Exercise 1 – Establishing Spatial Reference

Session Objectives: At the conclusion of this session, you will be able to:

- ❑ Assign a coordinate system to an ArcMap data frame
- ❑ Define and transform datum's and coordinate systems for vector and raster datasets

Material Created By: Todd Sutherland (December 2005)

Revision: Eric Kelchlin (October 2013)

Software: ArcGIS 10 SP5

Directory Path: C:\ or D:\CSP7200\Exercise1

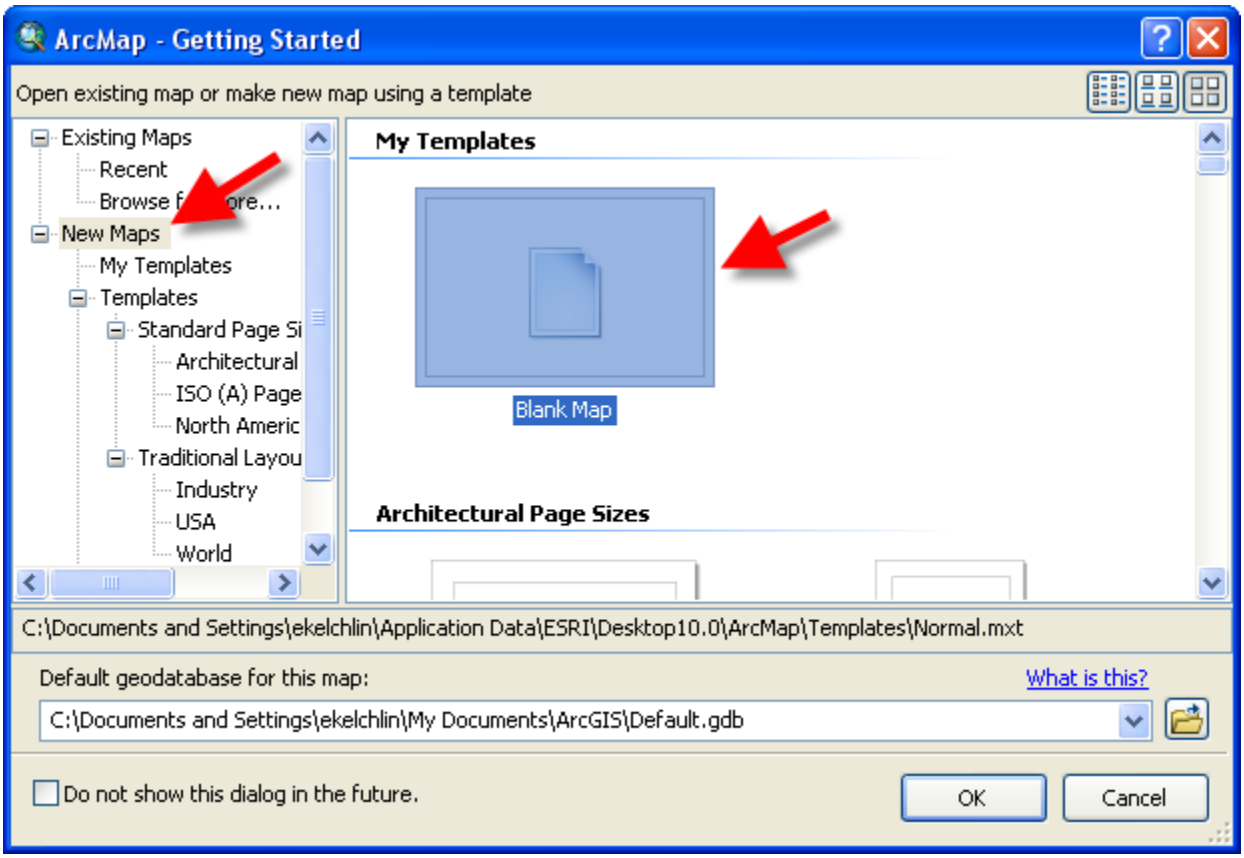
Shapefiles: mn_wpas_albers, mn_cnties_utm.shp, p8_brdsrvy.shp, p8_landcov.shp

Imagery: p08_doq.sid

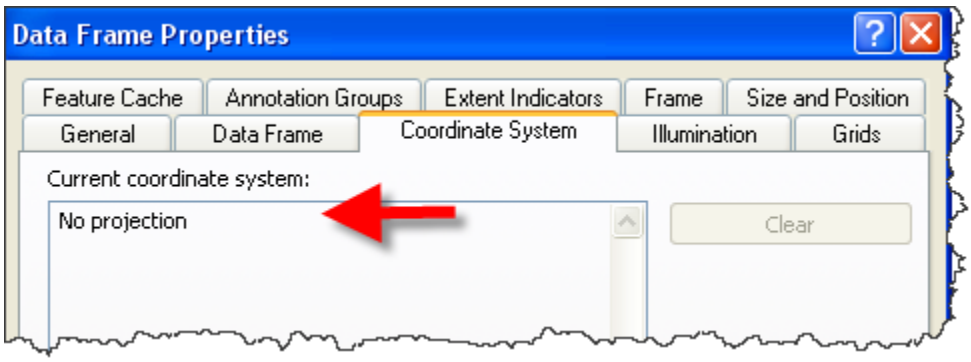
SECTION 1 – Assign a Coordinate System to a Data Frame

Unless stated otherwise, all data are located in CSP7200\Exercise1.

1. Launch ArcMap and open a New Blank Map.



2. Right-click on the **Layers** data frame and select **Properties**. Click on the **Coordinate System** tab. By default, no coordinate system is assigned to the data frame. Click **OK** to close the dialog.

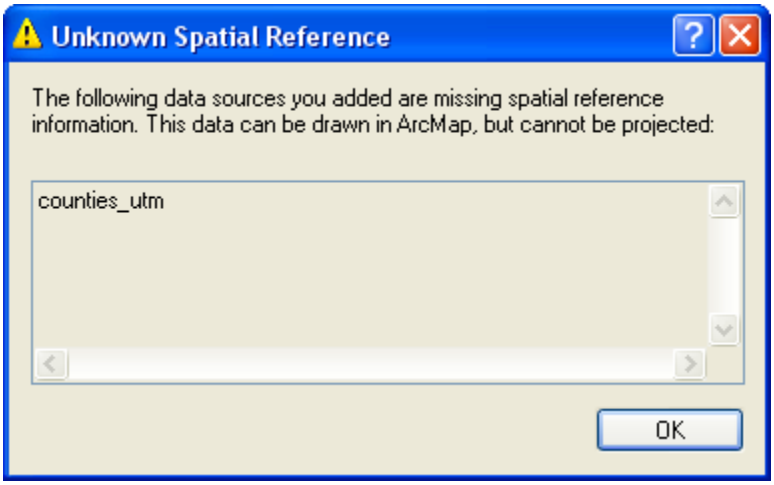


3. **Add** the **wpa_albers.shp** layer. This layer has a projection file (.prj) and therefore the data frame will assume the projection.

4. Check the data from properties again. What coordinate system is the data frame now_____?

   When adding multiple layers at the same time, ArcMap uses the last layer you select to set the data frame's coordinate system.

5. **Add** the **counties_utm.shp** layer. You should get a warning "Unknown Spatial Reference". This layer does not have an associated .prj file.



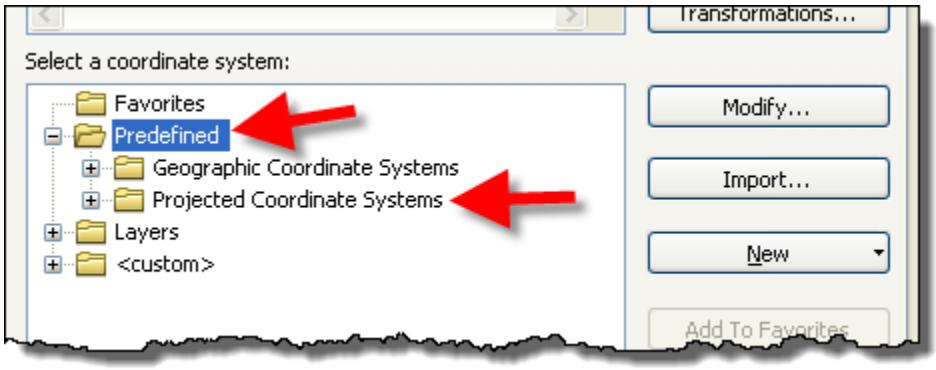
   This warning does not always appear when adding layers that lack spatial reference information. Hence, it is very important that you always define the spatial reference of your layers. This is vital for shapefiles!

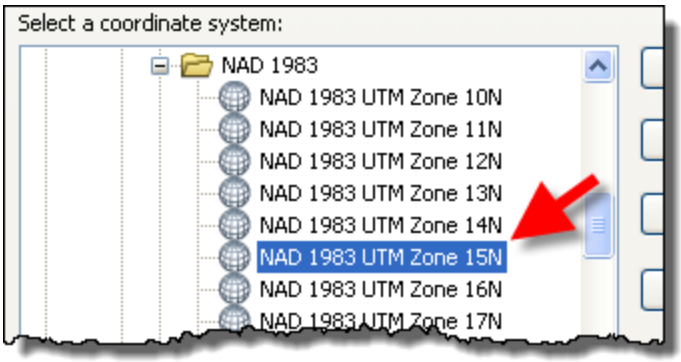
6. Click Full Extent on the Tools toolbar. These 2 layers do not overly even though both represent features in Minnesota. The **counties_utm** layer does not have a projection file, therefore Arcmap cannot determine its coordinate system. If this layer had this valuable information, then ArcMap could perform an "on-the-fly projection". These two layers would then be aligned in the same coordinate space.

7. The native projection for this layer is **UTM-Zone 15, NAD83**. So, let's assign this coordinate system to the data frame to get these two layers to line-up.

8. Right-click on the **Layers** data frame and select **Properties.** Select the Coordinate Systems tab.

9. In the Select a coordinate system section, navigate through the **Predefined > Projected Coordinate Systems > UTM > NAD 1983** folders and select **NAD83 UTM Zone 15N**. Click **OK**.





10. Click Full Extent on the Tools toolbar. Drag the **wpa_albers** layer on top of the **counties_utm** layer in the Table of Contents.

11. The two layers now overly correctly because the **wpa_albers** file, which has an associated projection file, is projected on the fly from Albers to UTM by ArcMap.

12. Is this the best approach for dealing with this issue? Why or why not_____

    _____?

13. Close ArcMap. Do not save changes.

SECTION 2 – Using the Define Projection Tool

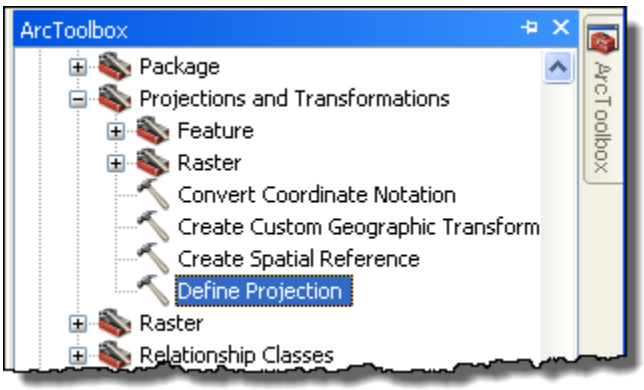
In this section you will define a projection for the **counties_utm.shp** file. For shapefiles, defining a projection means that you will be creating a .prj file.

1. Launch ArcCatalog from the desktop.

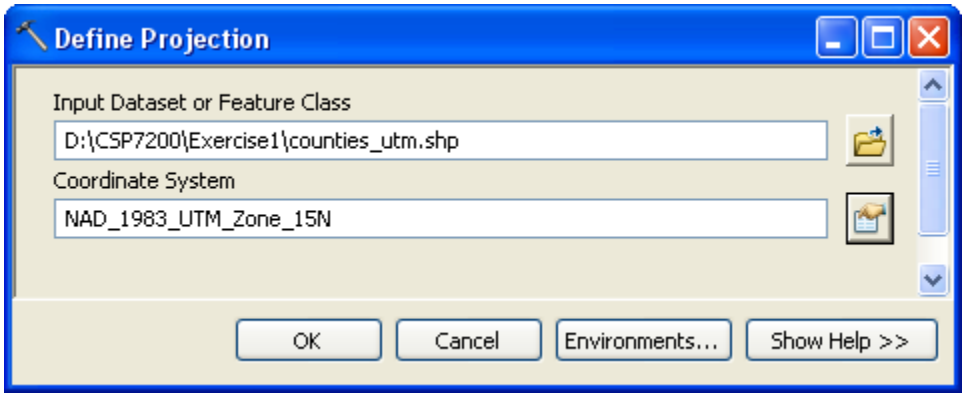
2. Right-click on the **counties_utm** layer in your catalog tree and select **Properties**. Click on the XY Coordinate System tab and notice how the coordinate system is unknown. Select **OK** to close the dialog.

3. Open ArcToolbox if it's not already docked on the right side of your screen.

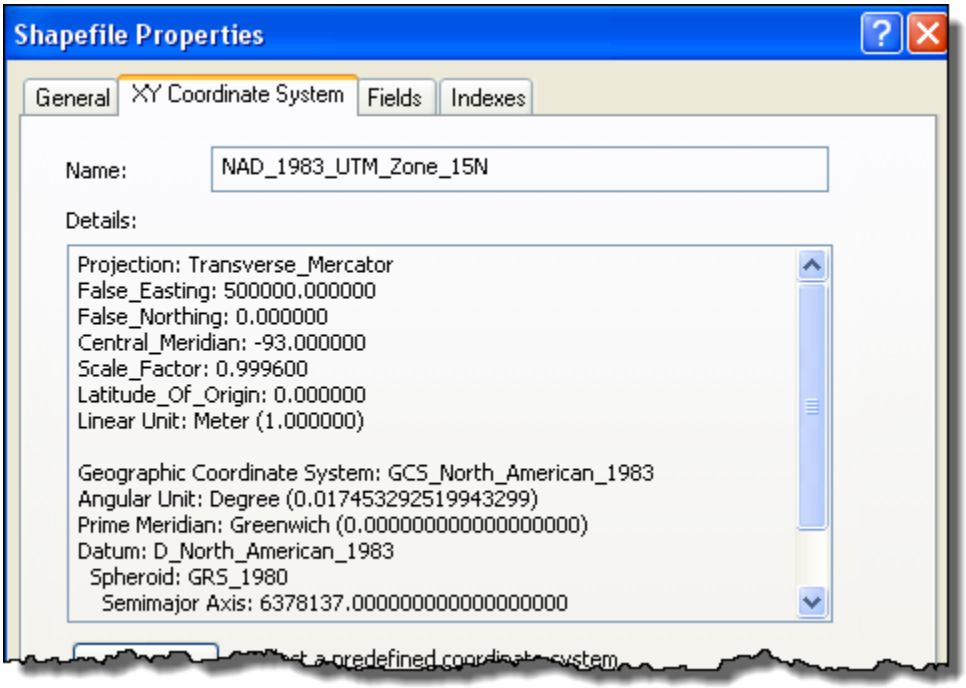
4. Find the **Data Management Tools > Projections and Transformations** toolbox and double-click on the **Define Projection** tool.



5. Navigate to the **counties_utm** layer and select the properties icon. Click on the Select... button and browse to through the **Projected Coordinate System** folders and select the appropriate coordinate system as shown below. Click **OK** when done.



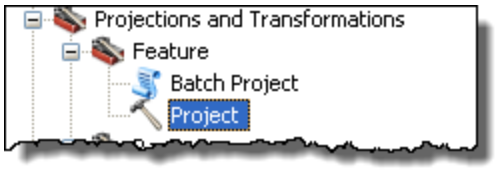
6. Right-click on the **counties_utm** layer in the catalog tree to see that the Coordinate System was assigned correctly.



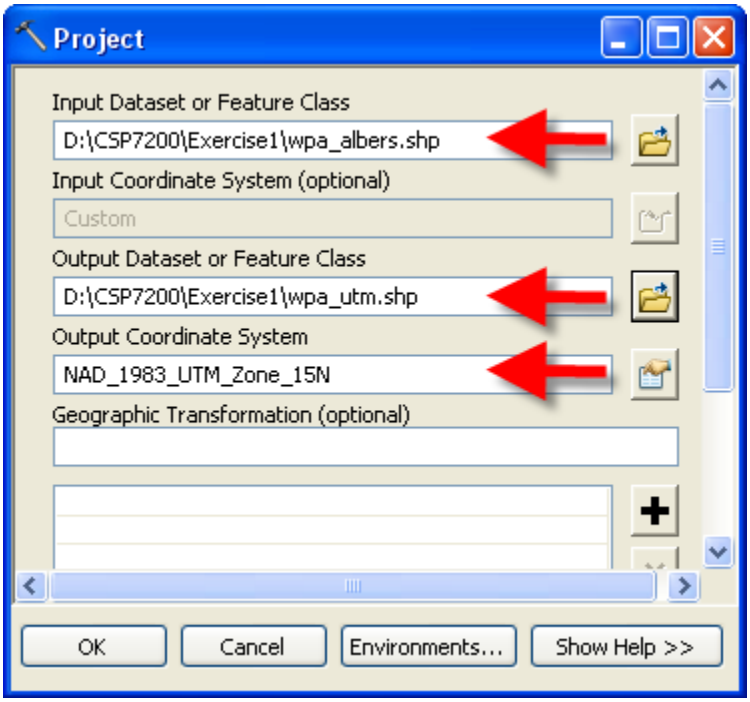
SECTION 3 – Using the Project Tool to Change the Spatial Reference

ArcMap's on-the-fly projection should only be used for display purposes. The recommended approach is to ensure that all GIS layers have the same spatial reference to avoid errors in spatial analyses. In this section you will change the projection of the **wpa_albers.shp** layer to match the **counties_utm.shp** layer.

1. In ArcToolbox, navigate to the **Data Management Tools > Projections and Transformations > Feature** toolbox and double-click on the **Project** tool.



2. Fill-in the fields as shown below. Name the layer **wpa_utm** and save in the same folder. Click **OK** when done.



SECTION 4 – Surviving a Datum Shift

This section demonstrates how one can obtain inaccurate results when conducting spatial analyses using layers that are NOT referencing the same spatial reference system. This could easily happen if you have not assigned spatial reference information to your files.

1. Close ArcCatalog and launch ArcMap.

2. Open a New Blank Map and **Add** the **bird_survey.shp** and **landcover.shp** layers. Click **OK** at the Unknown Spatial Reference warning dialog if it appears.

3. Notice that both layers appear to align, but if you open the **Properties > Source** tab in the **bird_survey** layer you'll see that this layers coordinate system is undefined.

4. What's the coordinate system for the **landcover** layer_____?

   A novice user may believe that these layers are using the same coordinate system since they both overlay. They both do in fact use the same map projection (UTM Zone 15), but different datums. Therefore, these 2 layers are not using the same spatial reference system.

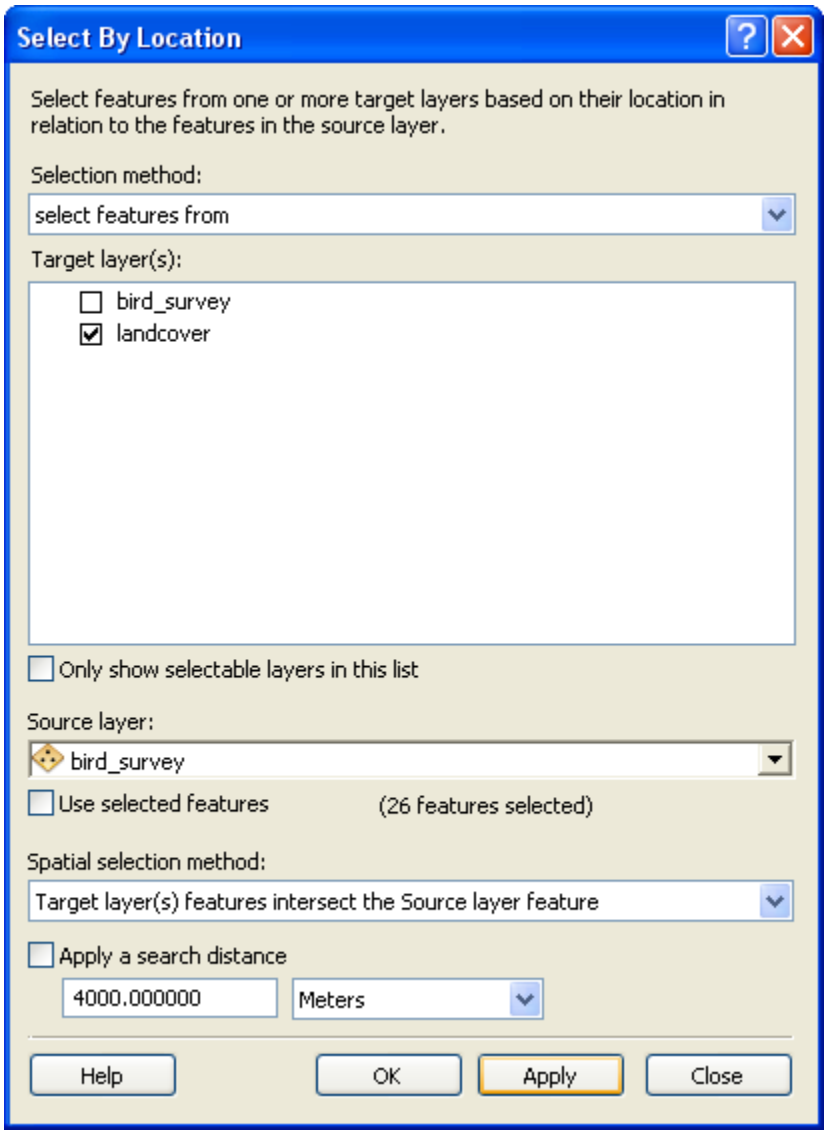
   In Minnesota, the difference between NAD27 and NAD83 coordinates is approximately 15 meters for the X value and -213 meters for the Y value. This amount of positional error will cause inaccurate results when performing spatial analyses. To demonstrate this fact, we are simply going to pretend everything is OK and conduct our spatial analysis.

5. For our analysis we want to identify all the habitat types that contained greater than 5 American Redstart observations in Pool 8 during the 1996 survey.

   From the **Selection** menu, choose **Select By Attributes** and create a query for greater than 5 American Redstarts (code = NAMRE) in the **bird_survey** layer.

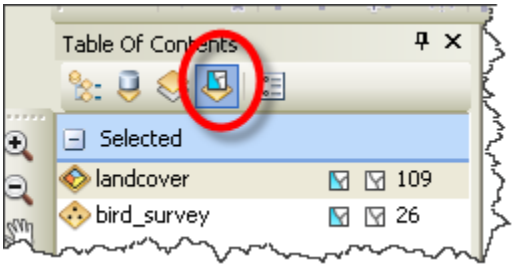
6. Click **Apply** and close the **Select By Attributes** dialog.

7. Click on the **Selection** menu again, but this time choose **Select By Location**. We want to select features from the **landcover** layer that intersect with the selected features of the **bird_survey** layer. See the example below.



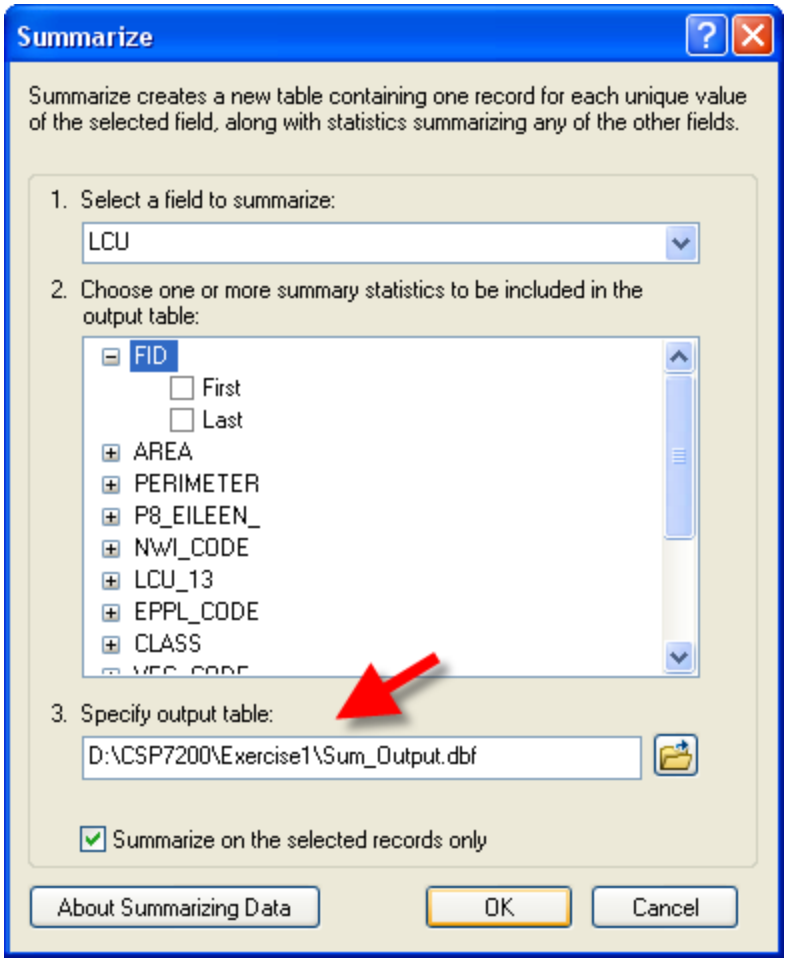
8. Click **Apply** and close the **Select By Location** dialog.

9. Click on the **List by Selection** icon in the table of contents.

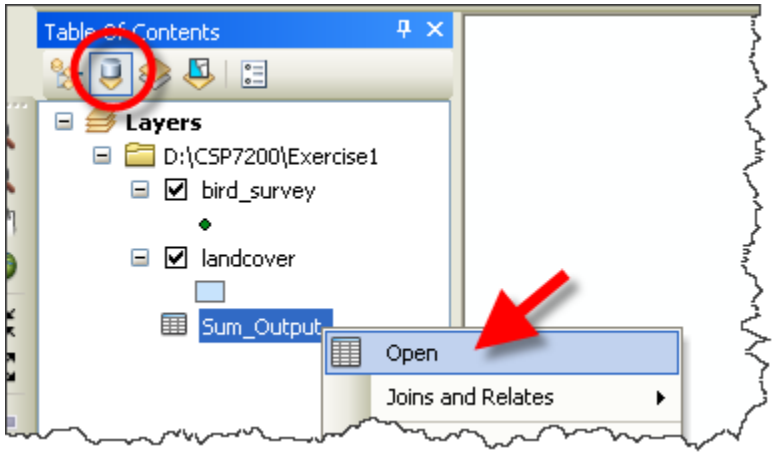


10. Right-click on the **landcover** layer and Open the Attribute table. Right-click on the **LCU** field and choose **Summarize**.

11. Just make sure the output is going to your **Exercise1** folder. Click **OK**.



12. Click on the **List by Source** icon. Right-click on the results table select **Open**.



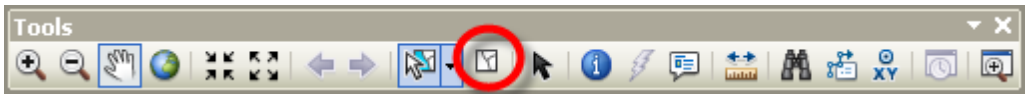
13. Right-click on the **Count_LCU** field and select **Sort Descending**. What are the top three land cover types and what is the count for each?

    _____ _____

    _____ _____

    _____ _____

14. Clear the selected features by clicking on the Clear Selection tool.



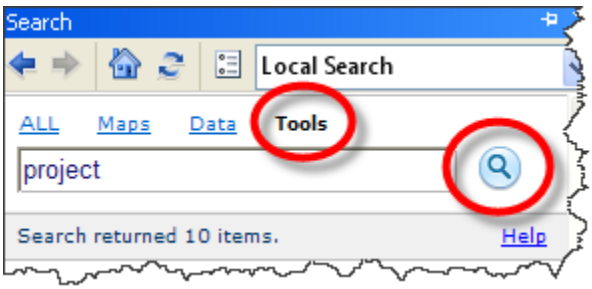
Next we are going to perform the same summary as above, but this time transform the bird_survey layer to the same datum as the landcover layer. Before we can do this however, we need to examine the metadata and write down the datum and coordinate system.

15. Right-click on the **bird_survey** layer in the table of contents and select **Data > View Item Description**. To view the datum and coordinate system simply scroll down and select the **ArcGIS Metadata** > **Reference System** section. What is the answer?

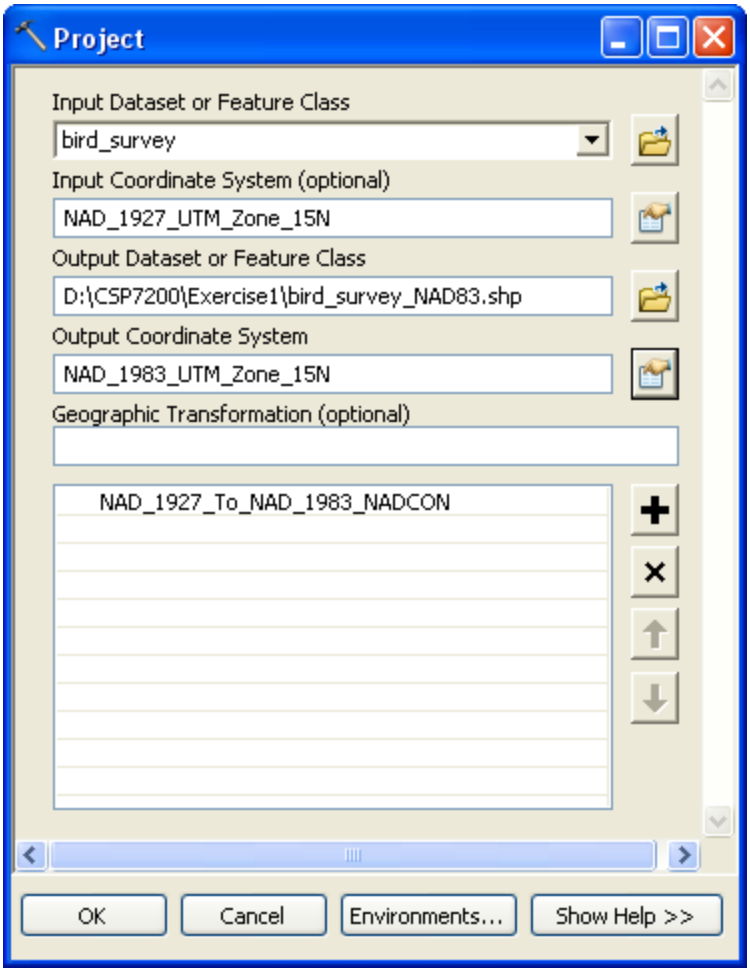
    _____.

16. Next, use the **Project** tool in ArcToolbox to define the appropriate projection to the **bird_survey** layer. A quick way to find the tool is simply use the **Search** tool located on the Standard toolbar or docked at the right side of the screen.

17. Select **Tools**, search for "**Project**". Click the **Project (Data Management)** item on the list to activate the tool.



18. Populate the fields as shown below. Name the output file **bird_survey_NAD83** and save in the **Exercise1** folder. Since the input and output coordinate systems use two different datums, we must select a Geographic Transformation. Click **OK** when done.



19. Your new layer will be added at the top of your table of contents. If you receive an error, refresh the active view and try again.

20. Remove the old **bird_survey** layer and perform the analysis again using the **bird_survey_NAD83** layer. What are your answers this time?

_____ _____

_____ _____

_____ _____

TIP: Unlike shapefiles, geodatabases require you to assign a spatial reference to all your layers (known as feature classes in a geodatabase) because a geodatabase has integrity and rules that must be followed. Shapefiles are angry stepchildren with bad habits and short memories. So, choose the right data type for your next GIS project.

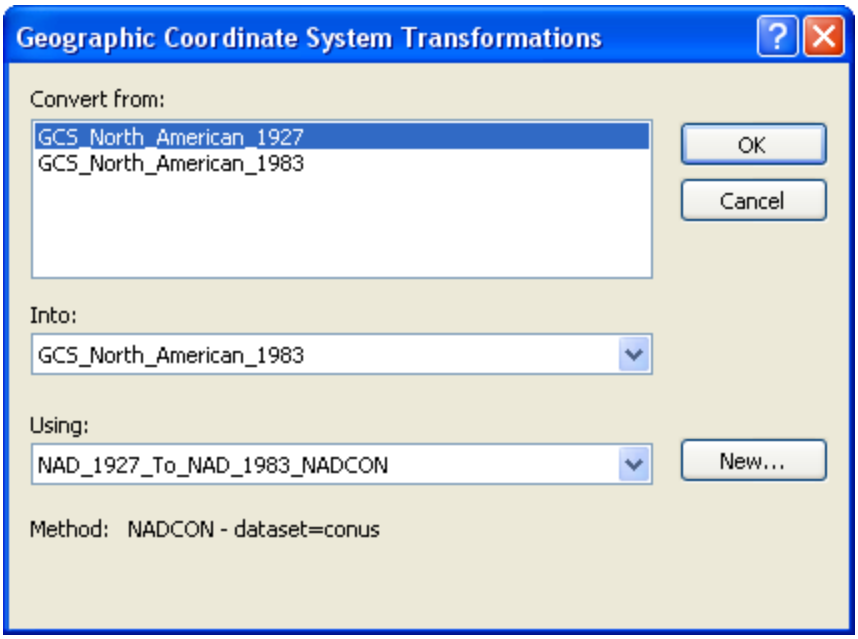
SECTION 5 – Transforming and Projecting Raster Datasets

1. Clear all selected features and add the **Mn_Imagery.sid** raster layer.

2. Notice the **Geographic Coordinate Systems Warning** dialog appears. You are informed that the layer you just added uses a different geographic coordinate system (datum) than the exiting map data or data frame. It also suggest that you may need to choose a different geographic transformation. It is very important to understand what is going on here. ArcMap warns you of this issue because there are several datum transformation methods that could be used and ArcMap has automatically selected one for you.

3. Click the Transformations... button and verify that the fields match those shown below. Click **Close** when done.

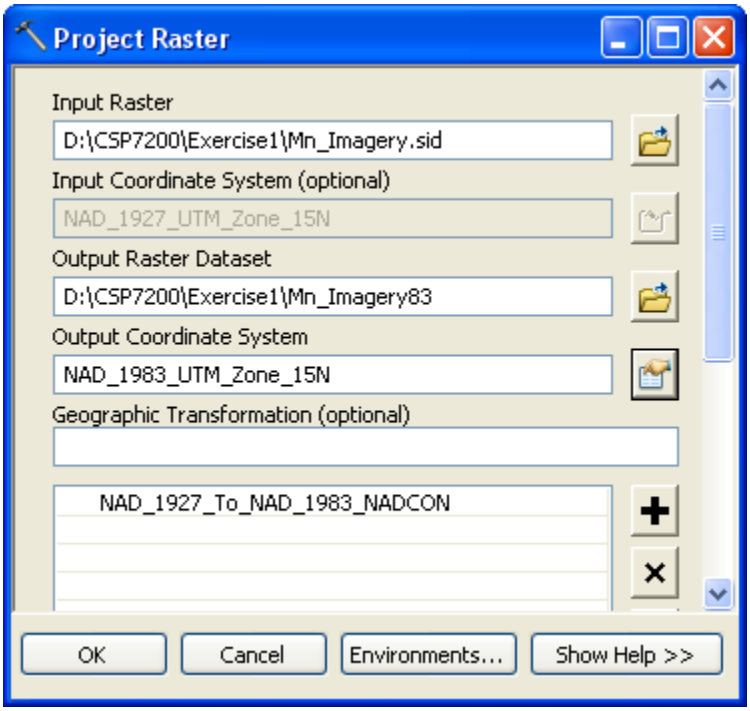
   The image has been on-the-fly projected; the spatial reference information is not permanently changed. This is really just for background use only, not analyses.



4. To permanently change the spatial reference information, first remove the **Mn_Image** layer from the table of contents.

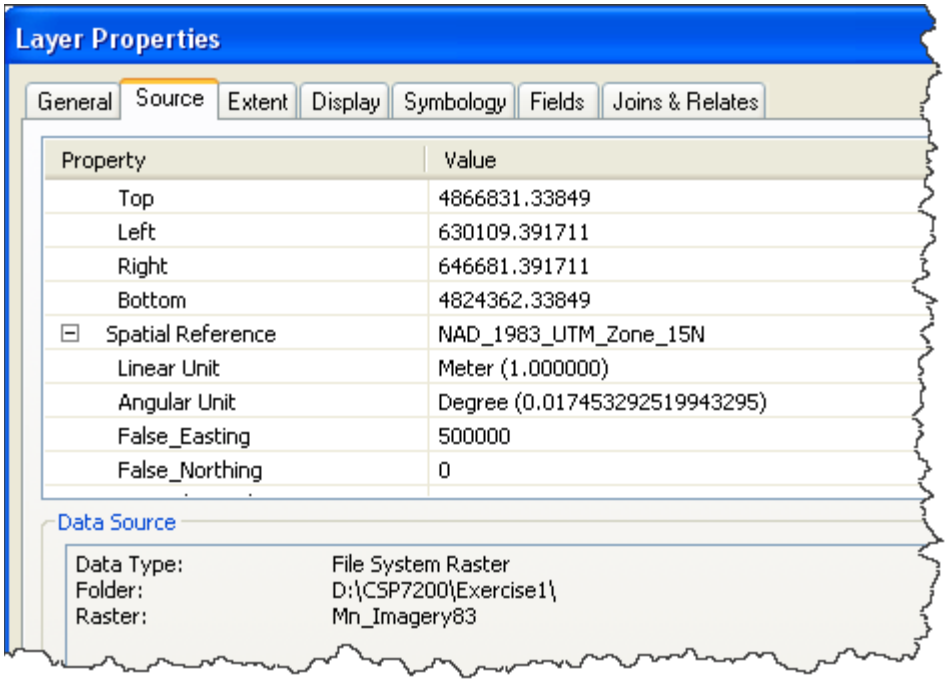
5. Use the **Search** tool to find the **Project Raster** tool in ArcToolbox. Click on **Project Raster (Data Management)** item to activate the tool.

6. Make sure the fields match those as shown below. Rename the image **Mn_Image83** and save it in the **Exercise1** folder. Note: the raster file name cannot be longer than 11 characters.



7. Click OK. The process will take a couple minutes to complete. Once done, the image will automatically appear in your table of contents.

8. Verify that the projection is correct by looking at the metadata as we did previously**,** or by simply right-clicking on the image layer and viewing the Source information.



9. Close ArcMap. Do not save your document.