Spatial and 3D Analysts

Introduction

Spatial Analyst is the extension ArcGIS uses to conduct analyses with raster data. 3D Analyst and ArcScene allow users to display and work with three-dimensional (x, y, z) data.

Objectives--By the end of this lesson, you should be able to:
- Create a new shapefile
- Edit a shapefile
- Convert a bathymetry grid to a 3D display
- Complete viewshed and hillshade analyses
- Select features within an attribute table
- Buffer a shapefile

As you proceed through this lab answer the questions in the word document provided to you. The questions should be answered as they are encountered rather then at the end.

*Generating Slope and Hillshade grids using the Spatial Analyst Extension*

1. Start ArcMap and add the **fb02_1mneg08** grid to the project.

2. Make sure the Spatial Analyst and the 3D Analyst Extensions are turned on.
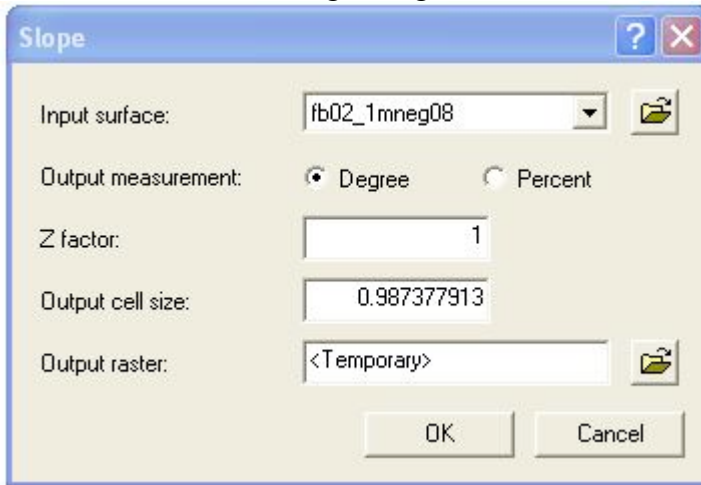
    Go to **Tools→ Extensions**.
    Check the boxes next to **Spatial Analyst** and **3D Analyst** and click close.
    To add the Spatial Analyst toolbar to your window, go to **View →Toolbar→Spatial Analyst**.

3. Add the 3D Analyst Toolbar in the same manner (see image below).
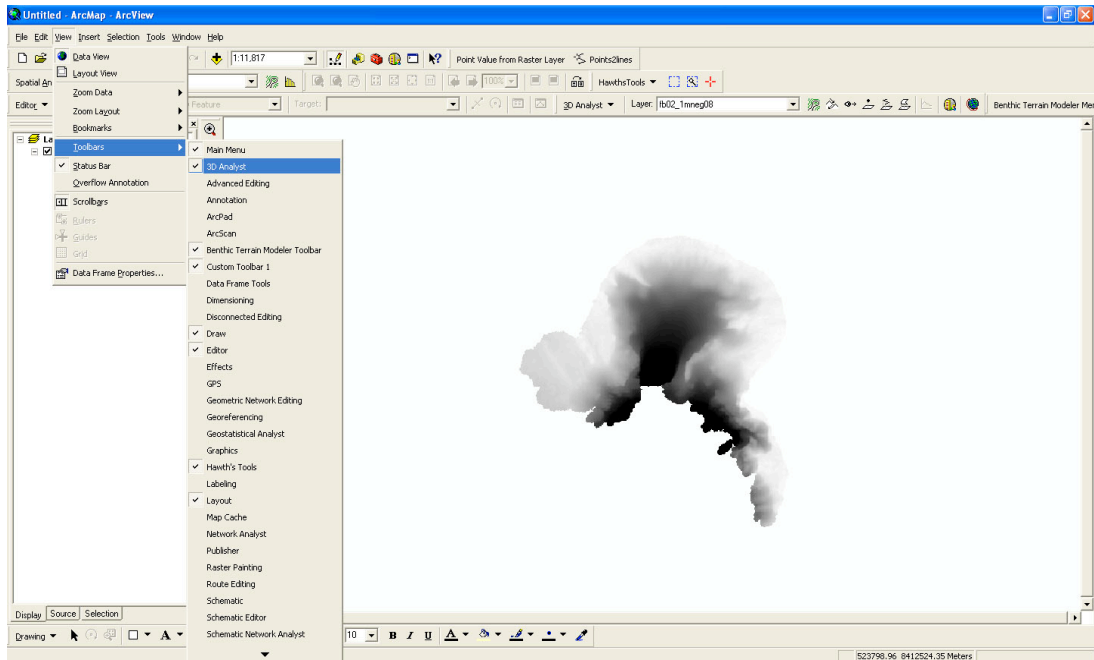
4. Create a slope grid: **Click on Spatial Analyst → Surface Analysis → Slope**
You will see the following dialog box:

Leave the default values as they are and click **Ok.**

Right click on the new grid and choose **make permanent**. *Important: Save your grid in the same folder that contains the bathymetry grid.*

Generating a Hillshade using the Spatial Analyst Extension:

Hillshade analysis is a way to see where light would fall on a landscape. The resulting grid will appear as a grayscale (black & white) image. Hillshade often has a photo-like quality to it.

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1. On the Spatial Analyst Toolbar, go to **Spatial Analysis→Surface Analysis→Hillshade**. This will bring up the Hillshade dialog box.
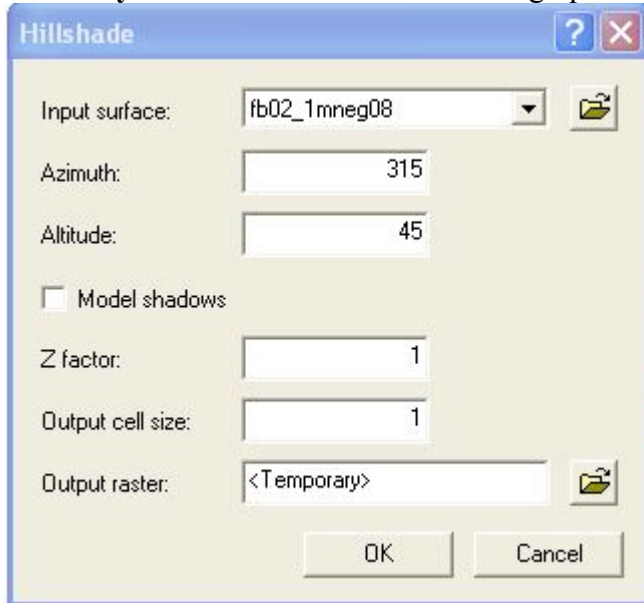
Make sure the bathymetry grid is showing in the *Input Surface* field.
For now, leave *Azimuth, Altitude, and Z factor* as their default values of 315, 45, and 1.

Change the *Output Cell Size* to 1 and choose a filename the same way you did above for

slope. Click on the open folder icon ![folder icon] next to *output raster*. Navigate to your bathymetry grid folder and choose an appropriate name for your hillshade. Click **Ok**.

2. Compare the hillshade grid to the slope grid you made earlier and answer the question below. Refer to the illustration below to help hone your recognition skills of various terrain features.
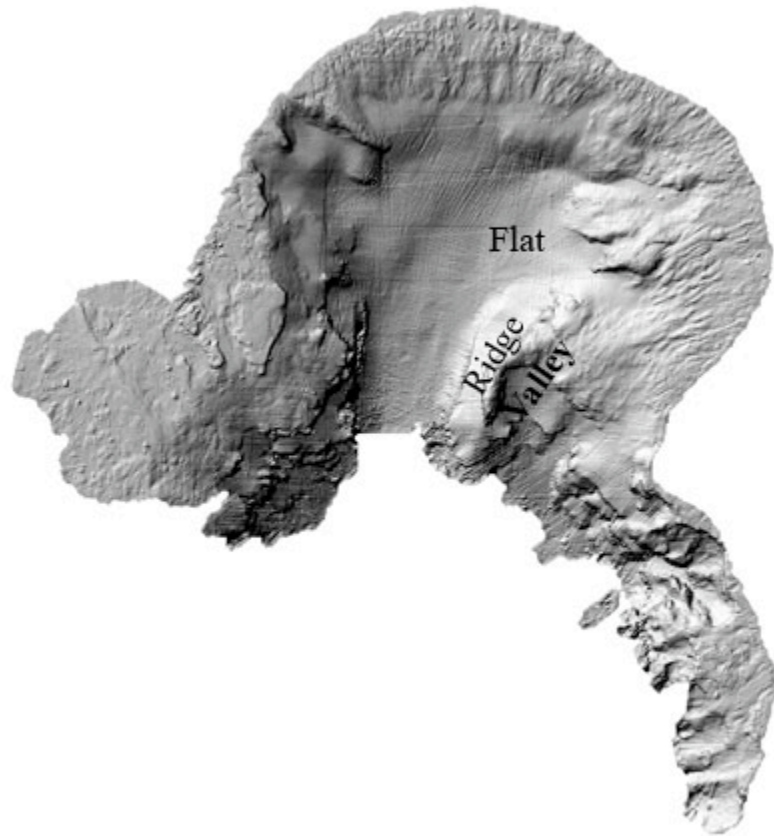
Q1. What are the general ranges of values of slope encountered in these three regions of your hillshade?

3. Now we will use the *Effects* toolbar to modify layer transparencies.   In the main menu click on **View → Toolbars → Effects**.

   In the **Layer** box on the *Effects* toolbar, make sure the **fb02_1mneg08** grid is showing. Click on the **Transparency** ▣ button. This will bring up a slider bar. Set the transparency to a value close to 40%. You may experiment with the slider bar to see what transparency level works best. (**Hint: the greater the percentage transparency used the more the transparent the layer.**)

4. Create a map showing your hillshade with bathymetry over it. (**Hint: you need to be in *layout* view.**) Remember to include:
   - title
   - north arrow
   - scale bar
   - name
   - date

- neatline

Creating a new point shapefile

1. Open ArcCatalog from ArcMap .

2. In ArcCatalog click the name of the folder in which you want to create your shapefile in the table of contents window (far left window). Now in the ArcCatalog main menu bar, click on **File→New→ Shapefile**. In the *Create New Shapefile* dialog box, change the name of the file to **observer_pts**. Make sure that **Feature Type** is **Point** and click **Ok.**

3. Now close ArcCatalog.

4. Go back to ArcMap and add your **observer_pts** shapefile to your project. Make sure the *Editor* toolbar is visible. If not, add it by clicking on **View→Toolbar and** scrolling to check off the Editor option.

5. On the Editor Toolbar, go to **Editor→Start Editing**. A dialog box will appear with a statement about your shapefile not being in the same coordinate system as the map. Click **Ok**.

6. Click on the Digitize Tool . Make sure that the **fb02_1mneg08** appears in the dropdown menu. Use the digitize tool to add a point to the observer_pts shapefile by clicking wherever you wish on the map. A highlighted point will appear. Add another five points wherever you would like.

7. Save your edits by going to **Editor→Save Edits**.

8. Stop editing by going to **Editor →Stop Editing**

You will use your **observer_pts** shapefile again later in the lab.

9. Save your project.
    Note: **Make sure you are saving where you intend!** Check the folder in the top of the *Save As* dialog box. When naming raster files, the name can only be 13 characters long and it is *never* a good idea to have spaces in a filename.

3D Analyst

1. Launch ArcScene from ArcMap by clicking the ArcScene button in the main menu bar.
2. Add the **fb02_1mneg08** and **observer_pts** files in ArcScene the same way you would add a layer in ArcMap

Note: You may have to rotate the image using [icon] to make the layer appear correctly.

3. Right-click on the **fb02_1mneg08** grid and go to **Properties**. Click on the **Base Heights** tab. Click the **Obtain heights for layer from surface** option. Choose the pathway to the fb02_1mneg08 file. Click **Ok.** The bathymetry later should now have a 3D appearance.
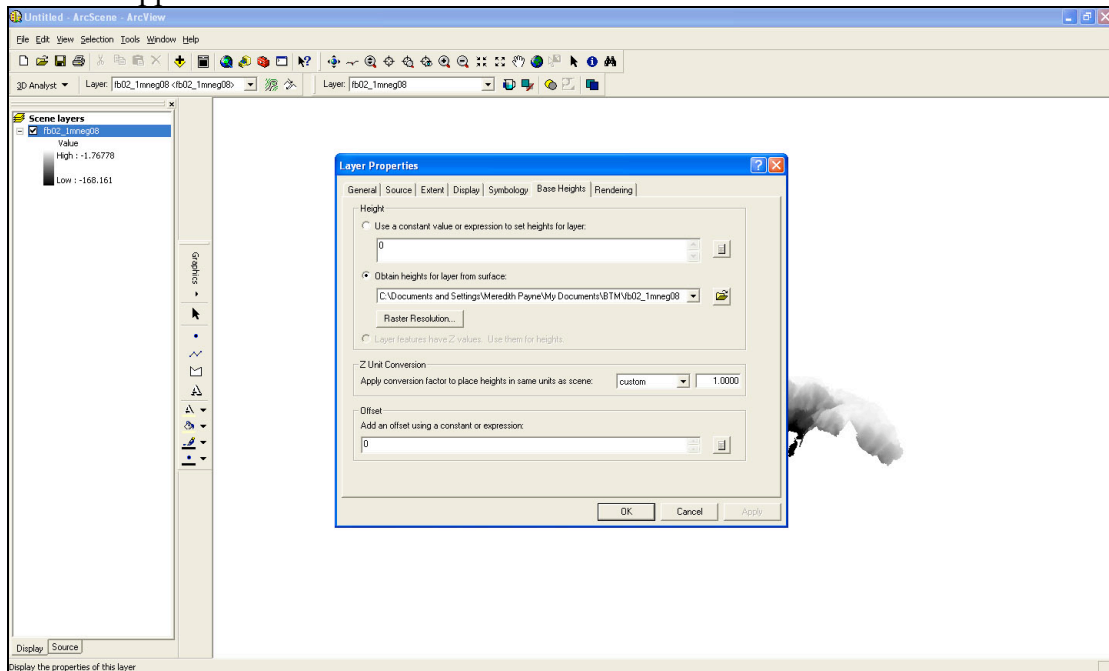
Viewshed Analysis

A viewshed analysis shows you what can be seen from a point on a raster file. This analysis is commonly used to determine what can be seen from a given point or group of points in an area.

1. Make sure 3D Analyst is turned on by clicking **View → Toolbars → 3D Analyst**.
2. Go to **3D Analyst→Surface Analysis→Viewshed**. This will bring up the *Viewshed* dialog box.

- For *Input Surface* choose **fb02_1mneg08**.
- For *Observer Points* choose your **observer_pts** point shapefile.
- Change the *Output Cell Size* to 1.
- Choose a filename. Since the output viewshed file will be a raster file. The name must be 13 characters or less.
- Click **Ok.**

The viewshed file will now appear in the table of contents. It will be divided into two areas. One area will represent parts of the terrain that are not visible (termed "Not Visible") from any of the points in the shapefile underwater and one area will represent

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parts of the terrain that are visible (termed "Visible") from any of the points in the shapefile. Using the viewshed grid, answering the following questions:

Q2. For what types of applications do you think a viewshed analysis would be useful?
Q3. What industries use viewshed analysis? Search the internet to find out. Be sure to say where you got your information.

3. Now add the hillshade file you created earlier in this lab to your ArcScene project. Make sure that the viewshed file is first in the layer list (above all other files in the table of contents) and that the hillshade file is second in the layer list.

4. Turn off all other layers (click to uncheck the boxes beside them).

5. Set the **Base Heights** for the viewshed using the **fb02_1mneg08** file.

6. Set the **Base Heights** for the hillshade using the **fb02_1mneg08** file in the same manner. Furthermore, in the **Offset** box of the *Base Heights* tab, set an offset for the hillshade of ⁻10.
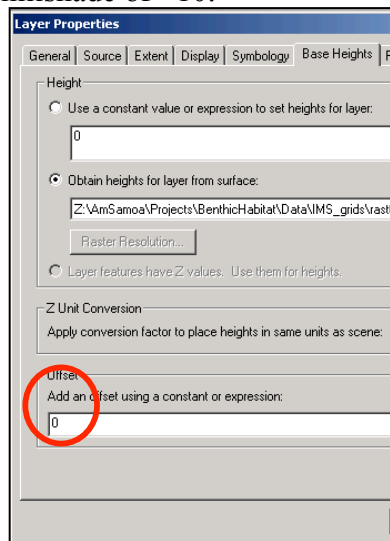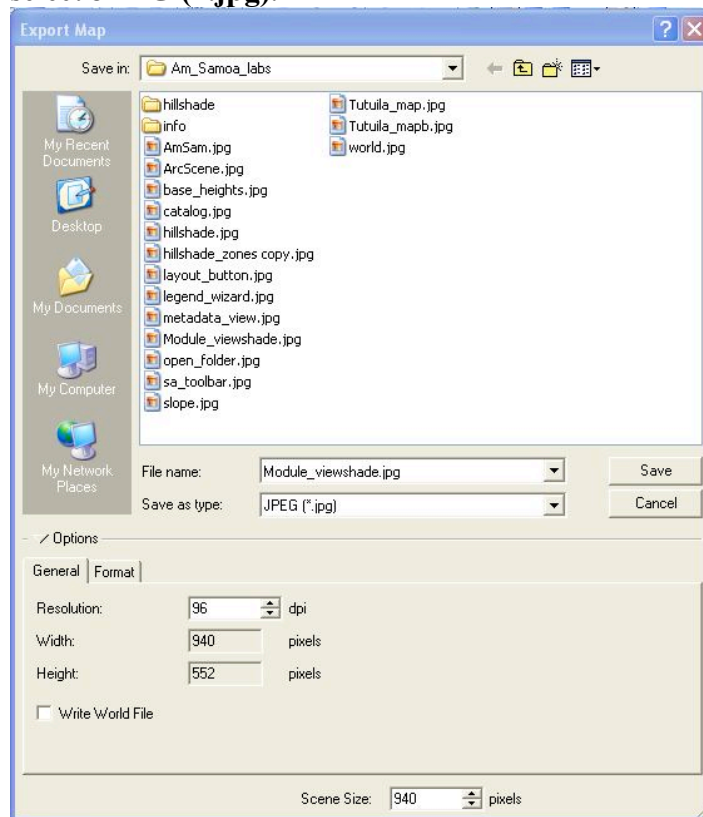

7. Set the transparency of the viewshed file to somewhere around 50%.

8. Using the Navigator tool , create a view of the top of the viewshed.

9. Export your scene by clicking on **File**➔**Export Scene**➔**2D** (see image below).
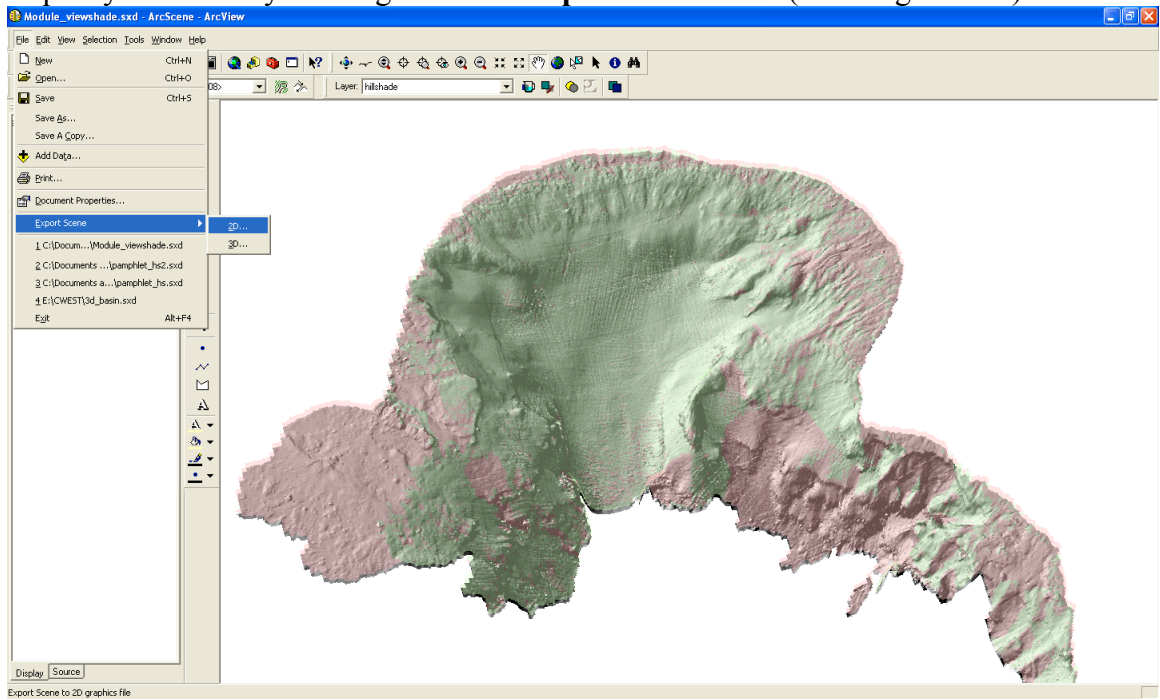
An Export Map dialog box will open and in the "Save as type" pulldown menu select **JPEG (*.jpg)**.

Use the default filename and click **Save**.

10. After saving your viewshed image in ArcScene, exit the ArcScene program by clicking on **File→ Exit**.

11. Now open a Microsoft Word Document and *Insert* your viewshade .jpg file into it. Save your Word document.

MPA Designation

Designating Marine Protected Areas (MPAs) can be difficult. It is important that the place chosen to be an MPA protect as many species as possible. Not only must the best location for an MPA be chosen, but the choice must be sensitive to the people who will be affected by a marine reserve in their area. There are two kinds of MPAs in American Samoa: no-take MPAs and MPAs where limited fishing is still allowed. The only no-take MPA in American Samoa is Rose Atoll National Wildlife Sanctuary.

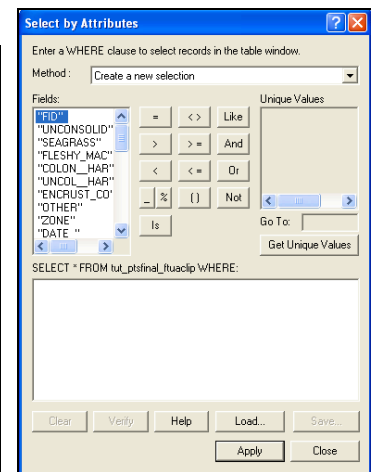*Buffering Analysis for an MPA in Fagaitua Bay*

You should still have your ArcMap project open.
1. Add **ftuaneg1m** and **ftua_ptsfinal,** to your project.

2. Right-click on the **ftua_ptsfinal** shapefile in the table of contents and click **zoom to layer**.

3. Right-click on the **ftua_ptsfinal** file in the table of contents and select **Properties.**

4. Click on the **Symbology** tab to change how the layer is displayed.
   Click on **Categories** and then **Unique Values**.
   In the **Value Field** pulldown menu, choose **AREA_1_MOD.**
   Click the **Add All Values** button. If the color scheme is something you like, click **Ok.** Otherwise, choose a different color scheme and click **Ok.**
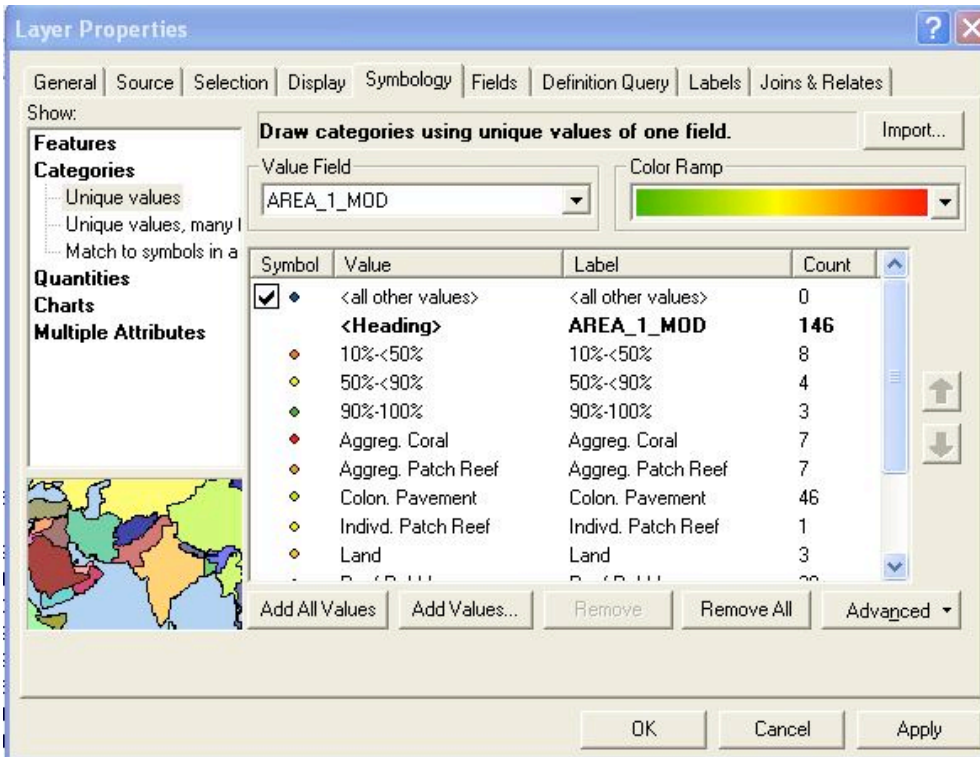
5. Open the *Attribute Table* for **ftua_ptsfinal** (below left). (Right-click on the name of the file and choose **Open Attribute Table.**)

6. Click on the **Options→ Select By Attribute**. This will bring up the *Select By Attributes* window (below right).

- Under *Fields*, double-click on "**AREA_1_MOD**"
- Click the = button
- Click the **Get Unique Values** button.
- Under *Unique Values,* double-click on 'Aggreg. Coral'

In the *Select From…*box, your equation should read:
"AREA_1_MOD" = 'Aggreg. Coral'

Click **Apply** and close the *Select By Attributes* window.

7. Now look at the attribute table for **ftua_ptsfinal** and at your map. Notice that the points that are highlighted are those that you selected in the attribute table.

8. In the ArcMap main menu bar go to **Options→Clear Selection.**

Now you will find out where most of the coral in Fagaitua Bay is located. To do that, you will again make a "Select by Attributes" equation and select points based on more than one Unique Value using the **OR** connector.

9. As above, Open the *Attribute Table* for **ftua_ptsfinal** and click on **Options→ Select by Attributes.**

10. In the *Select by Attributes* box write the following equation (**Hint: you can copy and paste the equation below into the Select by Attributes box.**)
    "AREA_1_MOD" = **'Aggreg. Coral' OR**
    "AREA_1_MOD" = **'Aggreg. Patch Reef' OR**
    "AREA_1_MOD" = **'Colon. Pavement' OR**
    "AREA_1_MOD" = **'Indivd. Patch Reef' OR**
    "AREA_1_MOD" = **'Scat. Coral/Rock'**

11. Close the *Select by Attributes* window.
    On the map, all of the selected points will be highlighted. In the *Attribute Table*, some records will be highlighted. If you want to see just the selected records, click the **Selected** button. If you want to see all of the records again, click the **All** button.

Now we are going to buffer around the selected coral points to determine the best place for a marine protected area (MPA). *Note***:** A **Buffer Analysis** defines an area around a feature of interest, in this case, coral. In this case, the buffered area around the coral can help identify an area that would provide protection for coral and reef fish.

12. Right-click on the **ftua_ptsfinal** in the layer list. Choose **Data→Export Data**. Make sure *Selected Features* is showing in the *Export* pull-down menu. In the *Output* box, name your file **ftua_coral.shp**. It is fine to use "this layer's source data" for a coordinate system. Click **Ok.** A box will pop up asking, "Do you want to add the exported data to the map as a layer?" choose **yes**.
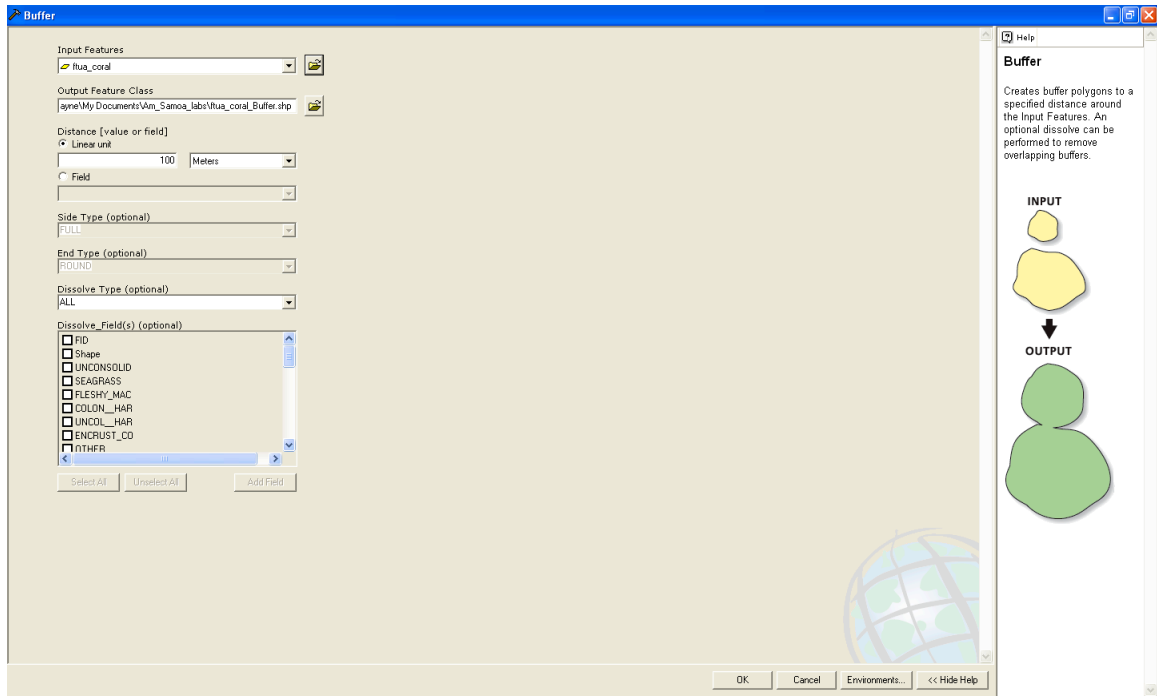
13. Now turn off the **ftua_ptsfinal** layer.

14. Open ArcToolbox by clicking on the ArcToolbox icon in the ArcMap menu bar.

15. In the ArcToolbox window, click on **Analysis Tools**. Your ArcToolbox window should look much like the image below.

16. Click on **Buffer**. The Buffer dialog box will appear as below.

- For *Input Features* choose **ftua_coral** from the dropdown list.
- For *Output Feature Class* make sure that the pathway points to the right directory and that your output file name will be **ftua_coral_Buffer**.
- We want to create a 100 meter buffer around the coral so type "**100**" under *linear unit* and make sure that "**Meters**" is the chosen unit in the adjacent dropdown list.
- Under *Dissolve Type* choose "**None**." Click **Ok.**

Now you need to decide where to designate an MPA.
   Some things to keep in mind:
- An MPA should be efficient: It should protect as much as possible while placing restrictions on as little area as possible.
- Many MPAs prohibit all fishing and collection, while others allow some types of fishing and collection.
- You will have to get those affected by MPA rules to agree to them.
- An MPA that only protects shallow areas may not protect fish that spend part of their time in deeper water.

17. Make a map (using layout view) showing the buffered areas and export it (**File → Export**) as a .jpg file as you did for your ArcScene map. Place the map in your Microsoft Word document below your ArcScene map and either using Microsoft Word drawing tools, or a pencil on a printout, draw where you would choose to create an MPA. Finally, answer the following questions.

Q4. How many points in the **ftua_coral** shapefile are classified as *Aggregate Coral?*
Q5. How many points in the **ftua_coral** shapefile actually contain coral?
Q6. What general areas of the bay have the densest clustering of corals?