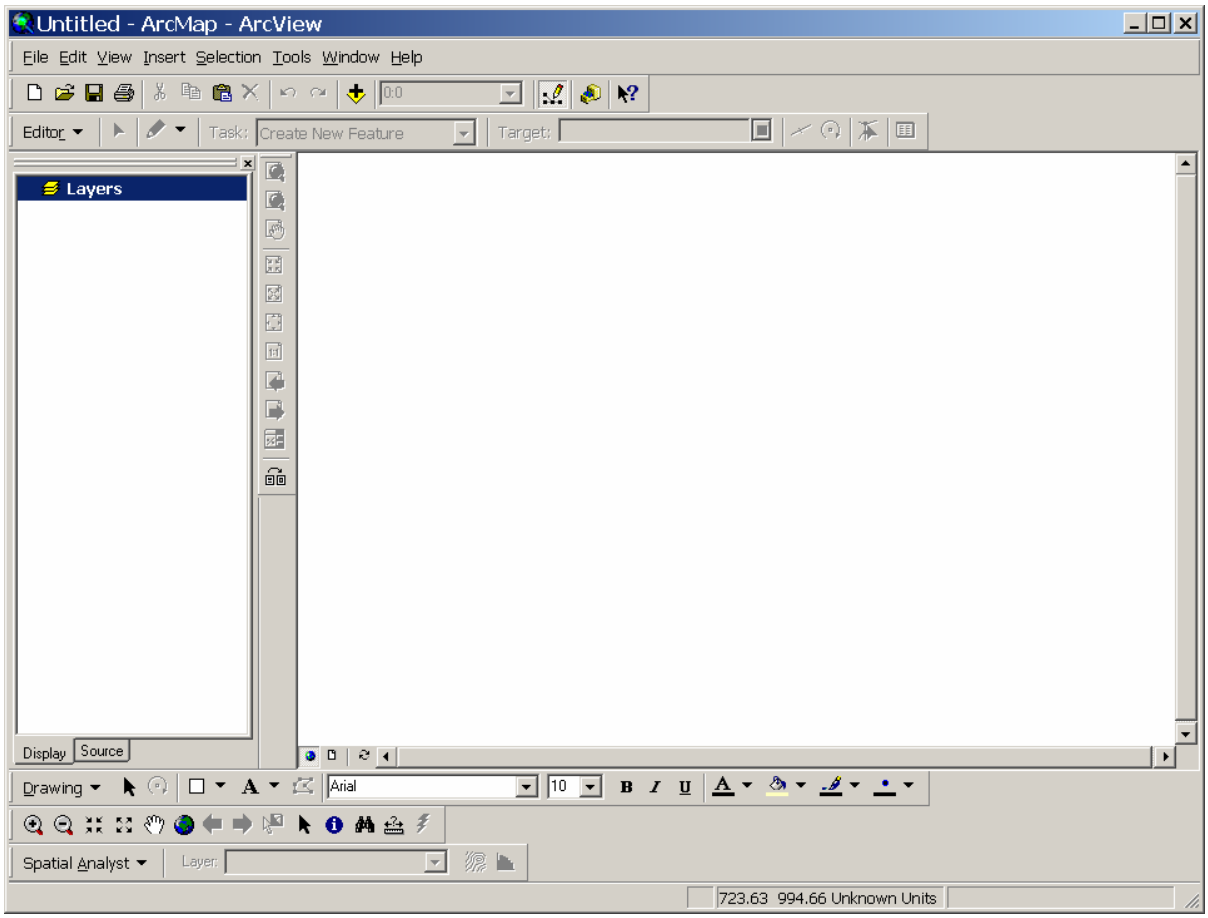
Shapefiles may consist of one of the three types of geometric objects: polygons (aka areas), lines (aka polylines) and points. A polygon consists of at least three line segments forming a completely enclosed area. Polylines consists of one or more line segments. A point is a single coordinate pair. It's a good idea to try to export all of these object types even if the map only consists of one object type (e.g., the counties dataset only consists of polygons). Click in the "Export Areas" box and specify the location and name of the polygon shapefile:



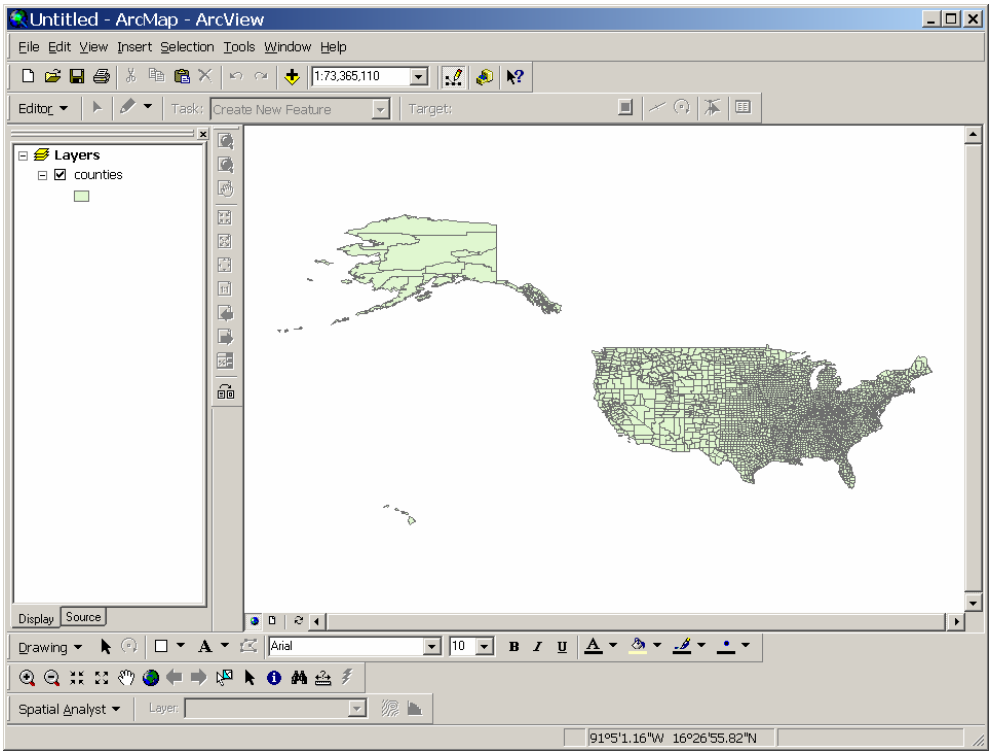
Repeat the procedure for polylines and points (because there are none of these objects in counties, these files won't be generated). Make sure to click the "Generate projection…" box. Click the "OK" button and the shapefile will be generated. Note that a *.prj file has been added to the shapefile files group.

ArcMap

Fire up ArcMap and you should see something that looks like this:

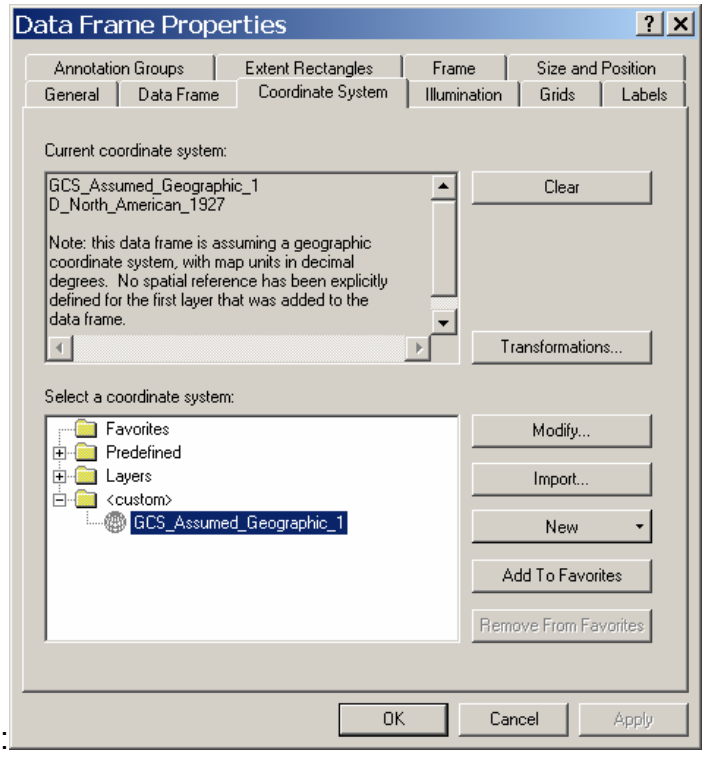


Your screen may look a bit different depending on what toolbars have been specified for display. Press View>Toolbars and make sure that the first five click boxes are checked. Let's add our counties shapefile or *theme*. Click the yellow  button and use the resulting dialog box to navigate to the counties file that you generated earlier on your local machine. You may have to click the  button to navigate to the right location. Once the counties theme has been added, your screen should look something like this:

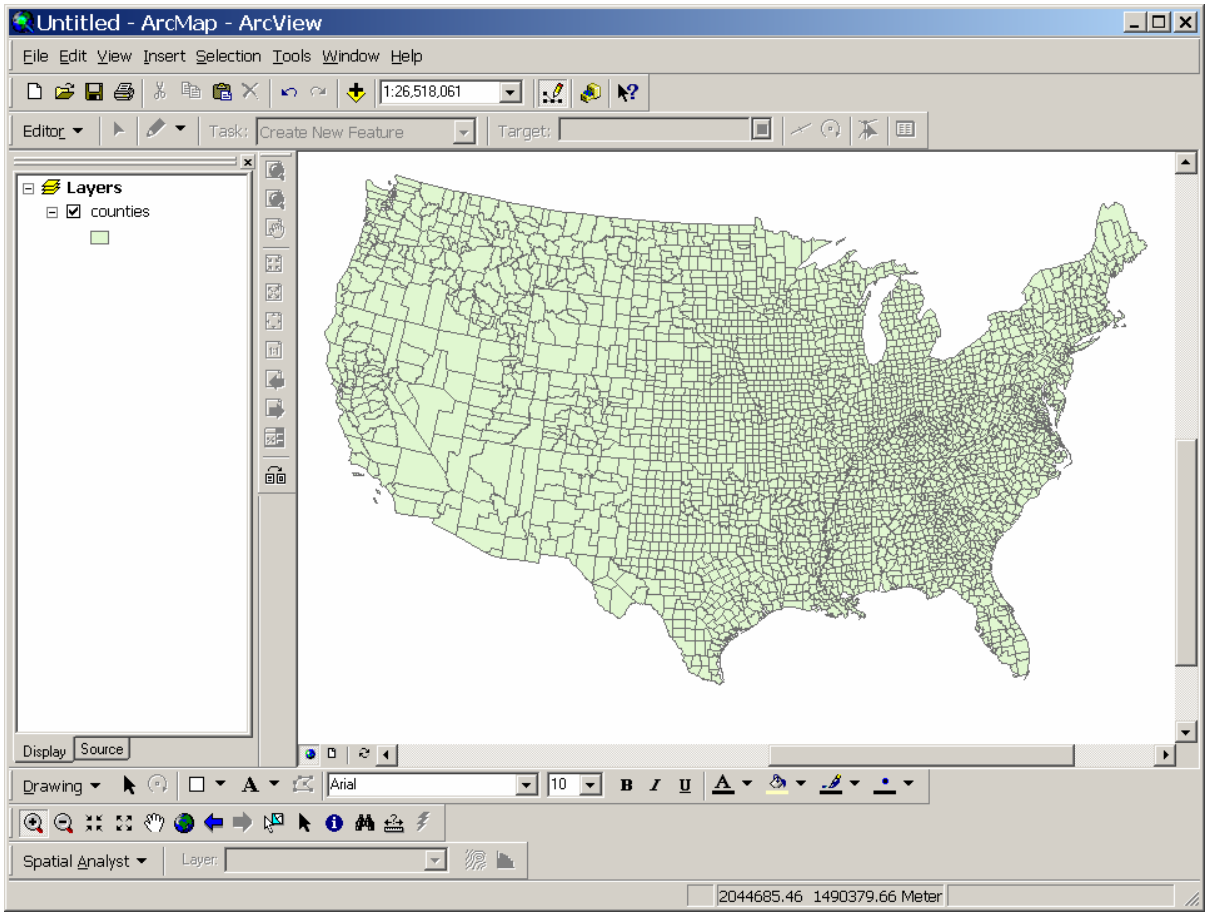


Reprojecting a View

Our counties map is displayed in geographic coordinates so it looks distorted. Let's reproject it into a more familiar form. Right click on the map and select Properties. The following dialog box should appear

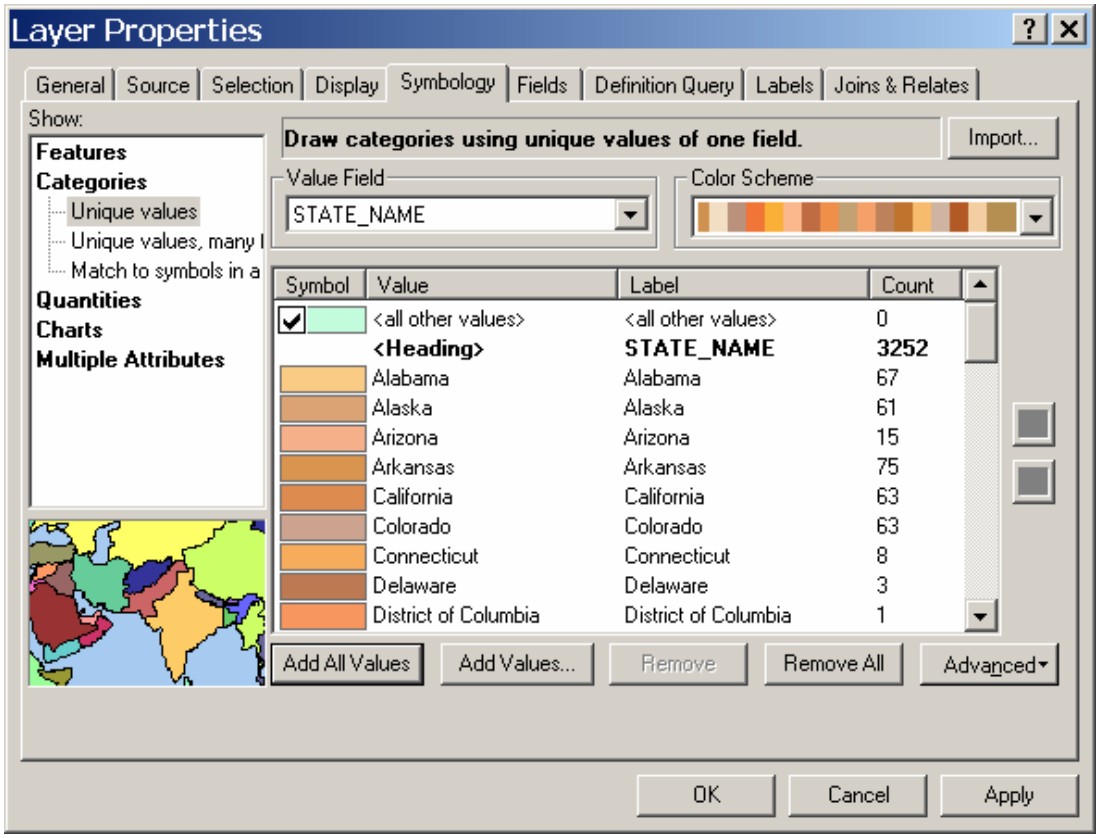


If “Coordinate System” is not the selected tab, select it. Click on the “Predefined” folder then the “Projected Coordinate Systems” folder, then the “Continental” folder, then the “North America” folder. Select “USA Contiguous Albers Equal Area Conic” and click the “OK” button. Click the magnify () button and click and drag over the contiguous states. You should have something that looks like this:

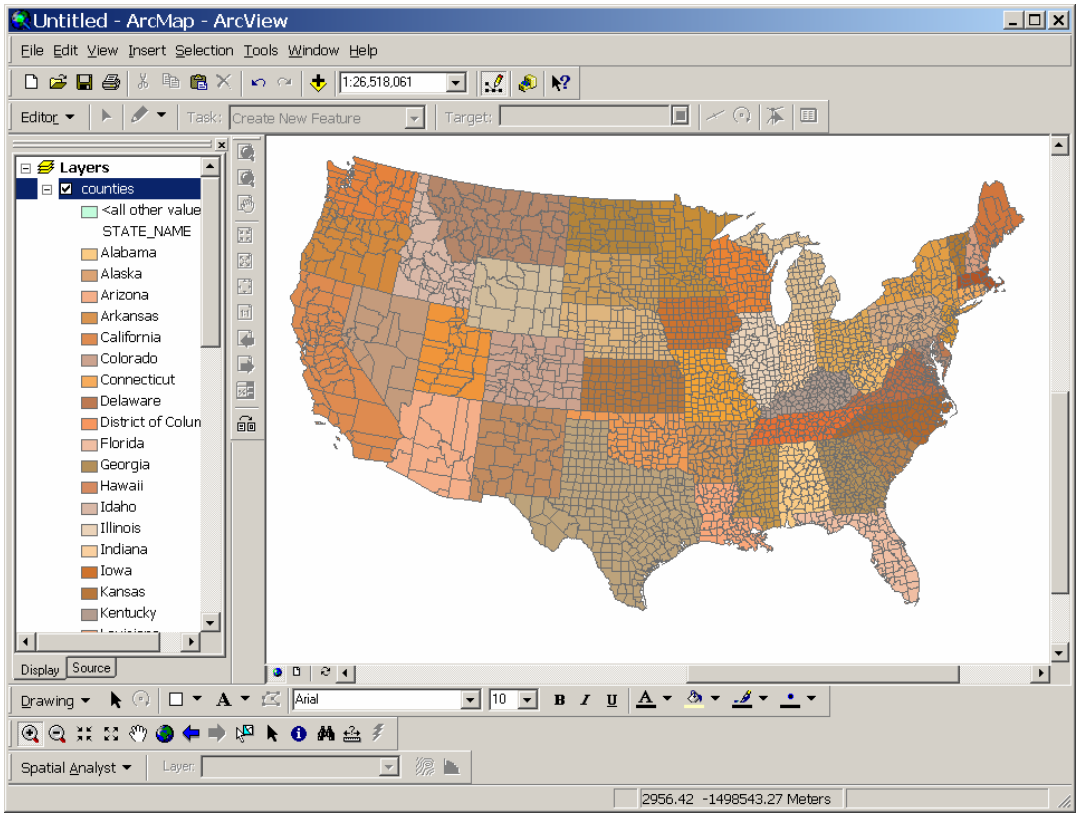


Symbology

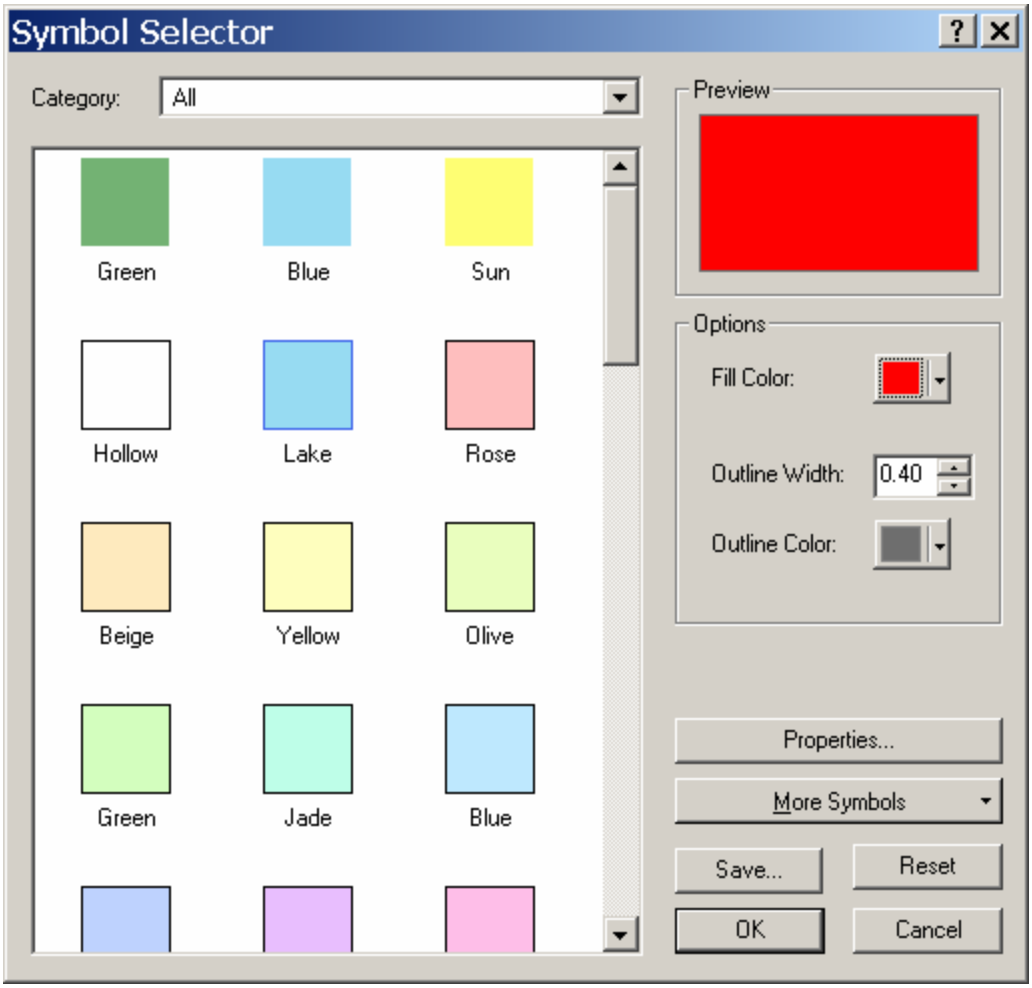
All right, let’s us some of ArcMap’s great display capabilities. Double click on the word “counties” in the left hand panel or right click on it and select “Properties”. A dialog box will appear. Click the “Symbology” tab. Click “Unique values” under “Catagories”. Pull down to STATE_NAME on the “Value Field” menu and pull down to a pleasing color scheme on the “Color Scheme” menu. Click the “Add All Values” button and you should get something that looks like this:



Click “OK” and you should see this:



Note that you can change any color by clicking on the corresponding color panel in the symbology dialog box. Double click on the Bama panel and pull down the fill color panel to some distinct color.

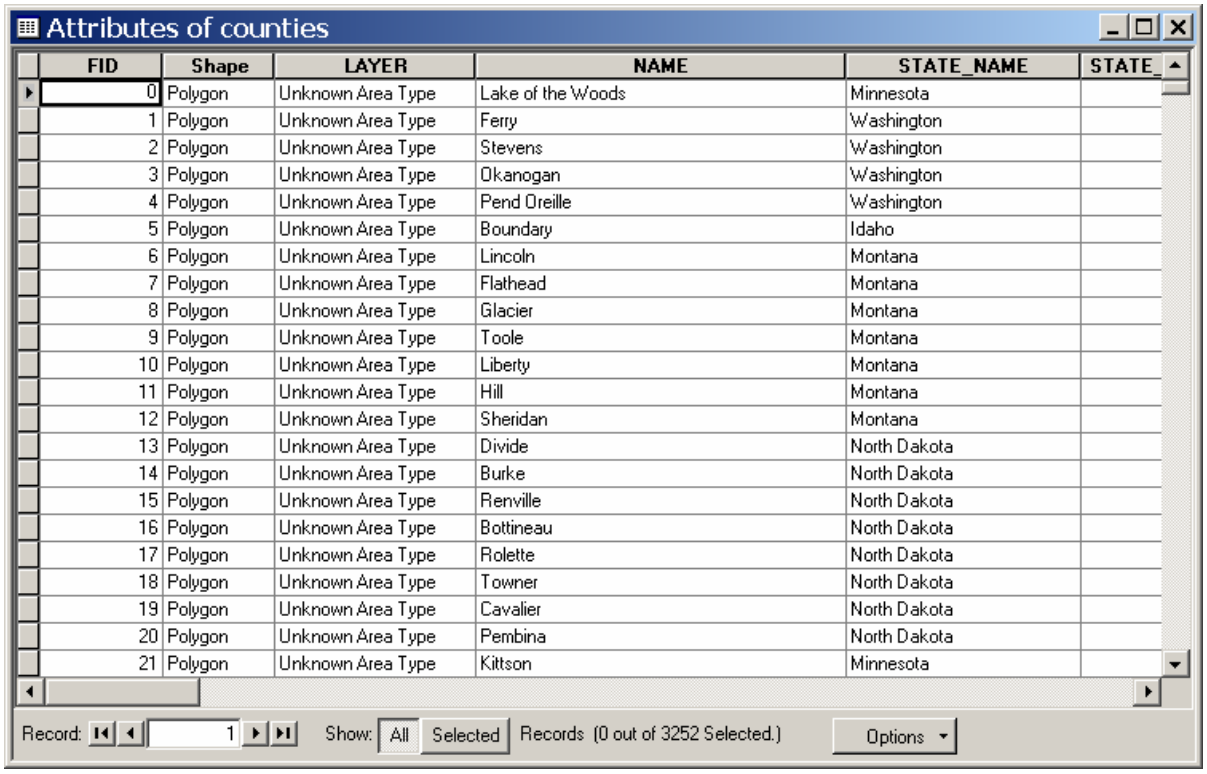


Click “OK” and verify the color for Alabama has changed on the map.

Attributes Table

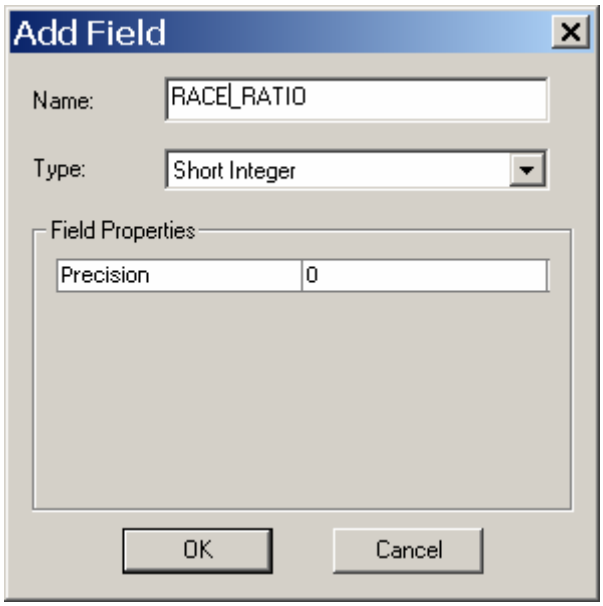
Every *feature* in a *theme* has *attributes*. We already examined feature attributes in Global Mapper by clicking on a feature with the pick tool ( ). The attribute table is stored in the *.dbf file and can be read directly with Excel. Open Excel select File>Open and when the dialog box appears, navigate to where you stored the counties shapefile. Pull down to “dbase files” from the “Files of type: “ menu and counties.dbf should appear. Open the file. Whatever you do CHANGE ABSOLUTELY NOTHING… NOTHING… NOT EVEN COLUMN WIDTH. Take a look at the data for all the counties in the US.

We can bring up a similar looking spreadsheet called the attribute table by again right clicking on the word “counties” in the left-hand panel and selecting “Open Attribute_Table”.



FID	Shape	LAYER	NAME	STATE_NAME	STATE_
0	Polygon	Unknown Area Type	Lake of the Woods	Minnesota	
1	Polygon	Unknown Area Type	Ferry	Washington	
2	Polygon	Unknown Area Type	Stevens	Washington	
3	Polygon	Unknown Area Type	Okanogan	Washington	
4	Polygon	Unknown Area Type	Pend Oreille	Washington	
5	Polygon	Unknown Area Type	Boundary	Idaho	
6	Polygon	Unknown Area Type	Lincoln	Montana	
7	Polygon	Unknown Area Type	Flathead	Montana	
8	Polygon	Unknown Area Type	Glacier	Montana	
9	Polygon	Unknown Area Type	Toole	Montana	
10	Polygon	Unknown Area Type	Liberty	Montana	
11	Polygon	Unknown Area Type	Hill	Montana	
12	Polygon	Unknown Area Type	Sheridan	Montana	
13	Polygon	Unknown Area Type	Divide	North Dakota	
14	Polygon	Unknown Area Type	Burke	North Dakota	
15	Polygon	Unknown Area Type	Renville	North Dakota	
16	Polygon	Unknown Area Type	Bottineau	North Dakota	
17	Polygon	Unknown Area Type	Rolette	North Dakota	
18	Polygon	Unknown Area Type	Towner	North Dakota	
19	Polygon	Unknown Area Type	Cavalier	North Dakota	
20	Polygon	Unknown Area Type	Pembina	North Dakota	
21	Polygon	Unknown Area Type	Kittson	Minnesota	

Although it's not something we'd do as geologists, let's add some data. Select "Add Field…" from the "Options" pull down. Fill in the dialog box as shown below:



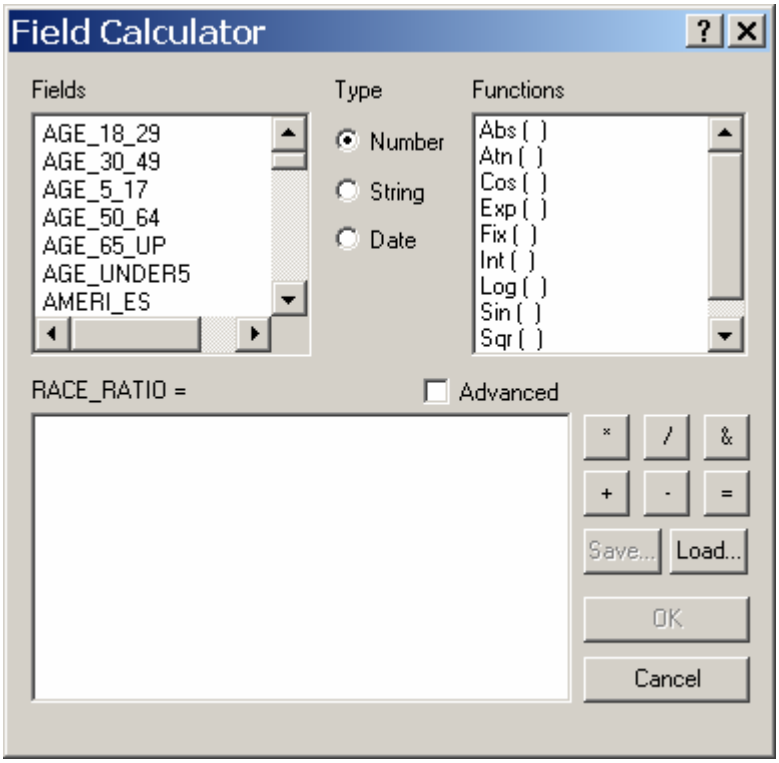
This will add a field to the table at the left-hand side.

Attributes of counties

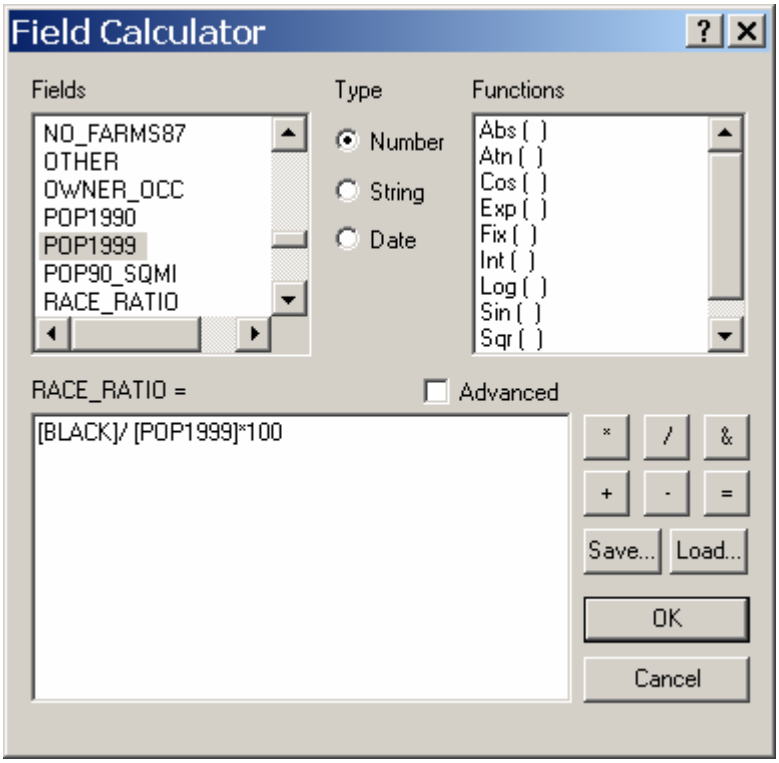
UNITS10_49	UNITS50_UP	MOBILEHOM	NO_FARMS87	AVG_SIZE87	CROP_ACR87	AVG_SALE87	RACE_RATIO
80	0	937	222	536	83787	27958	0
44	0	936	218	3489	29482	22155	0
264	0	3264	1073	490	131700	18138	0
286	0	3431	1476	907	144053	71970	0
89	0	1185	227	276	22923	10367	0
34	0	643	297	267	51806	29463	0
198	0	1941	245	251	19418	9346	0
976	267	4463	825	313	105359	24714	0
149	0	815	405	4065	484202	85215	0
84	0	341	393	2879	671593	74509	0
50	0	181	295	3167	-99	97342	0
310	86	1052	713	2415	1136593	76698	0
65	0	343	600	1708	687985	41185	0
3	0	98	599	1228	558077	39837	0
12	0	204	525	1162	469745	33372	0
0	0	229	454	1111	446213	43184	0
100	0	558	929	1078	873869	42628	0
107	80	718	536	945	361270	37279	0
24	0	170	557	1132	559834	60094	0
20	0	264	922	995	840482	64501	0
95	0	438	763	839	591424	129205	0
105	0	248	576	865	424855	86181	0

Record: 0 Show: All Selected Records (0 out of 3252 Selected.) Options

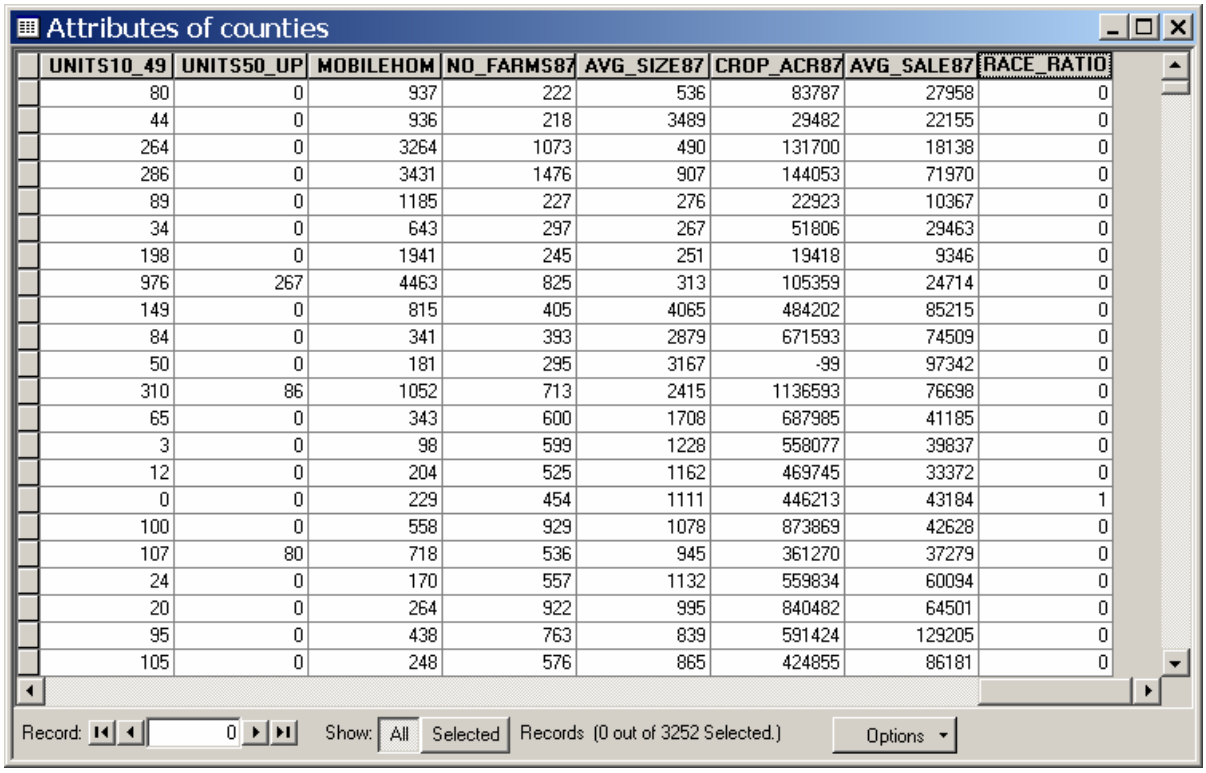
Left click on the column heading of the new column and select “Calculate Value”. You’ll receive a warning dialog. Press “OK” and the following dialog should appear:



Click “BLACK” in the right column, type “/” then click POP1999, then type “*100”. The dialog box should now look like this:



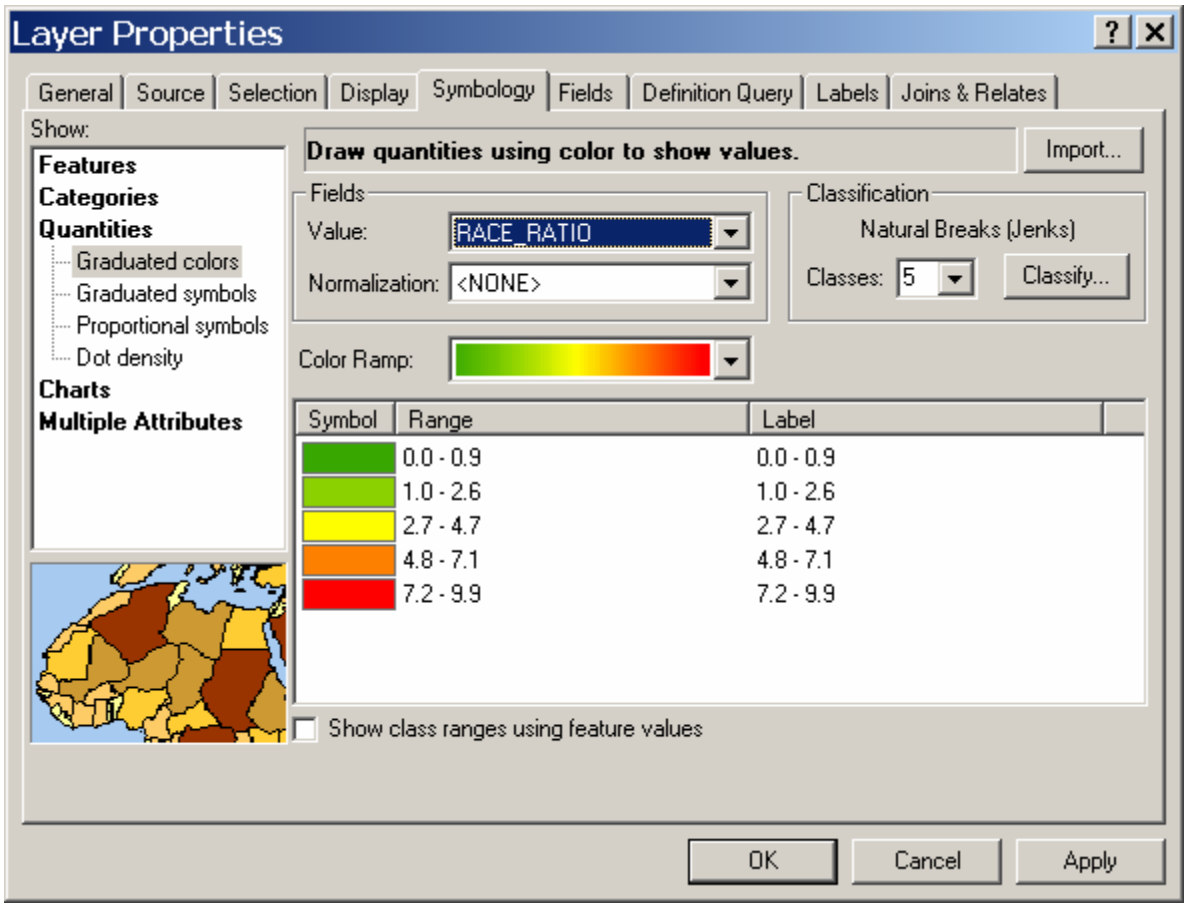
Click “OK” and voila:



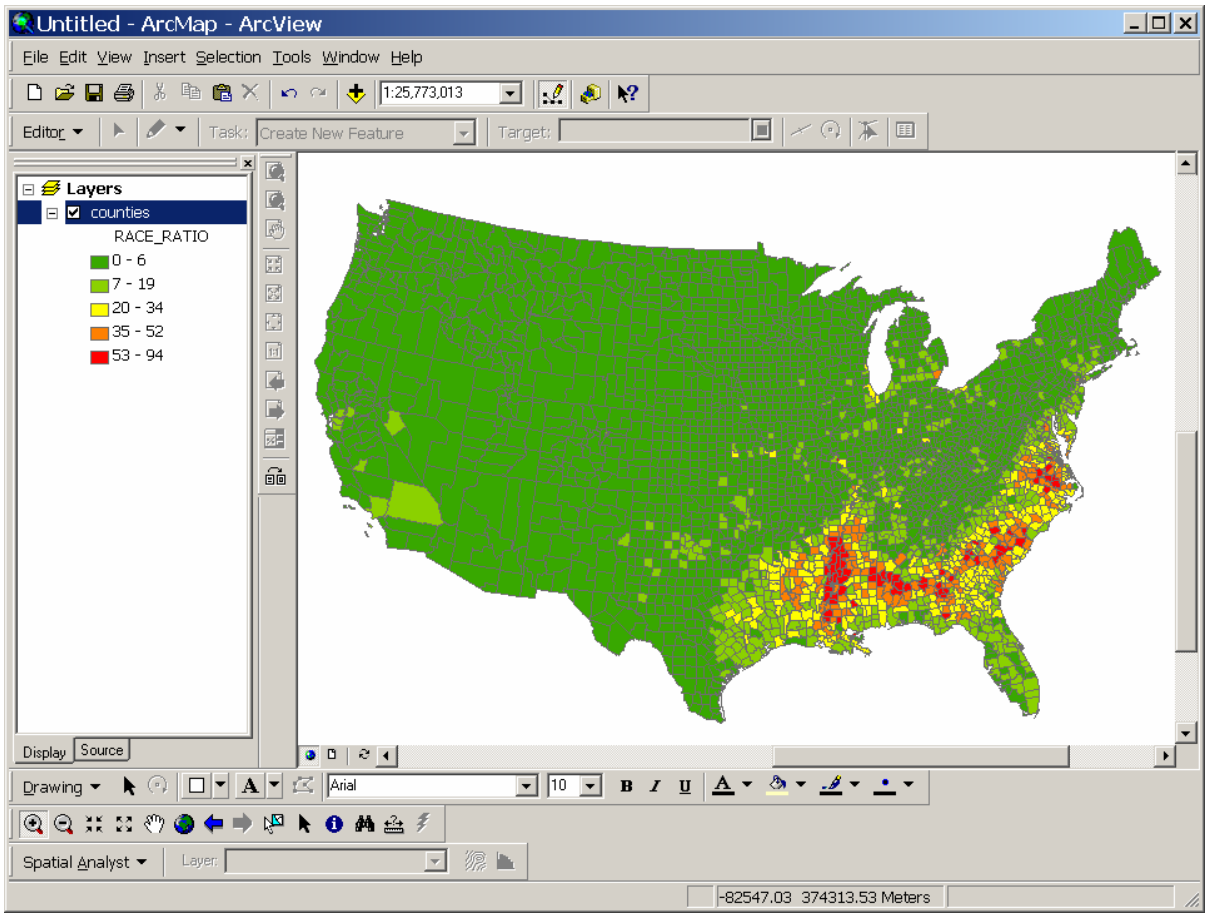
UNITS10_49	UNITS50_UP	MOBILEHOM	NO_FARMS87	AVG_SIZE87	CROP_ACR87	AVG_SALE87	RACE_RATIO
80	0	937	222	536	83787	27958	0
44	0	936	218	3489	29482	22155	0
264	0	3264	1073	490	131700	18138	0
286	0	3431	1476	907	144053	71970	0
89	0	1185	227	276	22923	10367	0
34	0	643	297	267	51806	29463	0
198	0	1941	245	251	19418	9346	0
976	267	4463	825	313	105359	24714	0
149	0	815	405	4065	484202	85215	0
84	0	341	393	2879	671593	74509	0
50	0	181	295	3167	-99	97342	0
310	86	1052	713	2415	1136593	76698	0
65	0	343	600	1708	687985	41185	0
3	0	98	599	1228	558077	39837	0
12	0	204	525	1162	469745	33372	0
0	0	229	454	1111	446213	43184	1
100	0	558	929	1078	873869	42628	0
107	80	718	536	945	361270	37279	0
24	0	170	557	1132	559834	60094	0
20	0	264	922	995	840482	64501	0
95	0	438	763	839	591424	129205	0
105	0	248	576	865	424855	86181	0

Reprojecting a View

Okay, let's display the data we just generated (again, this feature would rarely be used by geologists but…). Close the attribute table and once again display the counties theme properties by right clicking "counties" in the left-hand panel. Again, click on the "Symbology" tab. This select "Quantities" and "Graduated colors". Pull down to "RACE_RATIO" under "Value:":



Click "OK" and you should get something that looks like this.

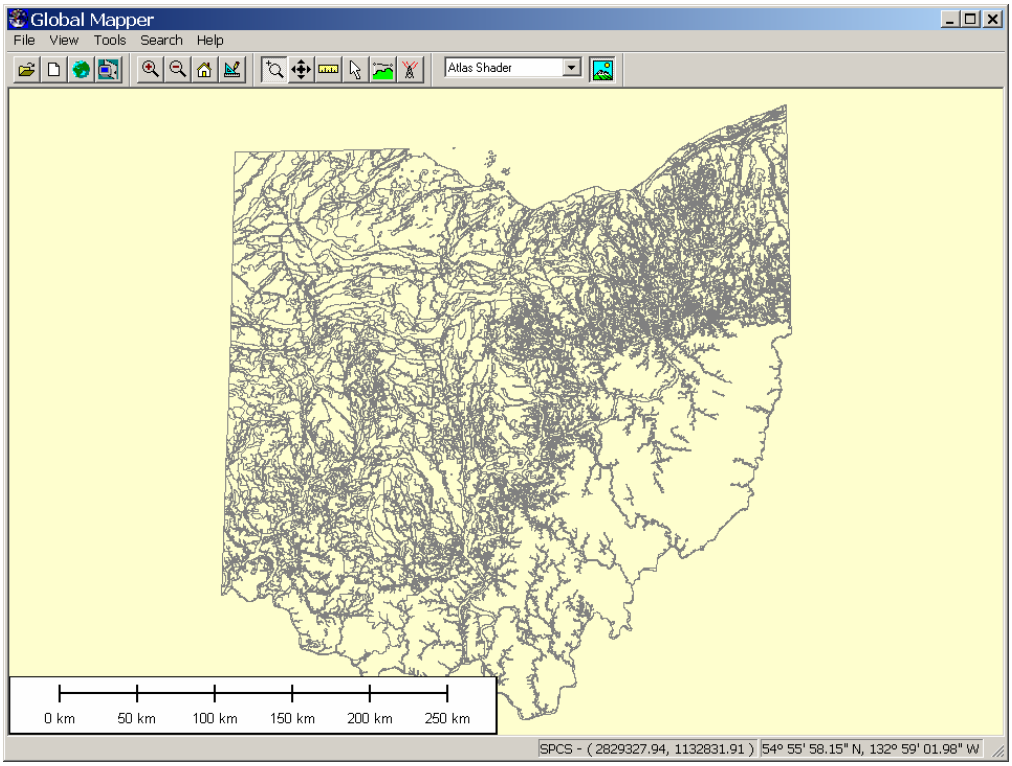


Fun with SAMP

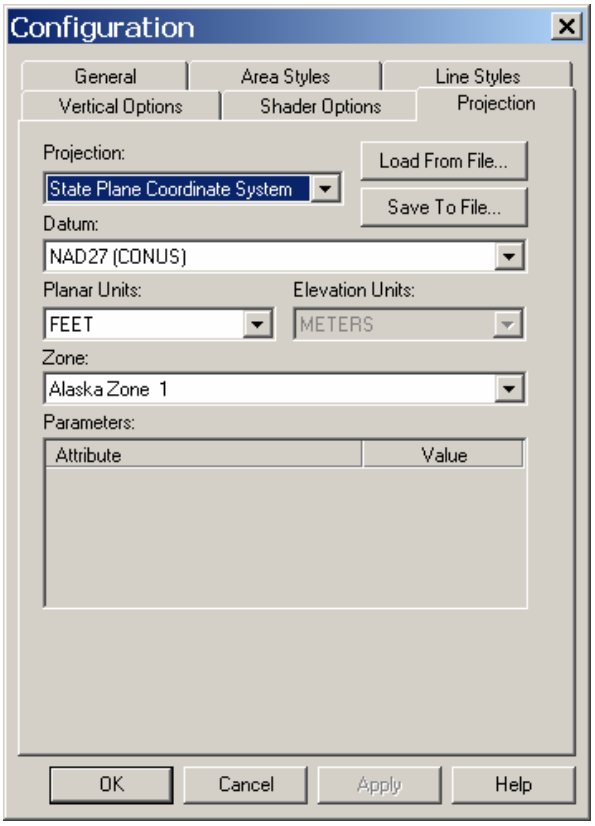
The statewide Unconsolidated Aquifer Map (SAMP) is a wonderful dataset that can be used to demonstrate the power (and frustrations) of GIS. It may be downloaded as either a shapefile or ArcInfo coverage from this site. As we have seen, shapefiles may be read directly by ArcMap. Coverage (.e00 files) are not directly readable but can be converted fairly easily with ESRI-provided software. They can, however, be very easily read with Global Mapper.

I have downloaded and unzipped the SAMP coverage to the course site on geocopter (?:\Courses\GIS in Geology\Week #2\datasets\SAMP). The dataset is very well documented. Open and read the “Read Me” file and “Unconsol Legends” documents to understand the attribute table of the dataset.

Creat a new folder on your local machine called “SAMP” and copy ohglaqua.e00 from the “Map” folder on geocopter to your machine. Open Global Mapper and have it read ohglaqua.e00 (make sure you open it on your local machine).

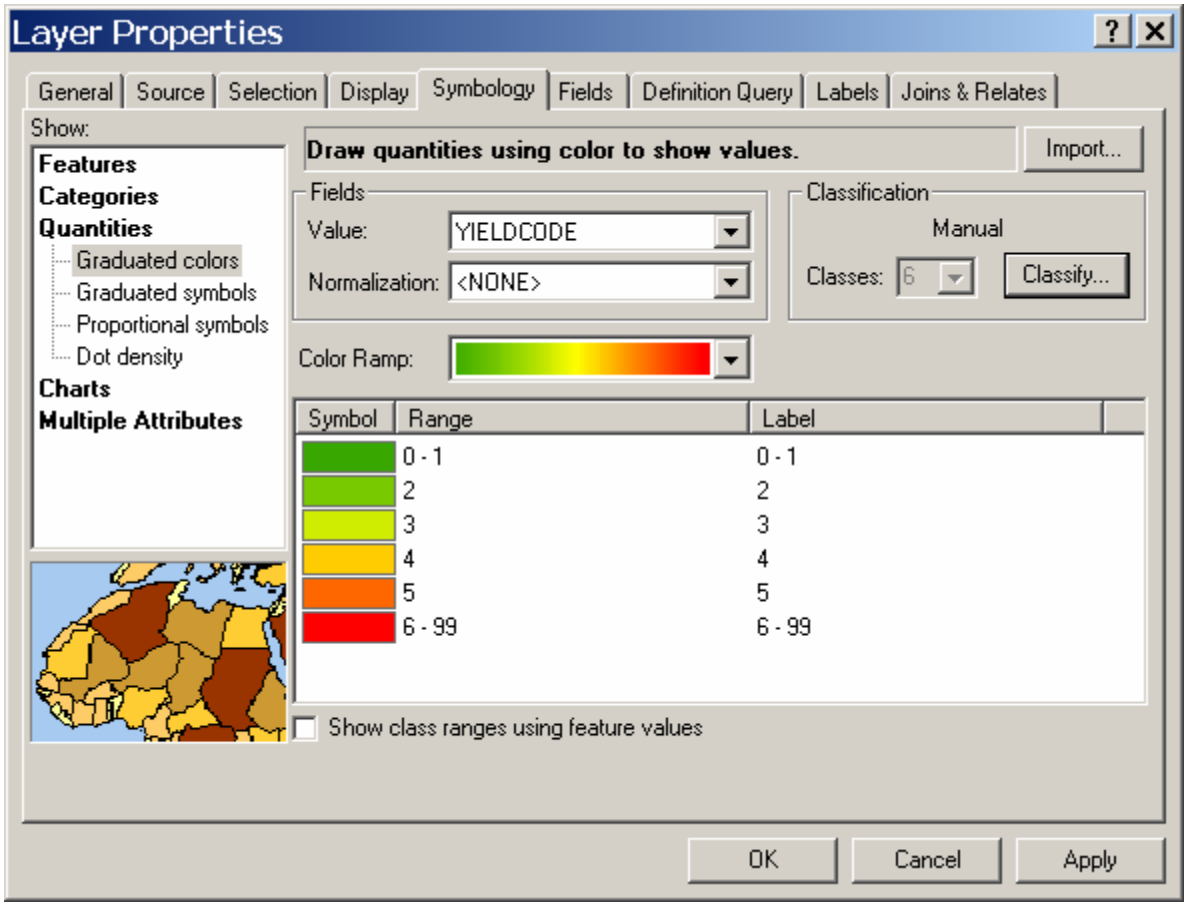


Global Mapper is smart enough to read the projection information from the file… unfortunately it reads it incorrectly (it get the state plane and units right but it thinks the state is Alaska.

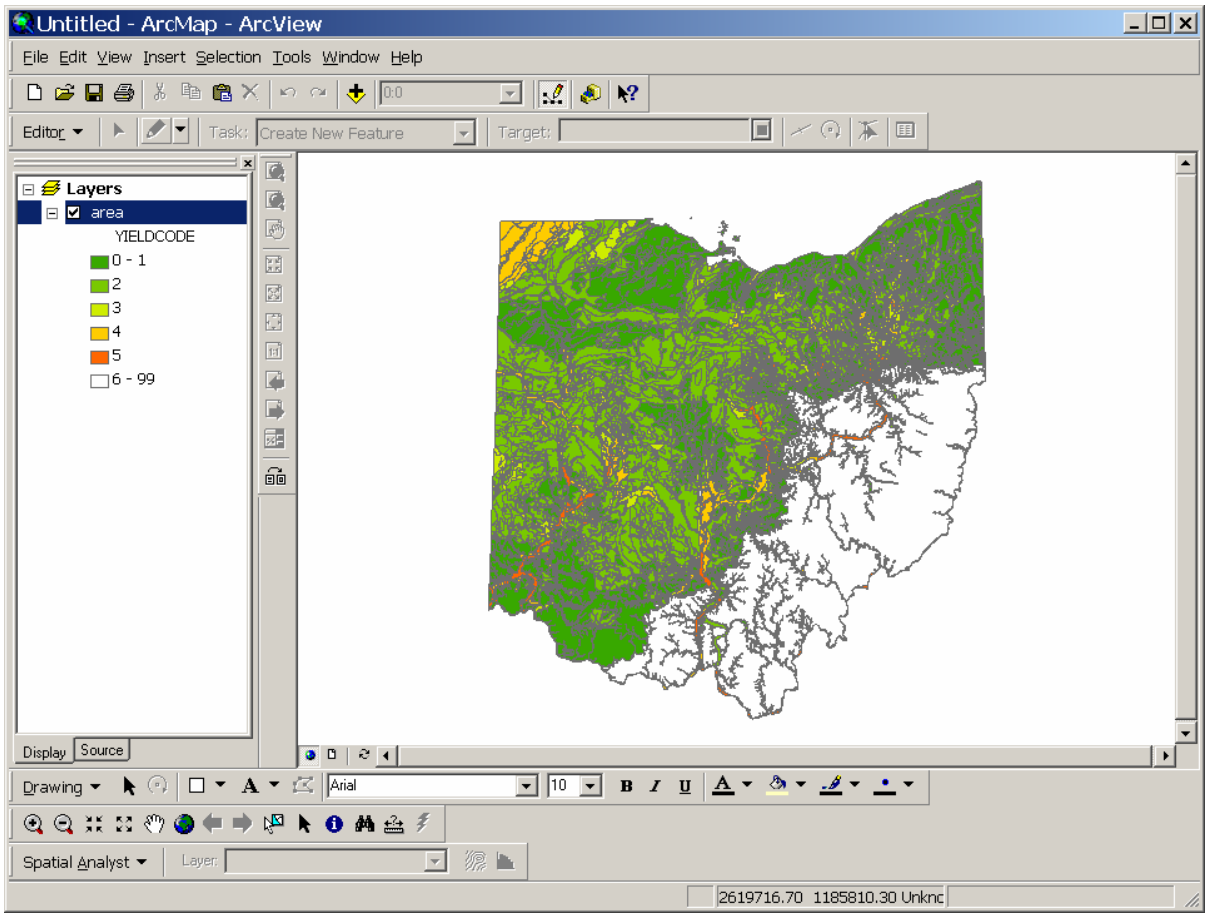


Using the same procedure we used previously, export the map into shapefiles (polygons, polylines and points… even though there are no points) let's not generate a projection file because it's wrong.

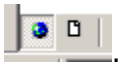
Open ArcMap and add the polygon theme you just generated. Right click the theme name in the left-hand panel and click the "Symbology" tab. Select "Quantities", "Graduated Colors" and set the "Value" field to "YIELDCODE". As you saw by reading the "Unconsol Legends" document (you did do that, right?), there are 6 different codes, 1-5 and 99. Set Pull down the "Classes" menu to "6" and the "Classify" button. Set the break values to 1, 2, 3, 4, 5, and 99 then click "OK". Symbology should look like this:

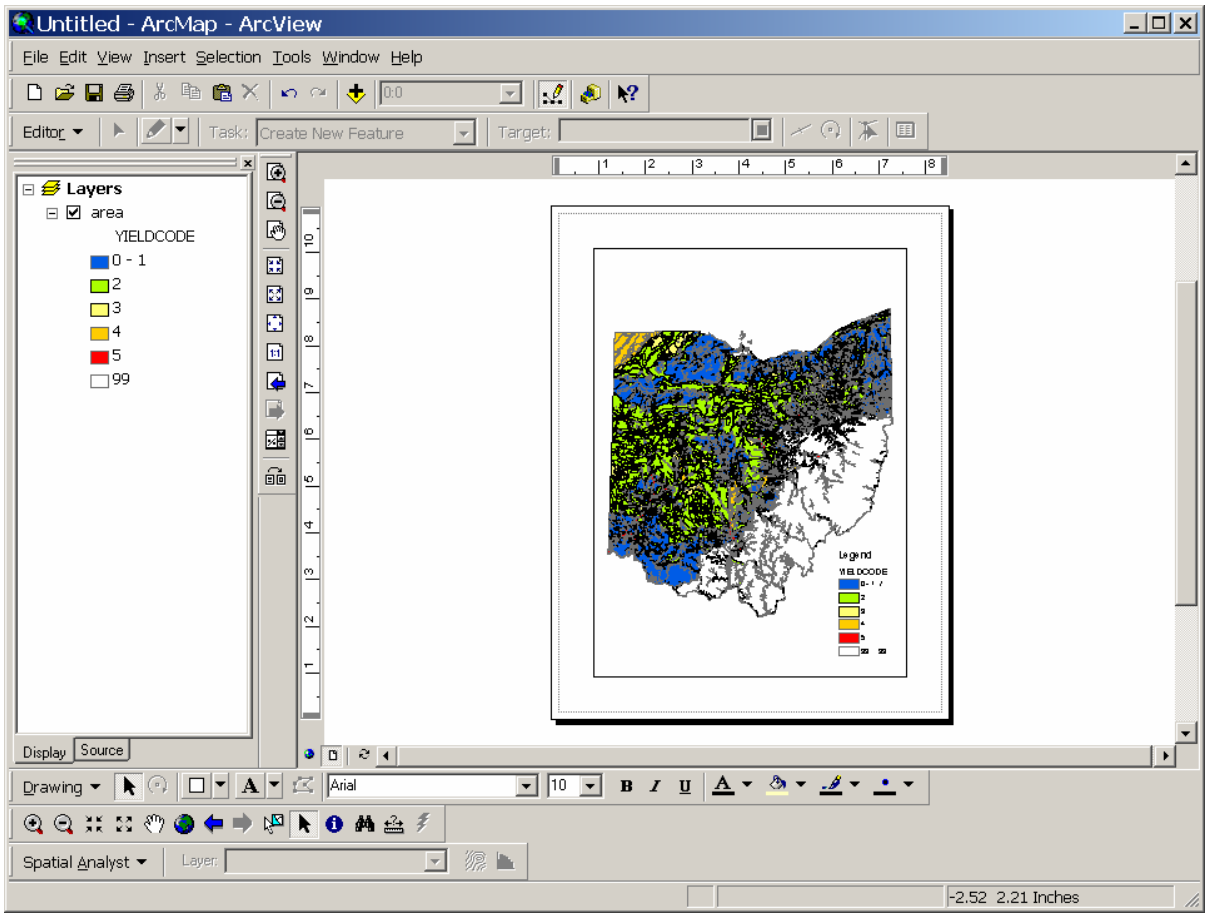


Double click the red block corresponding to 6-99 and pull down to "No Color" on the fill menu. Click "OK" and then "OK" You map should look like this:

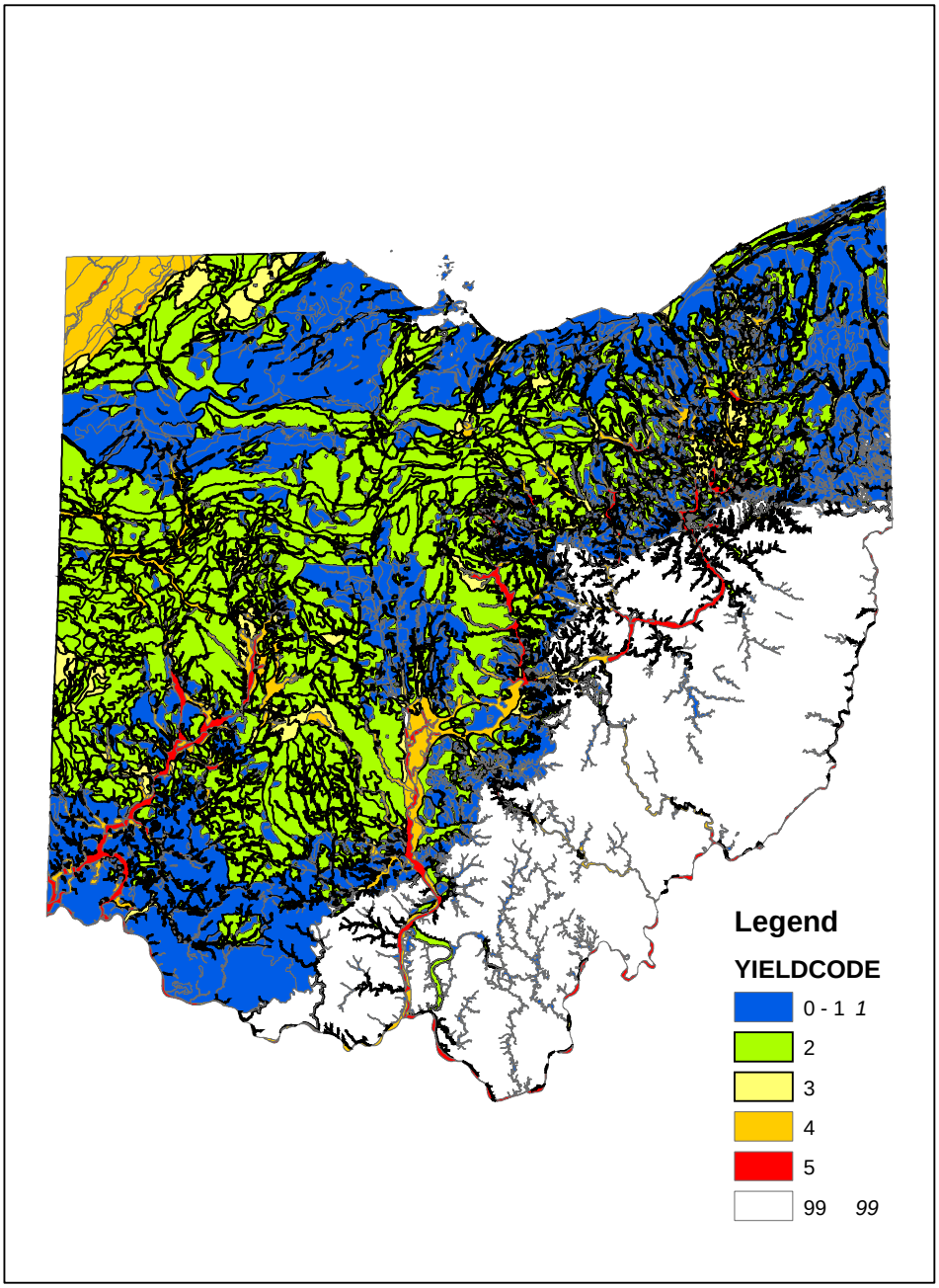


First Stab at Laying out a View

At the bottom right of the right-hand panel, you'll see teo "buttons",  . The left, highlighted button is the "data view" while the right button is the "layout view". Click the  button. This will take you to the layout window in which you should see your map (sizeable) on a background showing page size. We'll do much more in this view later but for the time being, we'll just generate a legend for our map. From the menu at the top of the window select Insert>Legend. Keep clicking "Next" and finally "Finish". This should place a moveable legend panel on your map. Move it over to an empty spot on the map.



At this point you may either export the map (File>Export Map and select *.emf as the format) for easy placement in a document or send it directly to a printer.


Legend
YIELDCODE
0 - 1 1
2
3
4
5
99 99

Saving an ArcMap Project

ArcMap projects are simply saved the first time by invoking File>Save As and thereafter by File>Save. Projects as saved as file type *.mxd. It should be clearly understood, however, that the actual data is not saved with the project; just the location of the datasets and how they are to be placed and displayed (otherwise the project file would be enormous). This means if you move or delete the input datasets you will need to either regenerate or find them using the procedure that will be demonstrated in class. Remember, if you plan to save a project to a CD or to a different machine, make sure to save all the datasets that it uses with it. Despite this warning, you are certain to make this error at some point so don't erase anything until you are able to open your project successfully from its new location.

It is generally a good idea to store all of your themes in one subdirectory directly below the directory in which you store the ArcMap (*.mxd) project.