Using a Geographic Information System (GIS) to look at marine fisheries data

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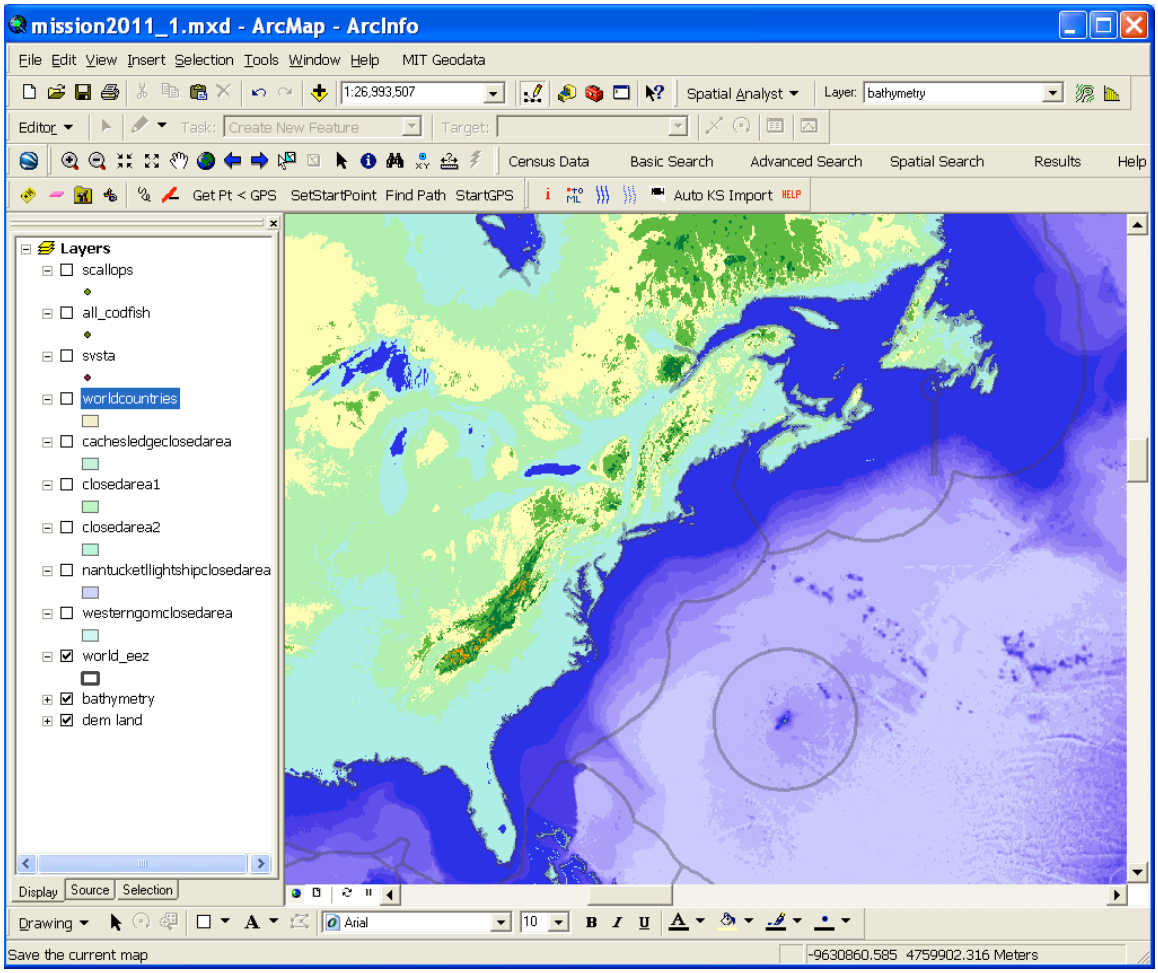
Introduction

GIS is a tool that is becoming well used in many aspects of science and management where space, or location, plays an important role. Location plays a vital role in marine fisheries management, as the environment, including bathymetry, or depth, and bottom type determines which fish may be present and how difficult it is to capture those fish. In this exercise, you will look at the abundance of a single species of fish, Atlantic Cod.

Atlantic Cod is considered a ground fish, many of which have been over fished in the last 40 or more years. In response to this, the National Marine Fisheries Service (NMFS), a branch of the National Oceanic and Atmospheric Administration (NOAA) has closed several important parts of the northeast traditional fishing grounds. The purpose of this exercise is to determine if you can see the effects of this closure through survey data collected by NMFS over the last 44 years. You will do this by evaluating the average size of Atlantic Cod over the last 44 years. You will also look at the average scallop size over a shorter period.

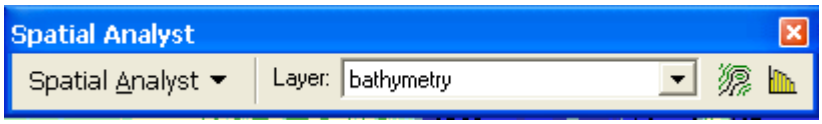
Processing and view data in a GIS

Start out by opening the application. You should see this window:

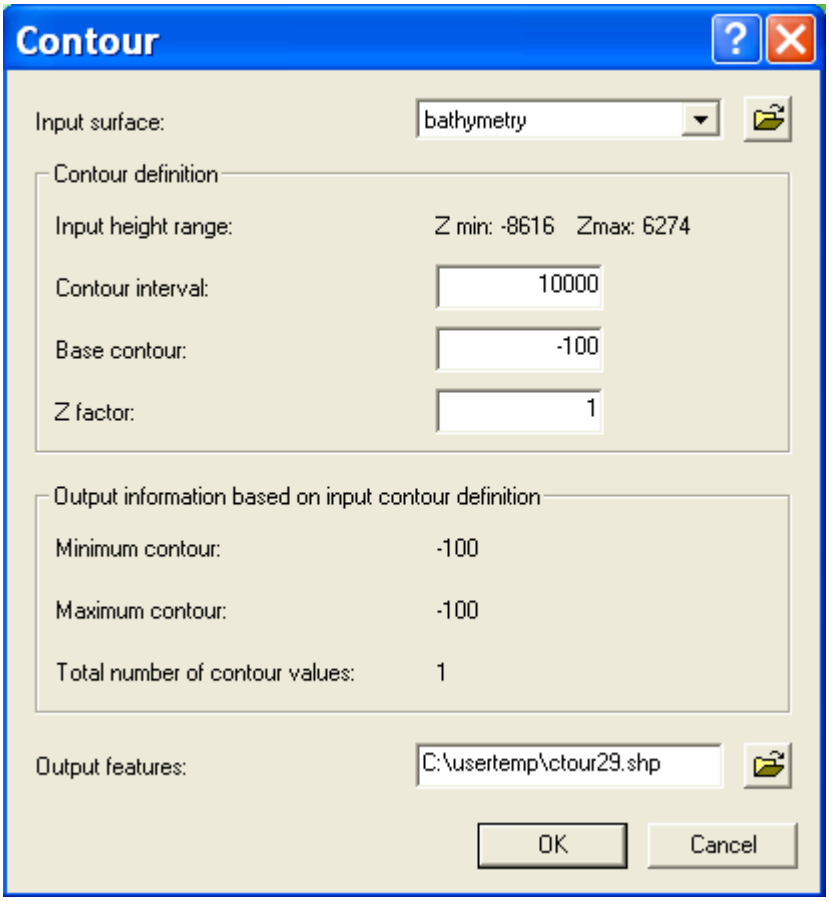


The map has several data layers already added, including the catch from the NMFS survey cruises for both Atlantic Cod and Sea Scallop. Also added are the current closed areas, the boundaries of the United States and other countries' exclusive economic zone (EEZ), and the topography of the land areas (dem land – a DEM is a digital elevation model) and the bathymetry. Both the DEM and the Bathymetry are in meters. You can see the legend for the topography and bathymetry by clicking on the small plus sign to the left of the checkbox by the name in the table of contents (the area to the left of the map). The checkbox is used to make the layer visible or invisible. Try these controls out.

Next, you will look use the bathymetry to determine the 100 meter depth contour. This contour generally outlines both Georges Bank and the Grand Banks, both of which were historically significant fishing grounds. To do this, you will use the Spatial Analyst toolbar, which looks like this:



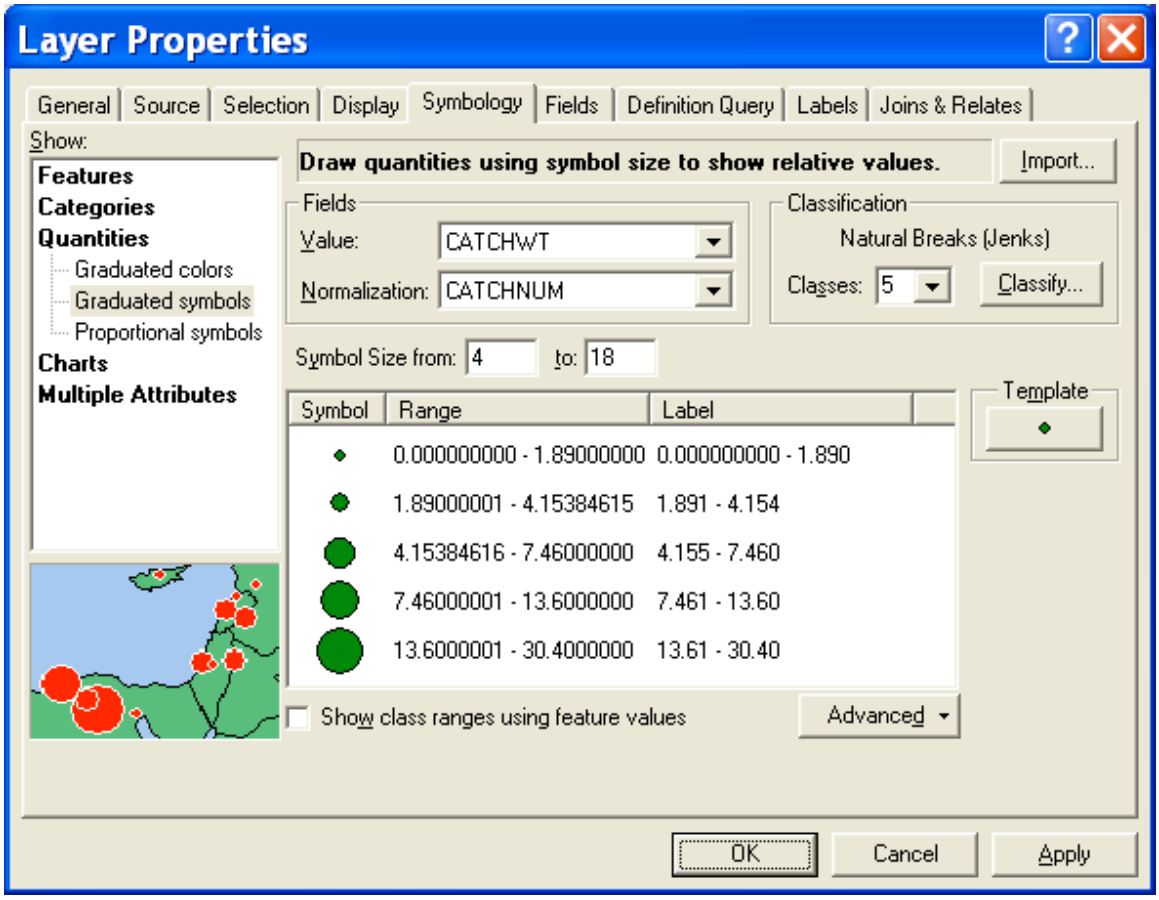
Click on the dropdown list (arrow to the right of 'Spatial Analyst') and select Surface Analysis then Contour. You should see a form like this:



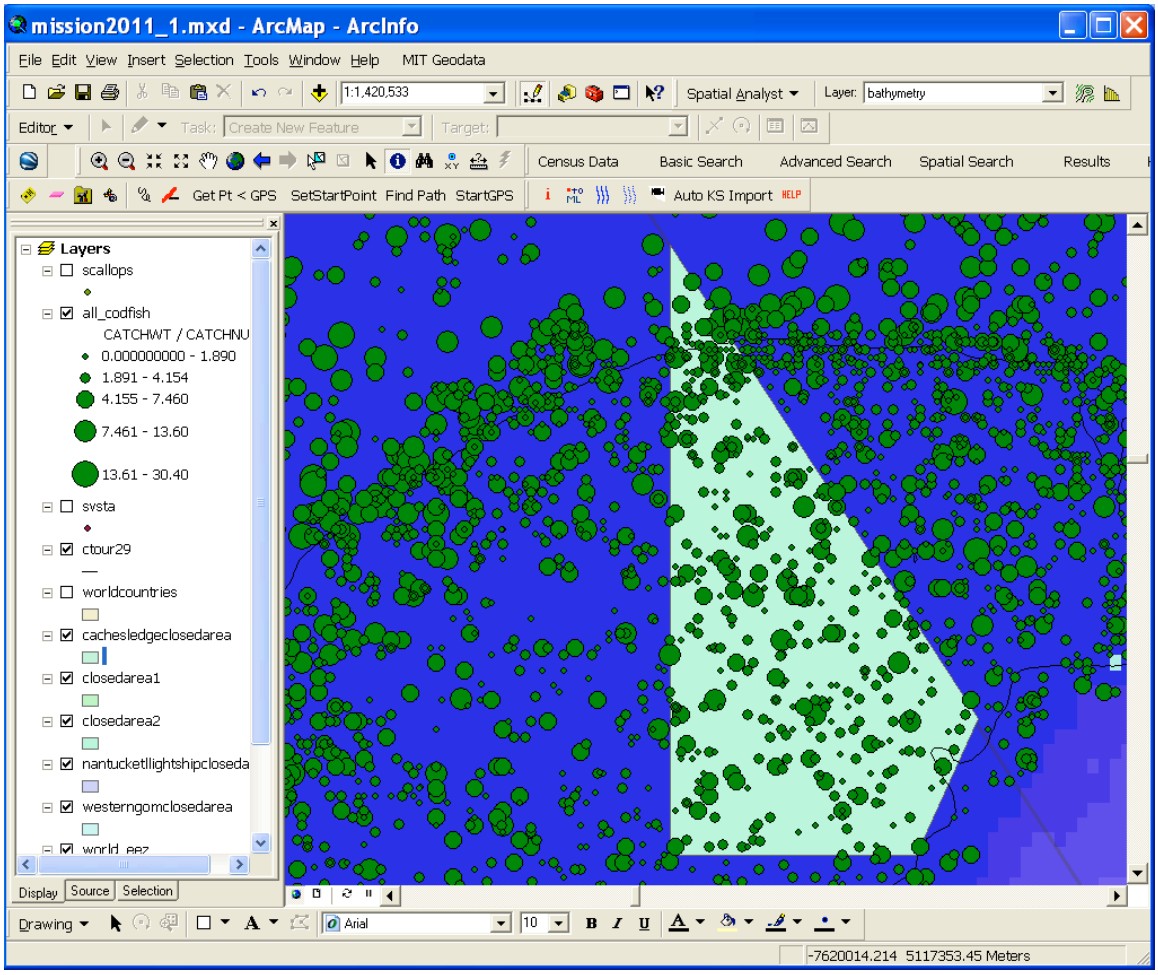
Fill out the form as you see here, except the Output. Put those in the drive the instructor tells you during the class. The contour interval of 10000 ensures that only a single contour line will be drawn, the base contour, which will be the 100 meter depth contour. Once you click OK and the processing is complete, check the map for the contour and look for Georges Bank and Grand Banks. Notice where the EEZ for Canada and the United States are in relation to both of these banks.

Next, zoom in to the northeast region (as defined by the National Marine Fisheries Service), from North Carolina to Nova Scotia. The zoom tool, changes the functionality of the cursor so that you can click on the lower left corner of where you want to look, keep the mouse cursor down, the draw the cursor to the upper right corner and release the button. The zoom cursor is the left most of the tools below:

Now make the closed areas visible to see where they are then make the all_codfish layer visible. The layer should show simply points where all of the cod where caught. Let's make this a little more useful by adding symbols. To get to the form, right click on the name 'all_codfish' in the table of contents and then click on Properties. Click on the Symbolize tab. You should see this form:

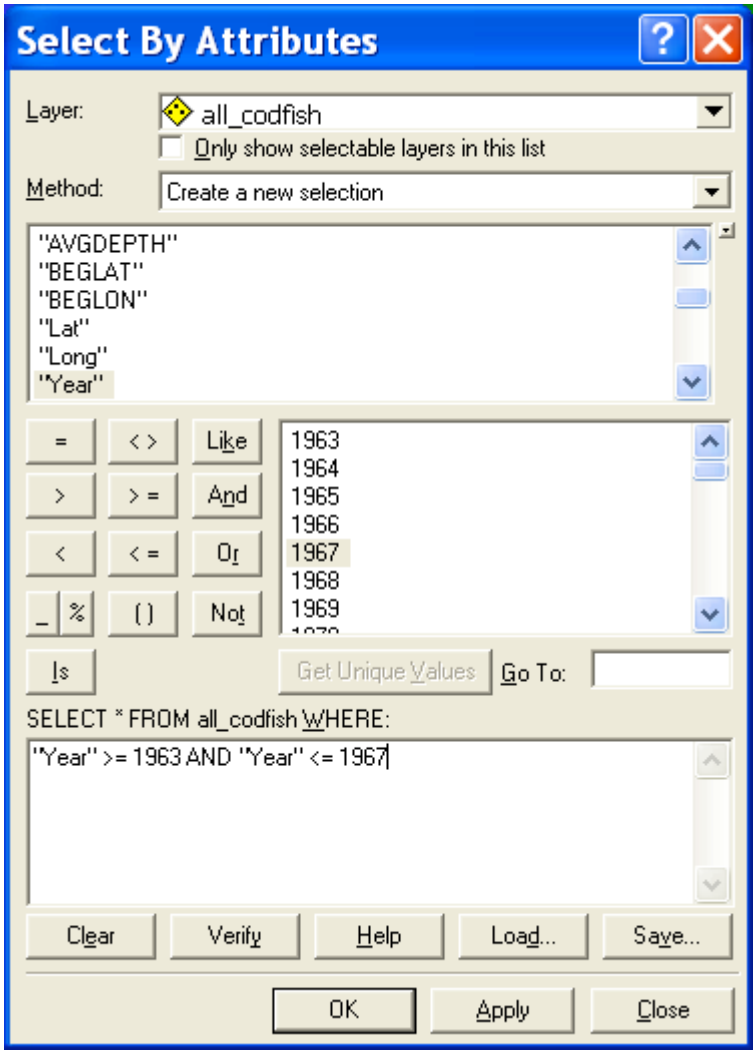


In the left window, change what you are showing from Single Symbol to Graduated Symbols under the Quantities heading. Change the Value to CATCHWT, which is the weight of all Cod caught a given station. Change the Normalization to CATCHNUM, which is the number of Cod caught at a given station. This gives you the average weight for all Cod caught at a given station. Click OK confirm this change. Once you do this, right click on the ClosedArea1 label in the table of contents and then click on Zoom to Layer. This will show you a map that looks like this:

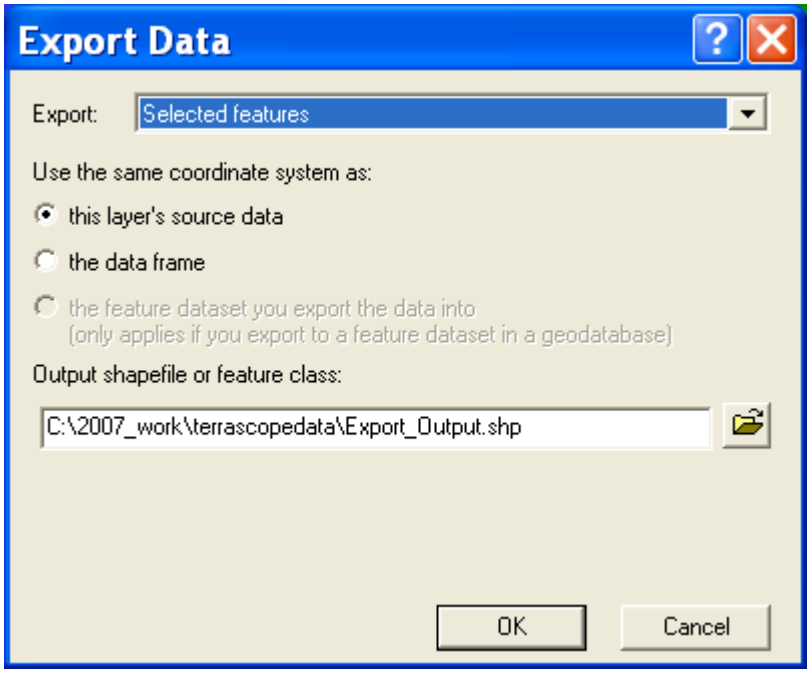


This map is centered on Georges Bank. You can see the productive northern edge of the bank, where the water drops off to the deeper Gulf of Maine, and relatively large Cod have been caught over the years of the survey.

Once you have this map, you will want to divide the data into years. Besides the CATCHWT and CATCHNUM fields, there is also a YEAR field, among several others. You will want to use the year field to separate the oldest and newest data from this dataset, which extends from 1963 to 2006 and is the longest time series of fish survey data in the world. To separate the data, click on the Selection menu and then click on Select by Attributes. This form should appear:

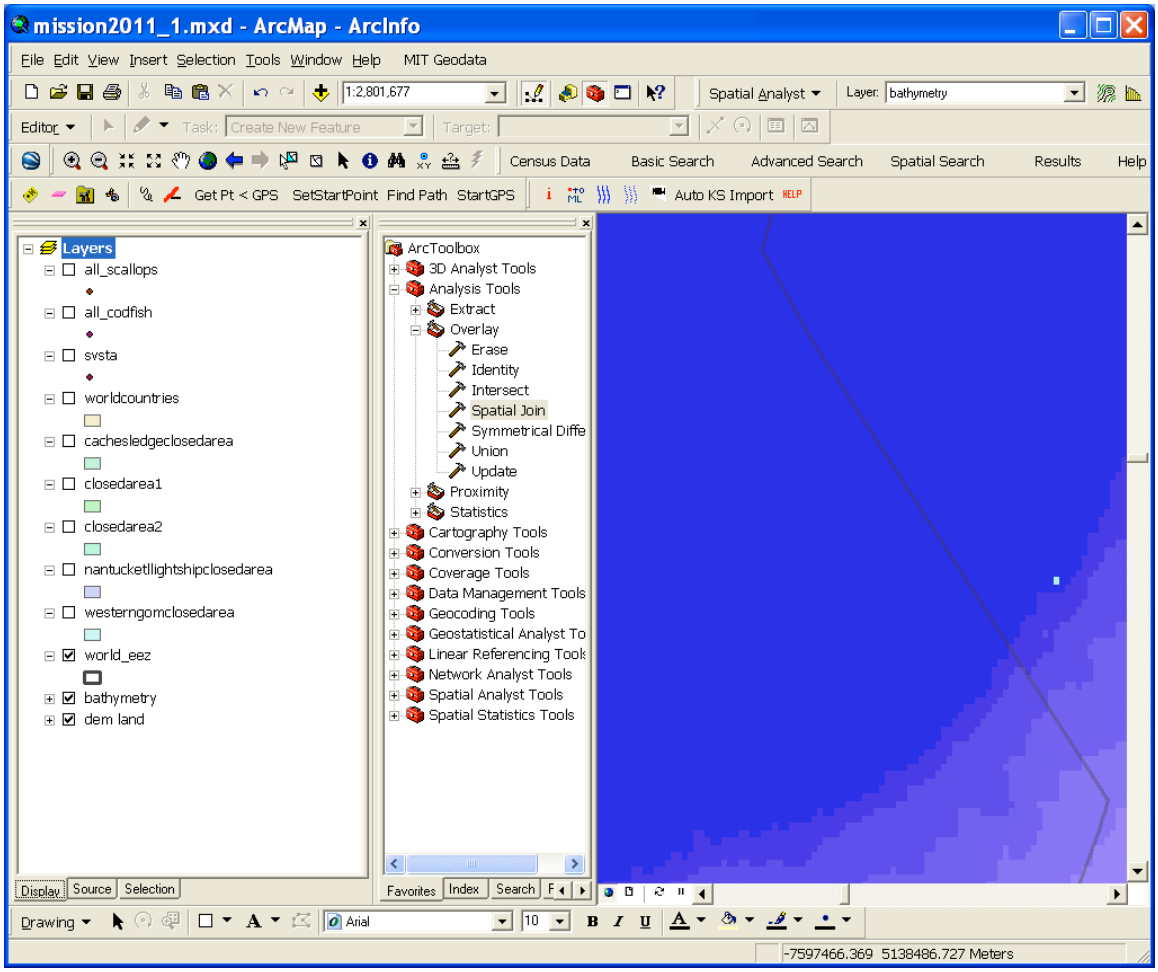


Fill in the form as you see here but double click on the field names and values (you will need to click on unique values to see the values) and single click on the 'AND' to add these to your select statement. This has the effect of selecting all of the stations in the all_codfish layers where the years match what you have selected. Once you have this, you can export this part of the data to a new layer, which you can symbolize separately from whole dataset. To export the data to a new layer, right click on the all_codfish layer in the table of contents, click on Data then click on Export. You should see this form:

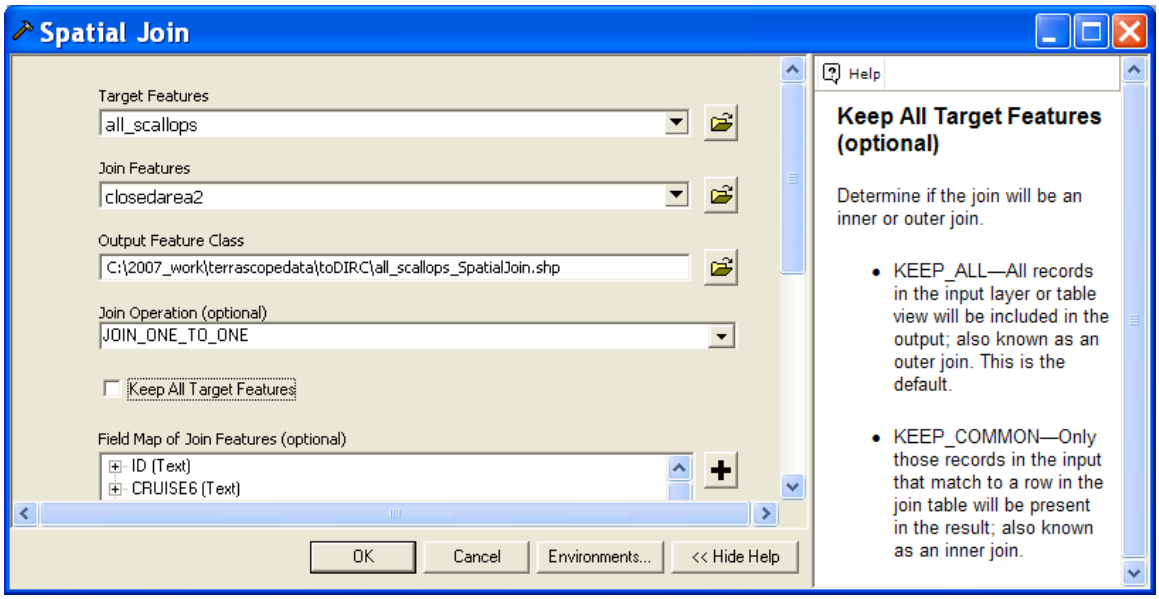


Be sure to save this to the same folder that you saved the contour data to and not the folder shown in the image here. You will be asked if you want to add the new shapefile to the map – please do so. You will need to change the symbolization for this new layer using the same directions as you did for the complete dataset.

You will also want to look at scallops, but only for those in the closed area (closedarea2). To do this, you need to do a spatial join. This operation selects points from a points layer that exist within a polygon layer. The operation creates a second layer. Attributes if the polygon layer are added to the new point layer. You need to open the Toolbox (instructor will help you find the red toolbox. You should see all of the toolboxes:



Navigate to the Analysis Tools then Overlay. Click on the Spatial Join Tool. You should see this window:



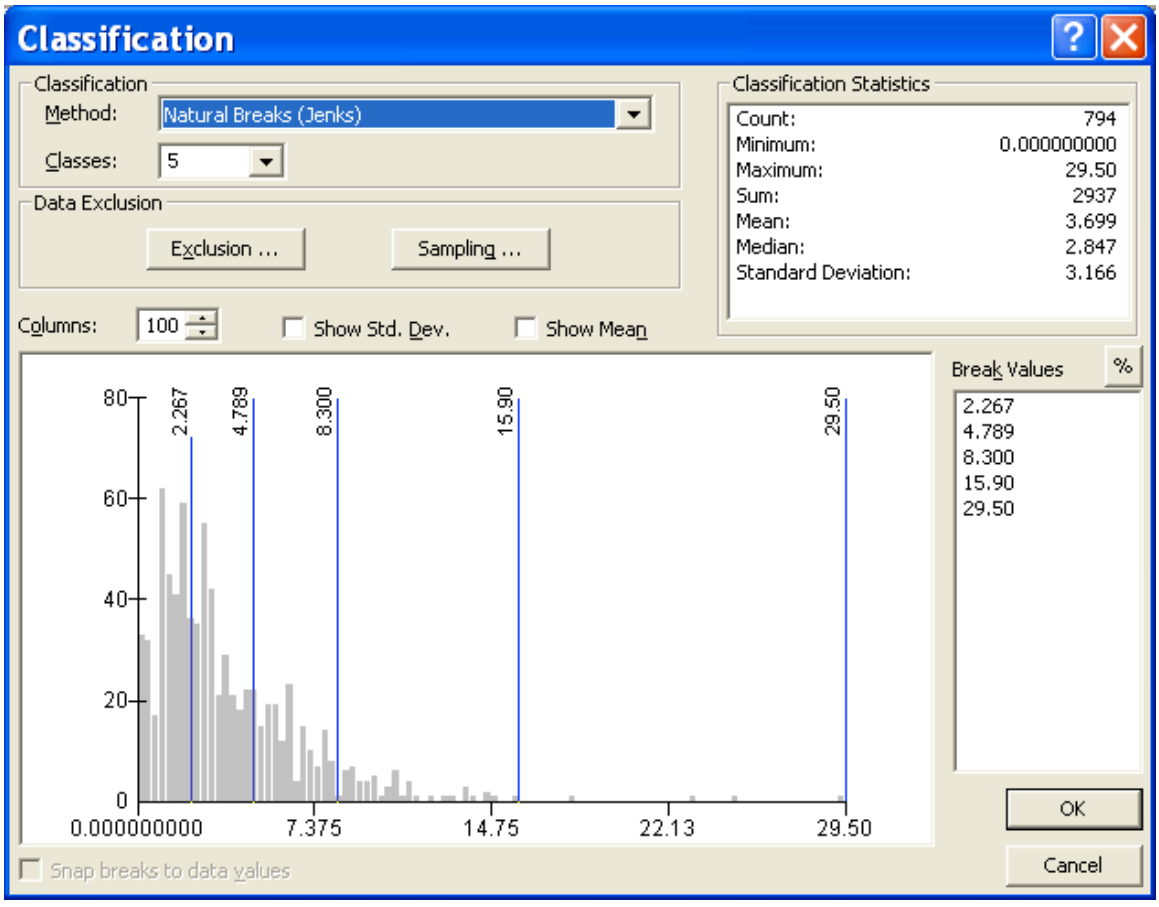
Fill in the values as you see above. The Keep All Target Features ensures that only those features that were found in the closed area are retained in the new layer. You can map with these data or your can open the attribute table, export it (under Options) and then open it in Excel and make graphs showing the average size over the years.

Project Work:

Create maps for the Georges Bank area showing Cod for the years 1963-1967 and 2002-2006. You can simply print out the maps (under the File menu) but add text in pen or pencil clearly stating the species and year as well as the ranges from the legend. Be sure to use the CATCHWT normalized by CATCHNUM. Turn off the Bathymetry otherwise your map will be hard to read. Retain the closed areas and the EEZ.

Do the same using the scallop data only this time use the years 1978-1982 and 2002-2006.

When making these maps with the data you exported, you should make use the same categories for the graduated symbols for each map. An easy way to do this is to make the first map with the earlier years for both cod and scallops. For the second map, start the process of making graduated symbols and after you added the Value and Normalization fields, click on Classify to see this form:



Change the Break Values (on the lower right side of the form), matching those from the earlier period. Start from the highest value. This form ensures that the values are in a logical order so if you add 5 as the first value in the form above (from 2.267), the form will reset it, since 5 is greater than the next value. Once you are done, click OK to get back to the Symbolize form then click OK.

For both of these cases, write a very brief statement describing whether the average Cod and Sea Scallop is increasing or decreasing in size. Discuss the difference in Scallop size across the Canadian boundary on Georges Bank and inside the closed area adjacent to the Canadian boundary. When discussing this, keep in mind your literature search.

Maps can be printed out by choosing the print option under the file menu.

Use these maps to help inform your discussion of how closed areas may work and prepare to hand them in during class on October 3.

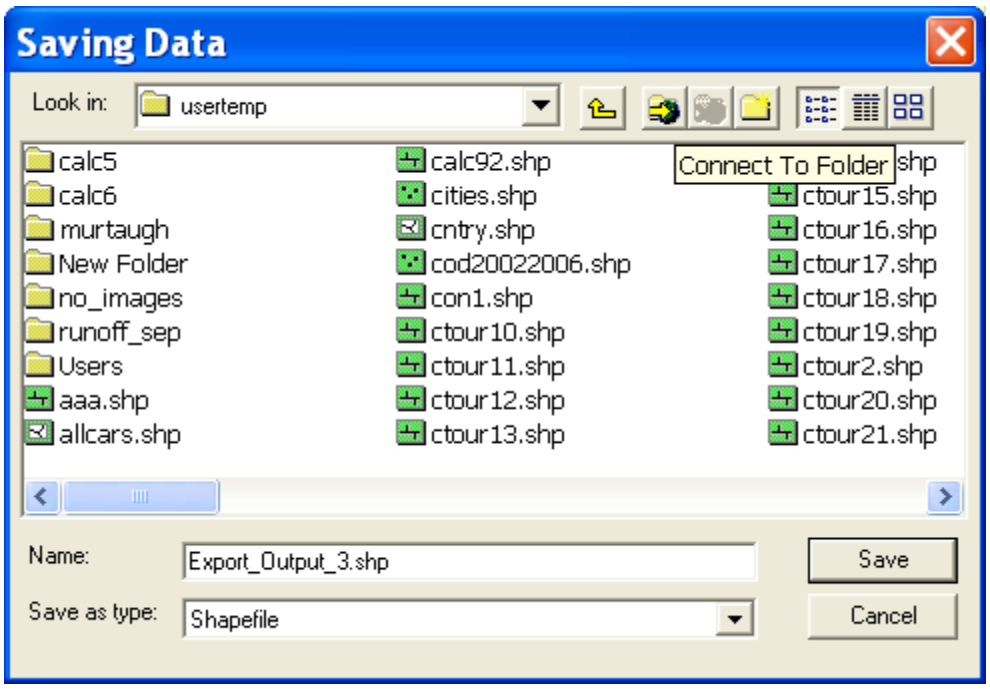
Working in 37-312 or the GIS Lab

There are over 20 fast Windows machines in 37-312, most with Arcgis installed. You can open the project that you worked on in the DIRC by opening the mission2011_1.mxd file from the

Z:\Athena.mit.edu\astaff\project\gis\workspace2\toDIRC

folder (that is a long path so be patient as you click through the folders using Windows Explorer). Once you have this opened, save you map to your own space (the H:\ drive). Choose the Save As option under the file menu.

When you are creating new shapefiles, you will need to save them to your H:\ drive. You will notice that the drive is not immediately visible. You will need to "Connect to Folder" using the second button on the top of the Saving Data form (see image below). Select the H:\ drive. Save this either in your H:\ drive or create a folder on the H:\ drive. Don't save this to the .Win* or the Win* folders!


Saving Data
Look in:
usertemp
Connect To Folder
calc5
calc6
murtaugh
New Folder
no_images
runoff_sep
Users
aaa.shp
allcars.shp
calc92.shp
cities.shp
cntry.shp
cod20022006.shp
con1.shp
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ctour19.shp
ctour2.shp
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Name:
Export_Output_3.shp
Save as type:
Shapefile
Save
Cancel