



Introduction to Cartographic Processes

Geography (GEOG 3305)

Lab 9: Projecting Geographic Data

What You Will Learn: Basic methods for map projections in ArcGIS Pro.

What You Will Produce: A map of Georgia in three different projections, and notes recording areas and coordinates for various projections and measurements. Your recorded measurements will be entered into a D2L Lab 10 Worksheet.

Background: The three sections in Chapter 6 of your textbook provides the necessary background related to map projections. We introduce unavoidable distortion when we flatten the Earth's curved surface onto a flat map. Different map projections represent the same points with different X and Y coordinate values. We cannot mix map projections in an analysis, so we often have to re-project some of our data layers.

Note that in the instructions below we often use the terms “map projection,” “projection,” and “coordinate system” interchangeably. A map projection is associated with a specific coordinate system, and to project data is to convert from one coordinate system to another.

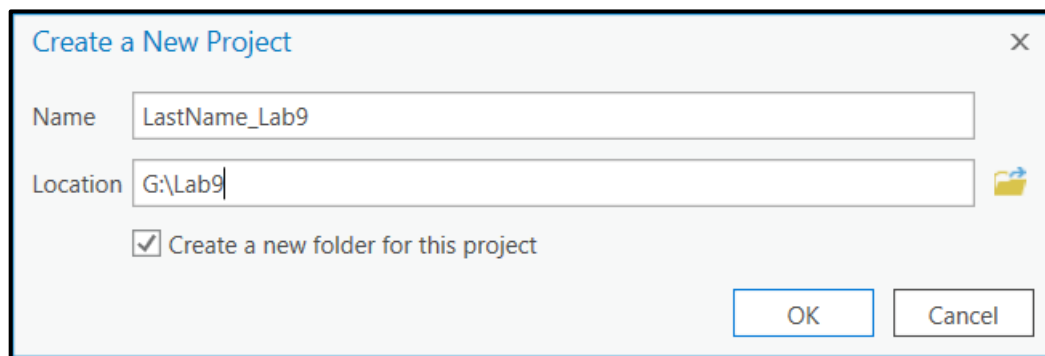
Data: For this exercise the data is found in Lab 10 module/folder in the class website on D2L; remember to download and save the lab data folder to your G (FileShare GIS Folder) drive on the GRID-GIS portal for safekeeping.

Step 1: Observing How Distance May Change with a Map Projection

Start ArcGIS Pro ([Start Menu > ArcGIS > ArcGIS Pro](#)) or if there is an icon on the computer desktop, you can start ArcGIS Pro by double-clicking it.

Next, if prompted, sign in using your licensed ArcGIS account. Use your username and password associated with your KSU GIS Account.

To open the files downloaded from D2L, click on “[New Map](#)” and then make sure to place the new map project in the correct working directory and name the project as your “[YourLastName_Lab10](#)”.



Next you will need to add TWO blank maps ([Insert](#) tab > [Project](#) group > [New Map](#) icon)

to your new project for this lab exercise.

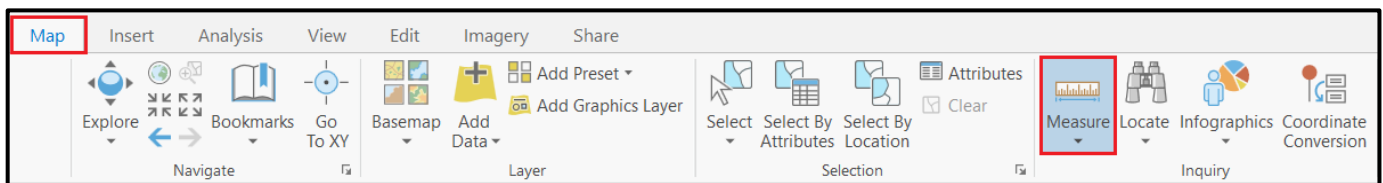
After performing this task, REMOVE any default base topography and map layers that ArcGIS Pro might have added.

Name the first map window as “**Albers**”, and name the second map as “**Mercator**”.

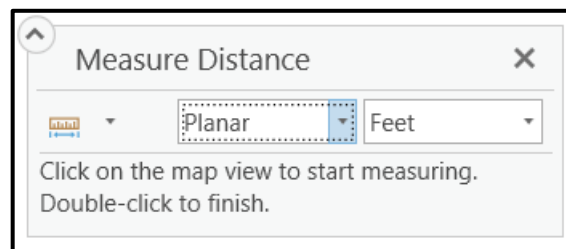


Make sure to **activate** the **Albers Layer** (left click map tab along the top edge of the map view) and click on **Add Data** (**Map** tab > **Layer** group > **Add Data** icon) and select the following two layers: **twocity_Albers.shp** and **USA_48_Albers.shp** from the Lab 10 folder to **Albers** map.

Then, click on **Map** tab > **Inquiry** group > **Measure** tool to enable it.




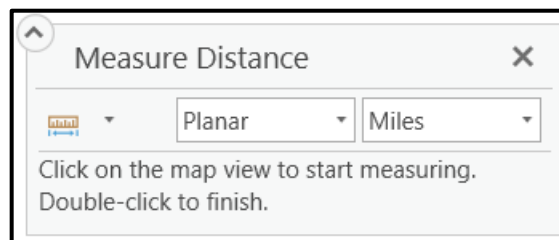
Next, set Measure tools to the following: **Mode** to “**Planar**” and **Distance Units** to “**Miles**”.



Go to the map and **left-click once** on **Los Angeles** and then move your mouse to New York and **double left-click** on **New York**.

Question 10.1. What is the distance (in miles) between the two cities on the Albers map? Look at the Distance information inside the drop-down window to help you determine the distance between the two cities.

Note: If you are not happy with your measurement, click on the eraser icon () inside the result icon and perform the task again.



Once you perform this step and answer the question, you will do the same steps but instead for

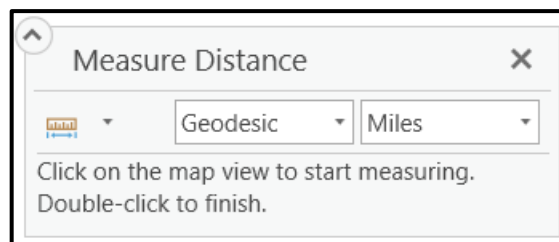
Mercator projection.

Activate the **Mercator** map and add the following data files: **twocity_Mercator.shp** and **USA_48_Mercator.shp** to your Mercator map. Again, with the **Measurement Tool** re-measure the distance between Los Angeles and New York.

Question 10.2. What is the distance (in miles) between the two cities on the Mercator map?

Question 10.3. Based on your two previous answers, do you see similar distances between Los Angeles and New York? If not, why not? Or in other words, why do you think cause the distance differences to exist between the Albers and Mercator map projections?

Finally, go back and change the measurement tool variables of **Mode** from “**Planar**” to “**Geodesic**” and keep the **Measurement Units** as “**Miles**”.



Then perform the same steps as you did in first two questions of the lab exercise for the Albers and Mercator maps.

Question 10.4. Based upon the Geodesic Mode, what is the distance (in miles) between the two cities for Albers and Mercator maps?

Note: Under the *Geodesic* option, the calculations approximate as close as possible the true distance measurement (recall from your chapter 6 reading) on the surface of Earth. The *Loxodromic* and *Great Elliptical* options are only slightly different than the Geodesic differences but are approximately equal to the Geodesic distance in this application. The big difference is with the planar method, which assumes both projections are good approximations of a Cartesian (2d) surface.

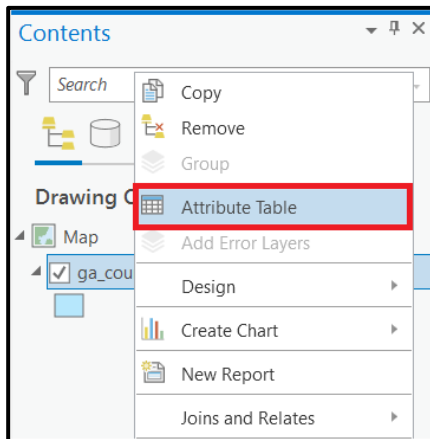
Step 2: Coordinates and “On the Fly Projection”

Now, we want to introduce the idea of a temporary, or “on the fly” projection, something that ArcGIS Pro often does when you add data to a map.

A map usually has a specified coordinate system. You can manually set the system, or ArcGIS Pro can establish one automatically when you first load data. Once a coordinate system for a map has been specified, ArcGIS Pro will display the approximate coordinates of the current cursor location along the bottom of the map frame.

Create a NEW map (**Insert** tab > **Project** group > **New Map** icon) and add the “**ga_count_dd**”

data layer from lab 10 folder to the map and **REMOVE** any default base topography maps. The data layer you added to your map is the Georgia county boundaries set in *decimal degrees coordinates*.



From the *Table of Contents*, open the *Attribute Table* of the **ga_count_dd** layer.

Right click over the layer name in the *Table of Contents* (on the left of your window), and then **left click** on the **Attribute Table** option in the dropdown list.

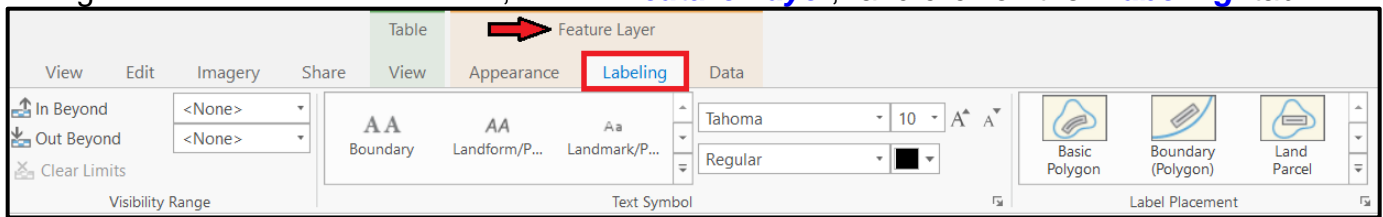
This should display the attributes associated with this polygon layer. Note that the table may be tied in with your other open windows, so you may have to “grab” the edges with your cursor to resize the panes.

In the attribute table, there should be a column “**Name**”, it contains the name of each county. We will use this column information to label the counties of Georgia on your map.

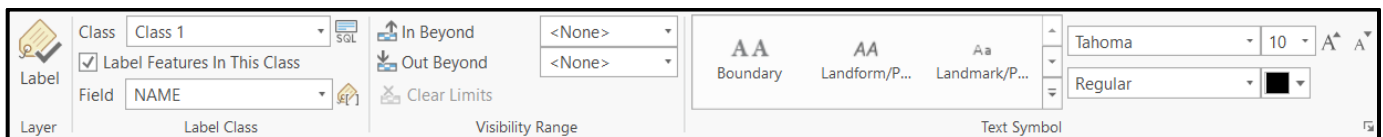
FID	Shape *	STATEFP	COUNTYFP	COUNTYNS	GEOID	NAME	NAMELSAD
0	Polygon	13	189	00348794	13189	McDuffie	McDuffie County
1	Polygon	13	025	00351605	13025	Brantley	Brantley County
2	Polygon	13	171	00326713	13171	Lamar	Lamar County
3	Polygon	13	115	00353665	13115	Floyd	Floyd County
4	Polygon	13	273	00352238	13273	Terrell	Terrell County
5	Polvaon	13	063	01672399	13063	Clayton	Clayton County

To label each of the county’s polygons on the map, you will need to **left click** on the tab toward

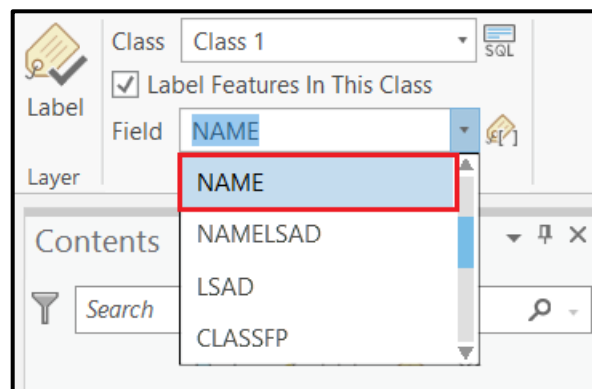
the right center of the main window, under “**Feature Layer**,” and click on the “**Labeling**” tab.



By click on this tab, a labeling ribbon and several group tabs will appear on your screen (as shown below). We select and style labels using these tools display on your screen.



First, you will need to select “**Name**” in the **Field Window** (lower left corner) inside the **Label Class** group of the **Labeling** tab.



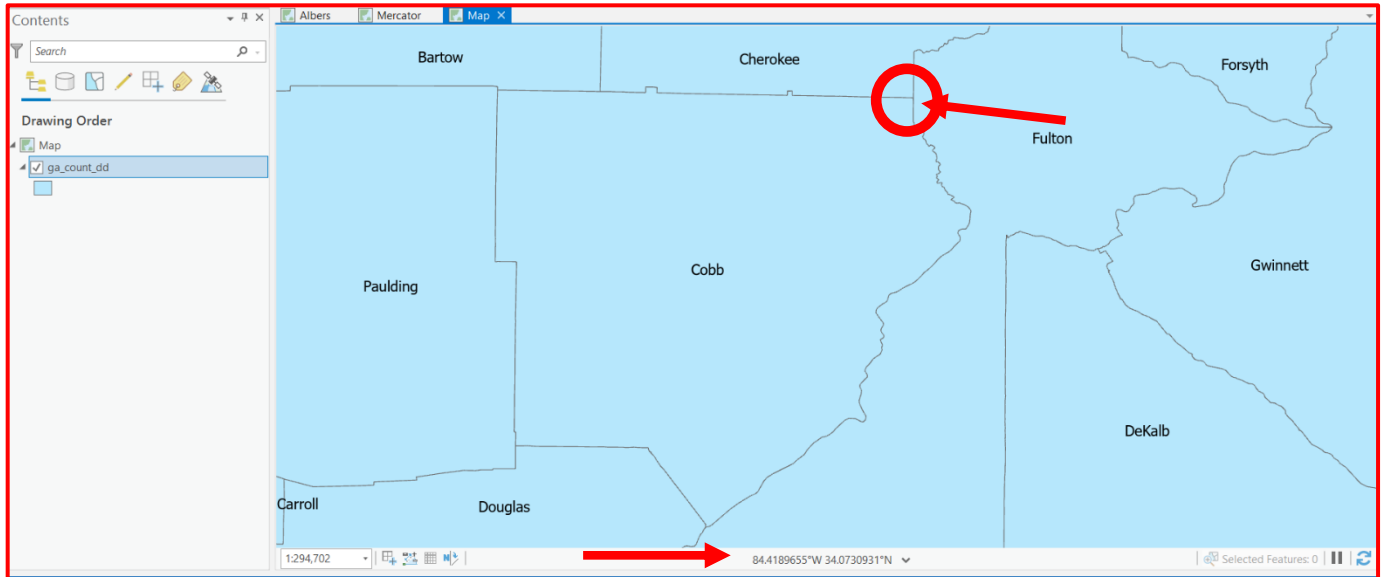
Next, click on the () **Label** icon (inside the **Layer** group) on the left of your window in order to Turn on the labeling of the counties in the state of Georgia.

You should see the labels appear on your map. Depending on the settings, they may not show up at first, and you may have to zoom in on the map for them to display. You can set threshold scales above or below which labels appear, and rules that omit overlapping labels. You can use the tools to change the font properties, label angles, and other characteristics.

Close the table (click on the **X** at the right edge of the tab), and then zoom to display the *northeast* corner of **Cobb County**, in the northwest portion of Georgia.

Move your cursor and notice the coordinates near the **bottom-center** of the map. These are cursor coordinates, in this case for the data layer you first loaded to the map, here *decimal degrees*.

Note: Your map may be displaying some other coordinate units, depending on if you displayed another layer previously, or your system default preferences are different from those we used.



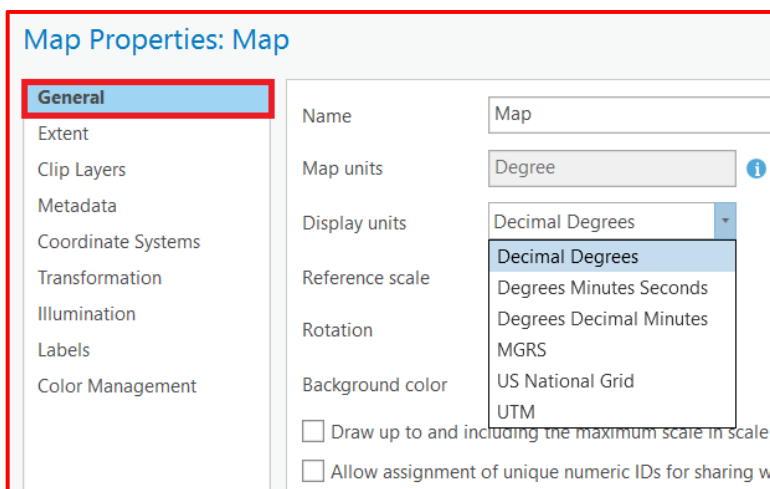
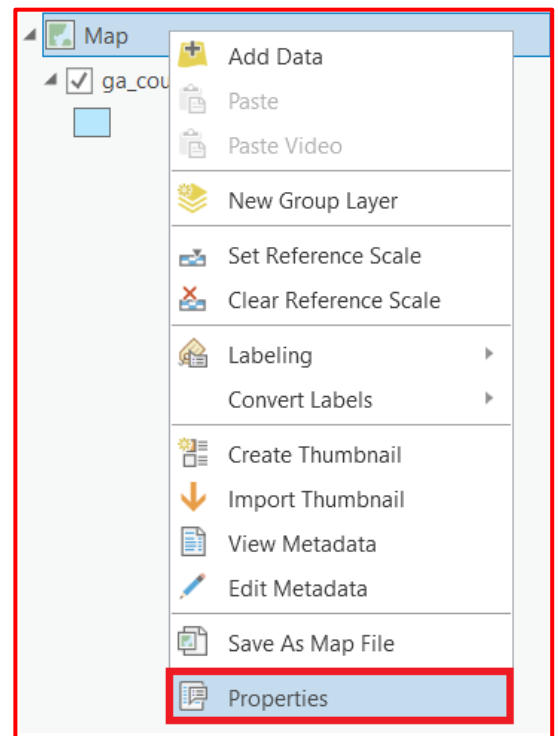
A question you may be asking yourself is there a way to change the coordinate units? The answer is YES. You will learn how to change the units.

To change the display coordinate units while navigating around the map follow the steps below:

Right click on the **Map** name in the *Table of Contents*.

Next, left click on **Properties**, then select **General** from the displayed list.

This will reveal several options, including setting the map units, and display units.



About half-way down you can set the **Display Units**, make sure they are set to **“Decimal Degrees”**.

Click on **OK** to close the window and verify that the units at the base of the map are displayed as

decimal degrees.

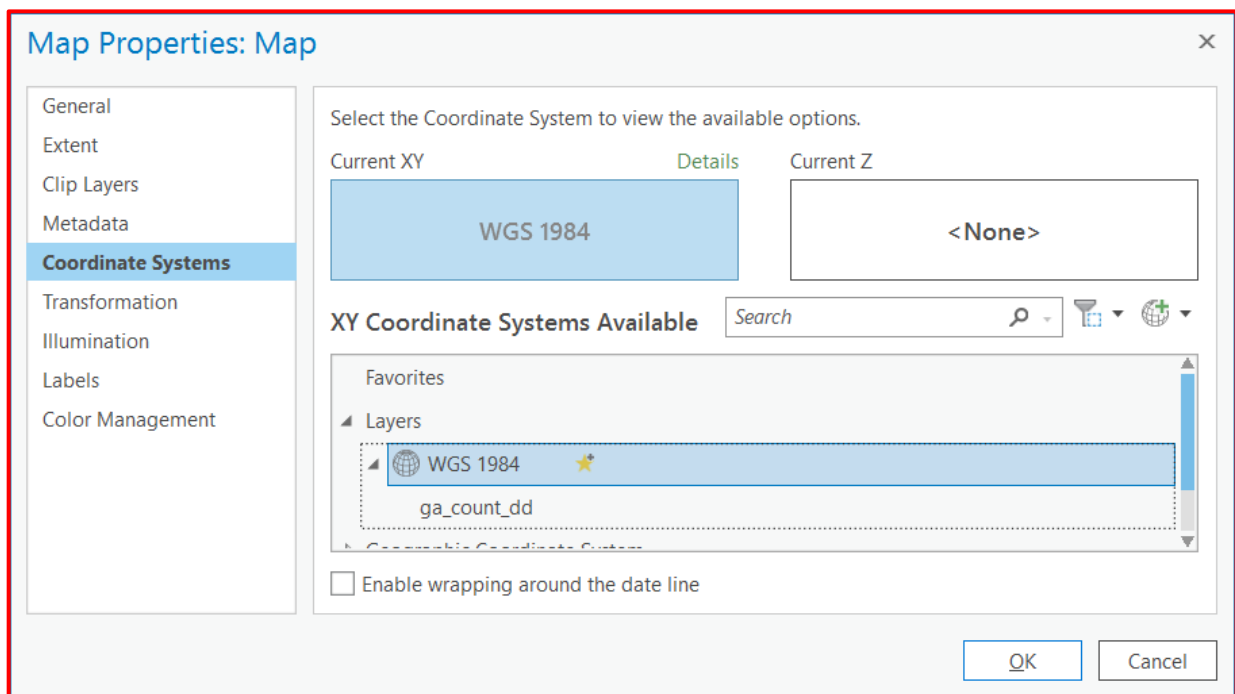
Now, zoom in and reposition your mouse cursor successively until you have an accurate reading for the coordinates of the northeast corner of Cobb County (see the figure above).

Note: You will know you are zoomed in enough when the coordinate values do NOT change or only change in the third decimal place when you move slightly off of the displayed corner.

Question 10.5. Approximately what is the coordinate units (latitude and longitude) in decimal degrees for the northeast corner of Cobb County?

Every data layer has a coordinate system associated with it. A map may have a different coordinate system. ArcGIS Pro will temporarily convert the layer coordinates to the map system (if it can), so that data will be displayed in the proper relative locations. This way we can display data from several different sources, each in different coordinate systems, together at the same time. The layer data are not changed in storage, they are only temporarily projected “**on the fly**” to align correctly. Sometimes this does not work, for example, when the information on the coordinate system for a layer is missing or corrupted, but usually everything works as planned.

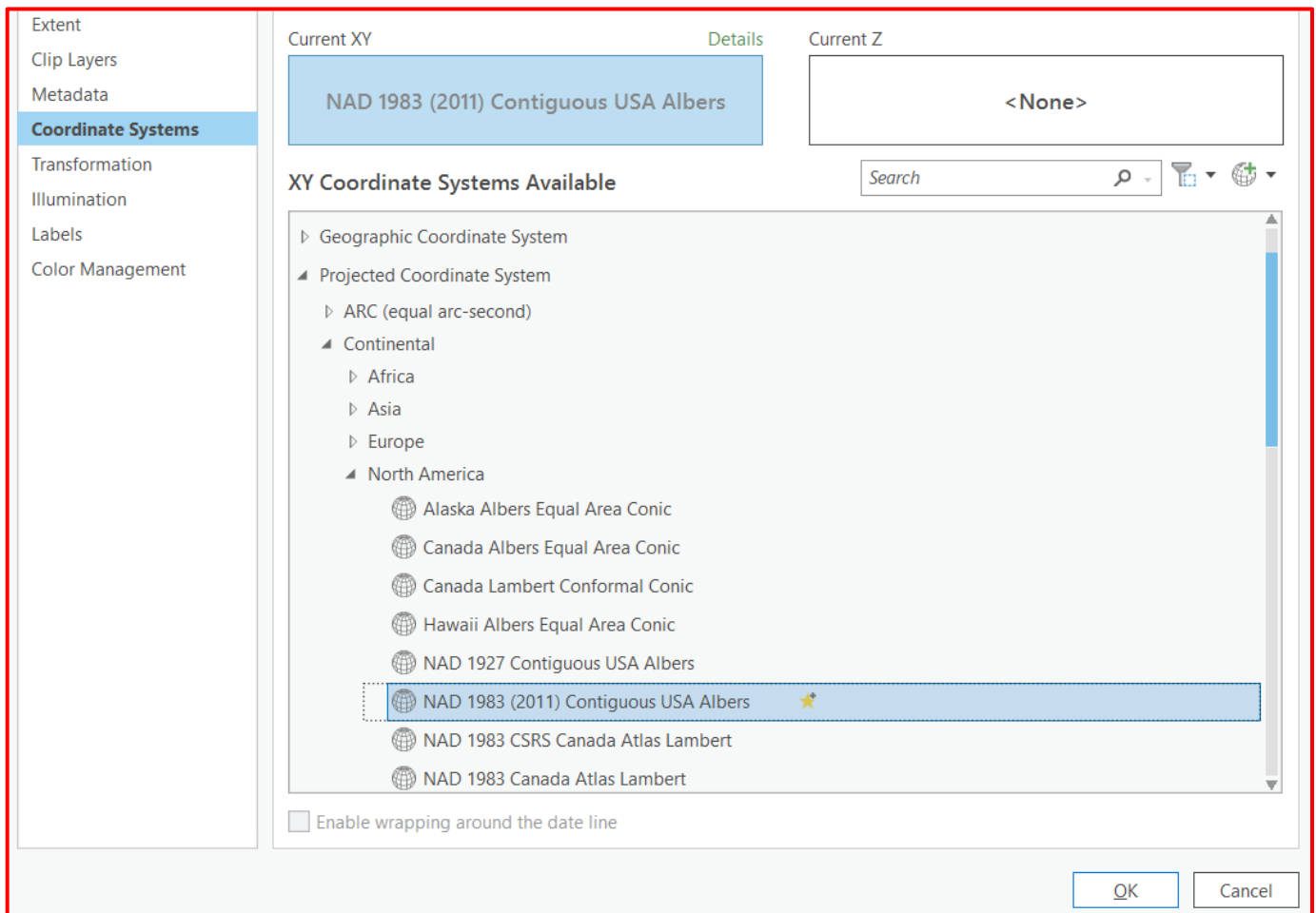
You may view and set the coordinate system for a map, to which every layer is temporarily projected by right clicking on the **Map**, and then selecting **Properties** from the dropdown (as you did earlier), but this time **left clicking** on “**Coordinate System**” in the displayed window.



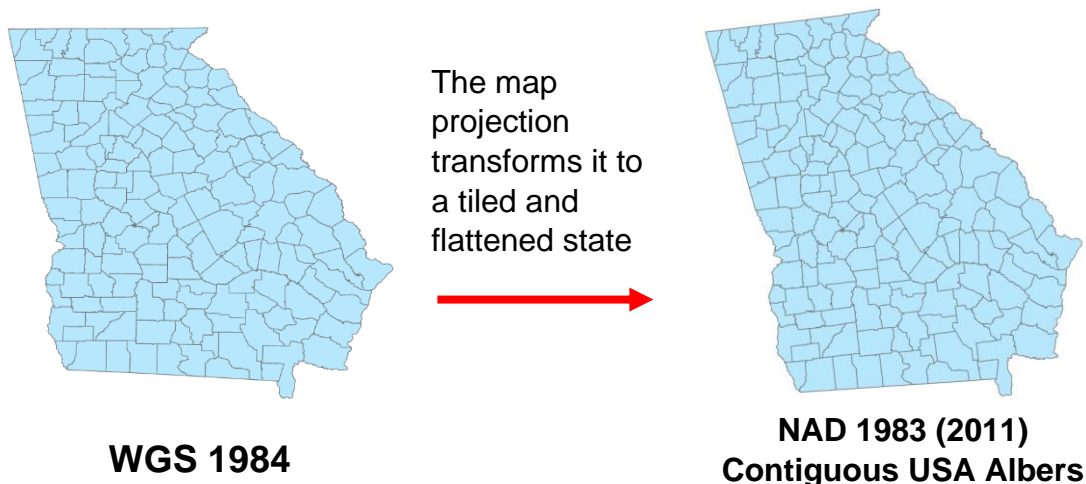
From this window, it shows that the current projection (**Current XY Details**) of the map is set to the **WGS84 GCS** (**G**eographic **C**oordinate **S**ystem). This means that all data added to this map will be projected to this system when displayed.

If we are not happy with the projection of the map, we can change it. Follow the steps below to change the projection of the map.

Inside the **XY Coordinate Systems Available** box of the **Coordinate Systems** tab, click on **Projected Coordinate System > Continental > North America > NAD 1983 (2011) Contiguous USA Albers**.



After selecting this map project, click on **OK** and the **Map Properties** window should disappear, and the counties change shape and orientation.



Switch the map coordinate system back to the **WGS 1984** (with the map selected, right click for **Properties** > **Coordinate Systems** > **Geographic Coordinate System** > **World** > **WGS 1984**).

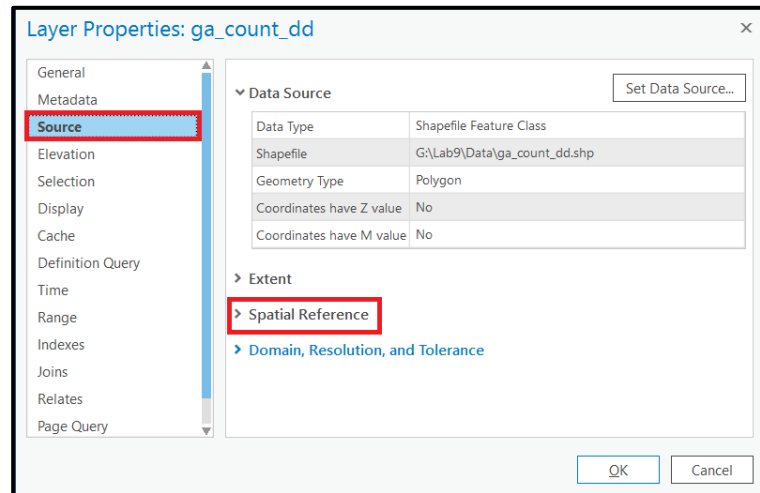
After changing back, the projection to WGS 1984, we can review and learn more about the coordinate systems of a **data layer** (ga_count_dd) NOT the actual map by performing the following tasks:

Right click on the data layer of **ga_count_dd**

Then **left click** on **Properties**

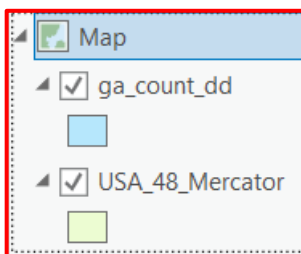
Finally, **click** on the **Source** tab

This allows you to inspect layer properties including the **Spatial Reference**, describing the coordinate system.



Left click on the **Spatial Reference** option, and view the spatial reference information, in a window similar to the figure below. This shows the characteristics of the layer's coordinate system. This is a geographic coordinate system (latitudes and longitudes) and the data show the particular properties.

Question 10.6. What is the geographic coordinate system (GCS) characteristics of the map data layer (Georgia County layer)? Describe what the angular unit, prime meridian, and spheroid of the data layer.

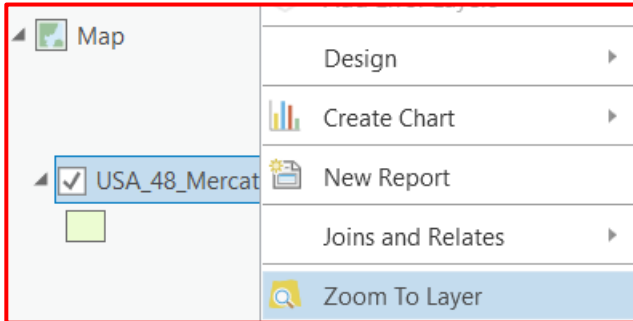


After you have answered the question, I would like you to add (**Map** tab > **Layer** group > **Add Data** icon) the following data **USA_48_Mercator** to the same map. Position or arrange the layers so the Georgia county data is on top (click and drag up/down layers) of the USA 48 Mercator layer.

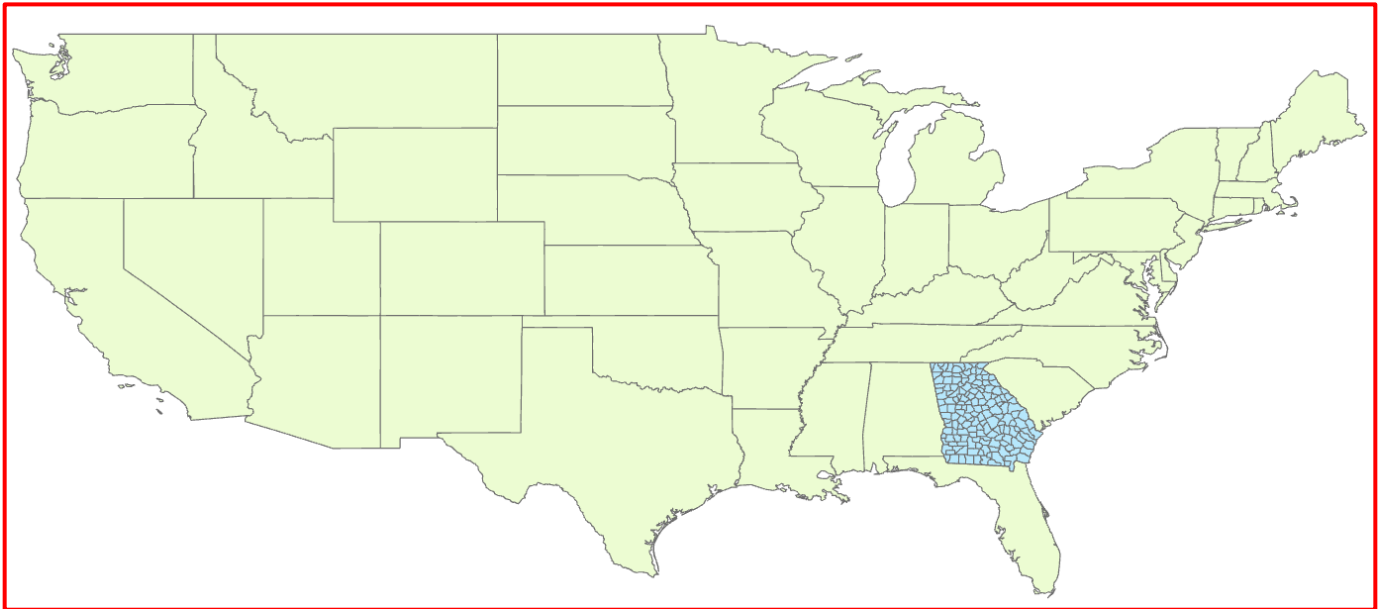
As done previously, you will need to open the **Properties**, click on the **Source** tab of this data (USA 48 Mercator) layer and select **Spatial Reference**. It should display something similar page to Georgia County layer (ga_count_dd).

Note: This layer displays more information than the GCS WGS84 for the ga_count_dd layer. The Mercator layer has both a projection, here a World Mercator, and an underlying GCS. As noted in the chapter readings, projected coordinate systems have both parts, and underlying GCS and then a projection, while geographic systems have only a GCS, but are not projected. Carefully review the map projection characteristics of USA 48 Mercator layer and answer the following question.

Question 10.7. What is the projection coordinate system (PCS) characteristics of the map data layer (Georgia County layer)? Describe what the linear units, central meridian, and standard parallel of the data layer.



After answering the questions about geographic and projection coordinate systems, I would like you to zoom to the full extent of the USA_48_Mercator (**right click** on the layer > click on **Zoom To Layer**), you should have something like the image below:



Note that although the different data sets are in different projections, they line up on top of each other. Why?

Answer: The layers line up because ArcGIS Pro is doing an “*on the fly*” projection, as described earlier in the lab exercise.

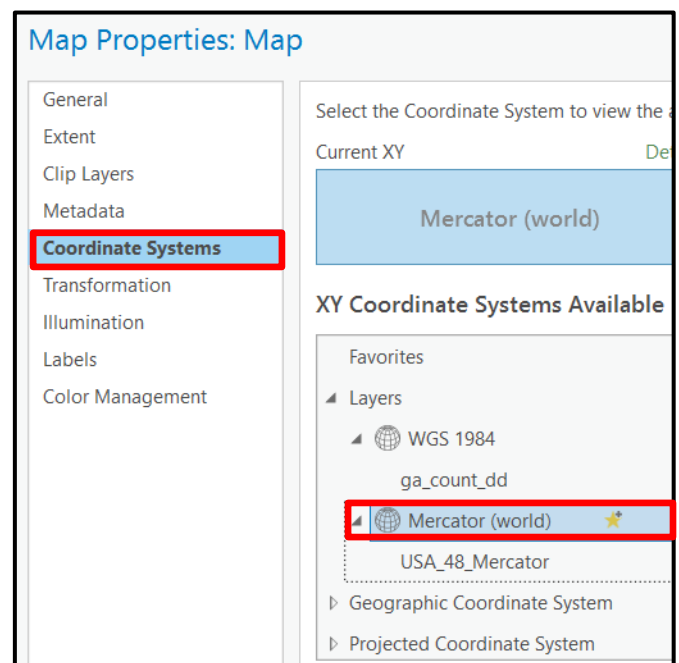
We need now set or change the map coordinate system to that of the **USA_48_Mercator** data layer.

To change the projection, follow the steps:

First, left click on the **Map** in the *Table of Contents*.

Next, select **Properties** > click on **Coordinate Systems** > **Layers** > **World Mercator**.

Notice ArcGIS Pro puts the coordinate systems for all layers in a map in a list at the top of the **Map Properties window**, for easy selection.



Notice after you click **OK**, the layers change shape slightly, as they are temporarily reprojected to this new coordinate system (Mercator).

Note: This can be quite confusing at first, but you need make sure you understand this concept of a map coordinate system, with temporary reprojection, and a data layer coordinate system (the coordinate system the data are stored in). If you understand this difference, you will likely save yourself much confusion and grief.

Why is this important? Some operations will NOT work correctly if data layers are in different coordinate systems (e.g., some editing, overlays, or distance measurements). You may think they are in the same system if you display them together, but your geo-calculations may be wrong. Sometimes you will be confused in interpreting data, or misidentify the coordinates because data are re-projected temporarily for display. If you have any questions about the coordinate system of a layer, look at the layer properties, as shown above.

We will need now explore this concept further, by changing the map coordinate system through the **Map Properties window** again.

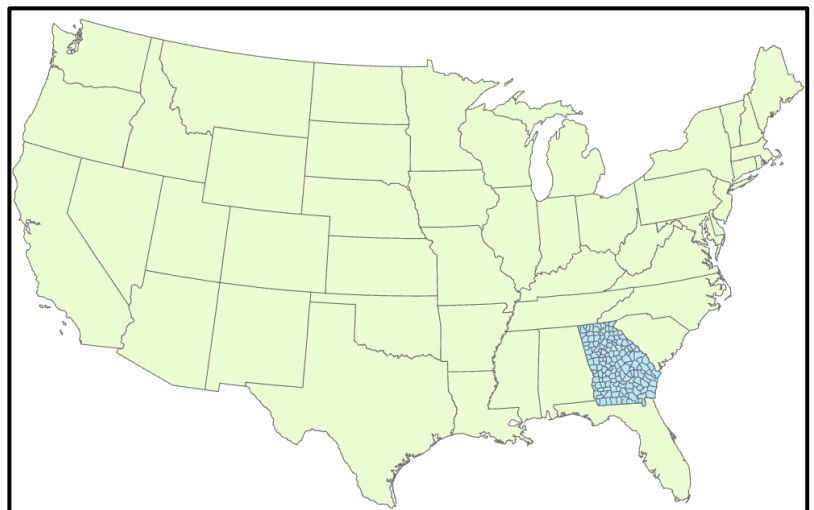
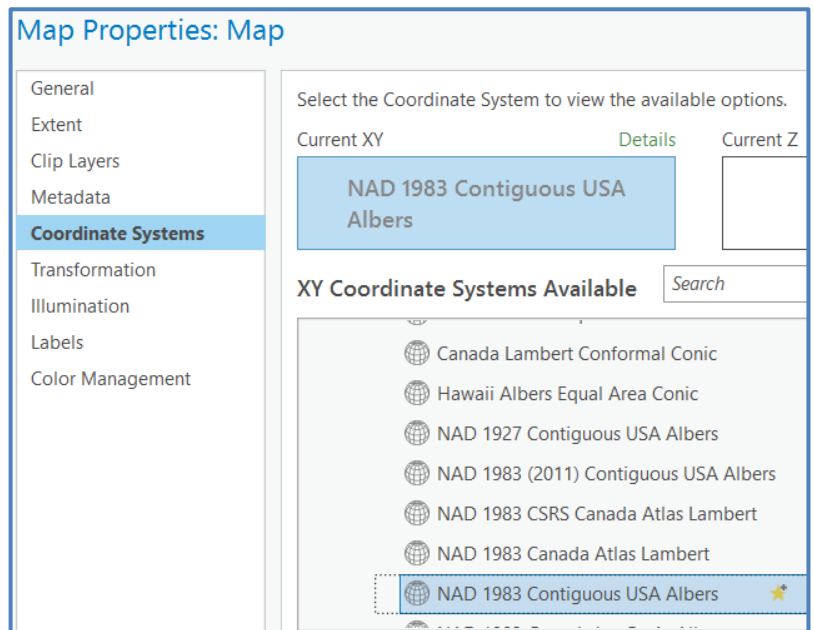
Right click on **Map** > and left click on **Properties** tab > select the **Coordinate Systems** tab > and pick **Projected Coordinate System** option > **Continental** > **North America** > **NAD 1983 Contiguous USA Albers** > and finally click **OK**.

This (NAD 1983 Contiguous USA Albers) is a common projection used to display or map for the lower 48 U.S. states.

Zoom to full extent of the layer and notice how this projected coordinate system changes the shape of the USA and Georgia data, to look something like the figure to the right.

Notice the curve on the western half of the northern border, compared to previous views.

The data on disk have not been changed, they have just been temporarily reprojected to this specific **Albers** coordinate system.



Next, I would like you to change the map coordinate system again, by right clicking on **Map** > and left click on **Properties** tab > select the **Coordinate Systems** tab > and next pick **Projected Coordinate System** option > **UTM** > **NAD 1983** > **NAD 1983 UTM Zone 17 N** > and click **OK**.

Zoom to full extent, and display the data, noting the change in the projection, as to the right.

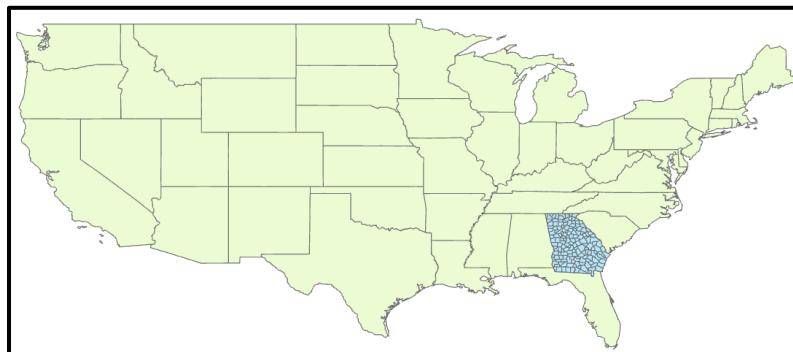
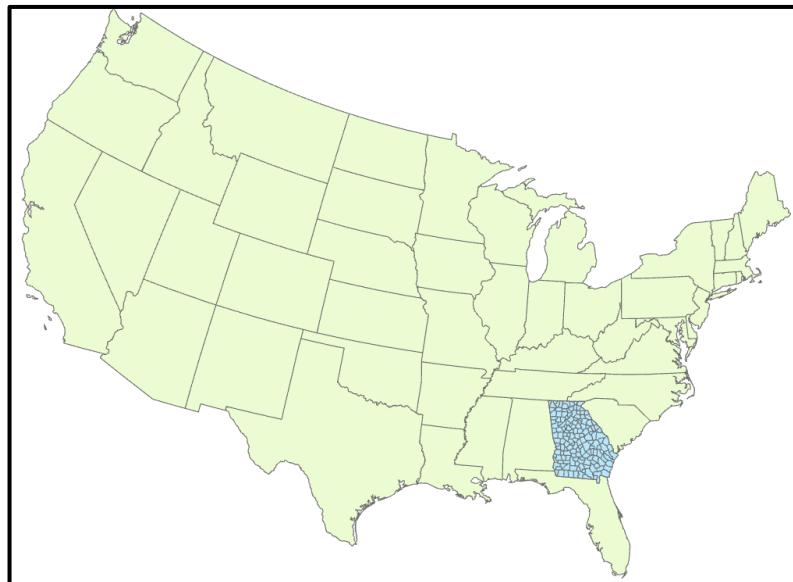
This projected coordinate system was selected because most of the state of Georgia is in this zone (17 N). If you are conducting a local or state analysis, you are more than likely to select this coordinate system.

Finally, we are going to switch the map coordinate system one last time. This time right click on **Map** > and then left click on **Properties** tab > select the **Coordinate Systems** tab > **Geographic Coordinate System** > **North America** > **USA and Territories** > **NAD 1983** > and click **OK**.

Note the change in shape. We have not changed the projection of the data on the disk, we have just told ArcGIS Pro to project “*on the fly*”, to a new system, before display.

It is generally okay to mix data from several coordinate systems in a map. However, you should be careful when performing operations that alter or create new coordinates, because there could be some ambiguity in which coordinate system ArcGIS Pro will choose to use. It is best to either run a small test to verify the specific ArcGIS tool, or to convert all the data to a common coordinate system permanently, saving to new layers (we will show how to do this later in the lab), so that all your data are in the same coordinate system before manipulating x and y values.

You should also be careful when performing area calculations with mixed data sets, because it is easy to become confused about the units of the outputs and present possible wrong or misleading results to your audience.



Step 3: Projecting Data to a New File – The Project Tool

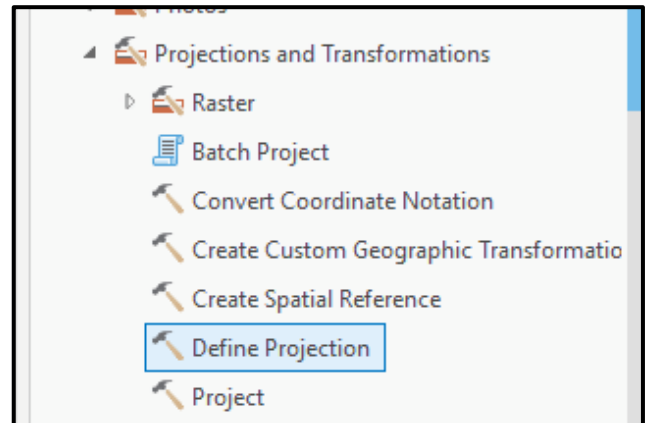
The above section describes “*on the fly*” projection, which changes coordinate values temporarily so they may be viewed together. However, we often want to permanently project a data set from one coordinate system to another, creating a new data set in a different projected coordinate system.

We accomplish this in ArcGIS Pro with the **Project** tool. Each time we apply the Project tool, we identify the source data set, the output data set, and the output projection. Most source data sets have a coordinate system associated with them. The Project tool reads this coordinate system to determine the input. We then specify the output, including the datum transformation, if needed, and save the new file to a target location.

There is another tool, the **Define Projection** tool, which is much more rarely used. The Define Projection tool changes information within a layer about the name of the projection. It does not change any coordinates. You ONLY use the Define Projection tool when you know the projection name for a layer is missing or incorrectly recorded.

The toolbox is shown at the right, but do not look for it or try to use it now, we will describe how to find and use it in the next section of this lab.

We include it here to emphasize that these two tools that are often confused. You only use the Define Projection tool when you have a projected data layer, you know what the projection identity is, but that projection identity has been corrupted or erased from the layer.



If you do not know a layer’s projection, you need to either (1) identify it unambiguously by matching coordinates or overlaying with other data, or (2) discard the data, because it is not very useful without knowledge of the projected coordinate system.

The Define Projection tool is often confused with the Project tool, listed just below Define Projection in the figure above). The Project tool is more commonly used and converts a layer from one coordinate system to another. It reads the information in a layer about its coordinate system, and then re-projects the data to another known coordinate system and modifies the information in the layer.

After you have read the information about Project and Define Projection used in ArcGIS Pro, I would like to insert THREE new empty maps (**Insert** tab > **Project** group > **New Map** icon) to your project file. Make sure to REMOVE any default layers that might be loaded to the maps.

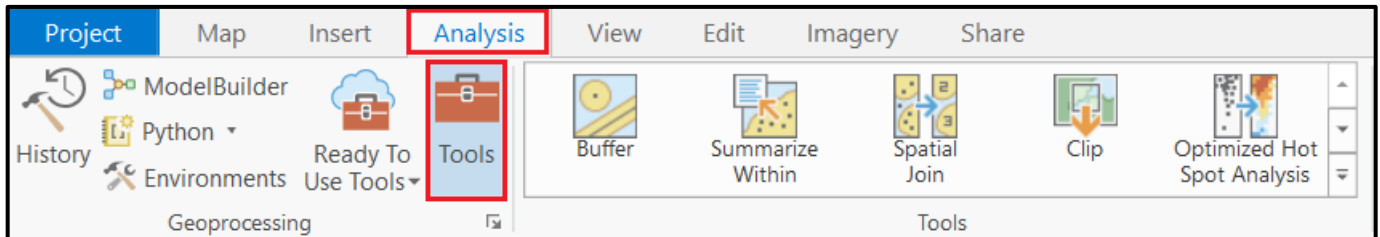
Next name each new map with the following titles:

- **Map 1:** Name it as “**Albers**”
- **Map 2:** Name it as “**UTM**”
- **Map 3:** Name it as “**Mercator**”

After you have named the new three maps, you will learn where to find the **Project** and **Defined Projection** tools available in ArcGIS Pro.

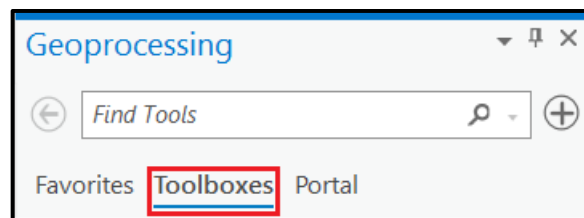
To locate these two map projection tools, left click on the **Analysis** tab at the top of the menu screen.

Next click on “**Tools**” icon inside the “**Geoprocessing**” group.

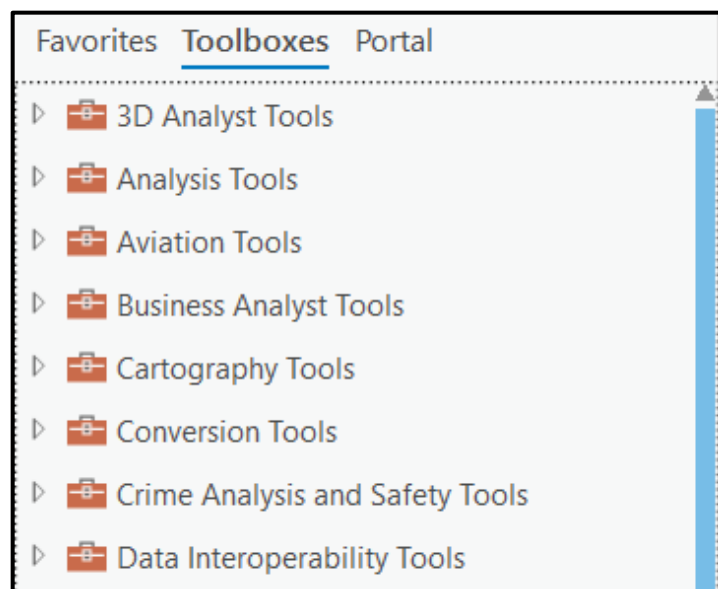


After you click on the **Tools** icon, a new **Geoprocessing** window should open on the right side of your screen.

Click on the **Toolboxes** label just below the **Find Tools** search box.



A list of available tools will load in the Geoprocessing window (see below).



To project the data, click on

Data Management Tools

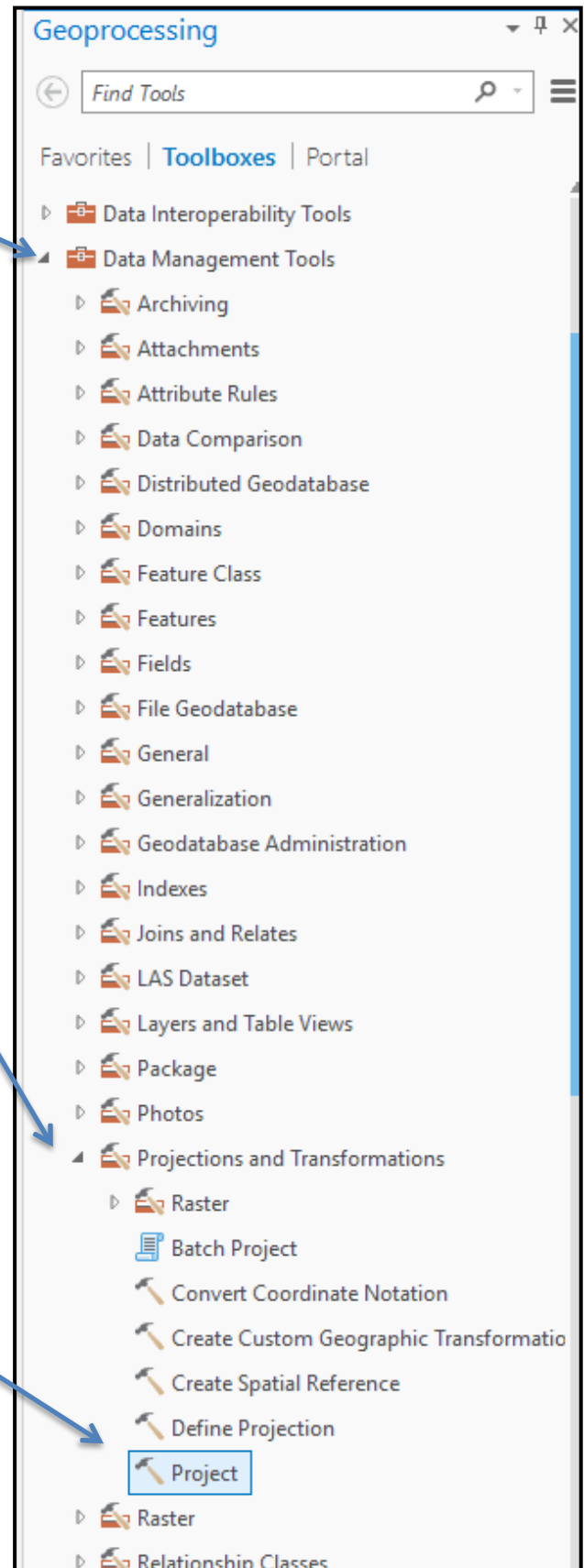
then

Projections and Transformations

then

Project

The **Project** tool converts data from one coordinate system to another, saving the projected data to a new file



Detailed instructions for specific projection examples are provided a bit further on in this document, but the general process is to start the **Project** tool, and then:

- Select a data layer containing the features you want to convert to a new coordinate system
- Specify an output location and name for a new data layer
- Specify the output projection, and if need be, a datum transformation (ArcGIS Pro calls it a Geographic Transformation).
- Apply the projection

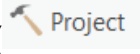
Remember, ArcGIS shapefiles store information about the projection in a .prj file. For example, a layer named **ga_county_dd** may have projection information stored in the file **ga_county_dd.prj**. Without a .prj, ArcGIS Pro is ignorant of the projection system, so you may have to specify the input as well as output projections in the general steps above.

Step 4: Using the Project Tool

This section will show you step-by-step instructions through the projection screens. You will use these steps several more times in this lab exercise.

We assume you have three empty maps in the same project, one named **Albers**, one **UTM**, and one named **Mercator**. If not, create them now.

Make sure the **Albers** () map is active.

Next, double click on the **Project** tool () within the **Toolbox** as shown in the previous figure.

This should open a **Geoprocessing** tab and menu in the right-most column of the main ArcGIS Pro window:

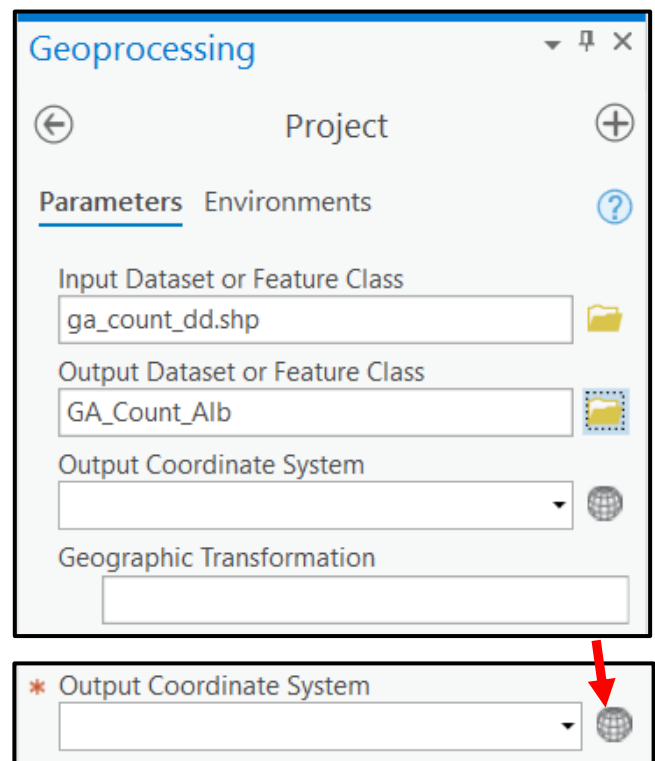
This allows you to specify the input and output files, the **Output Coordinate System**, and if needed you make need to perform a **Geographic Transformation**.

Click on the folders to the right of the input and output data set windows to specify the input and output files.

Use the **ga_count_dd.shp** as the **Input Dataset**.

Name the **Output Dataset** with the following name "**GA_Count_Alb**" and place it in your Lab 10 folder with your input data and project.

Next, specify the **Output Coordinate System** by clicking on the **Globe** to the right of the entry row in the Geoprocessing window.

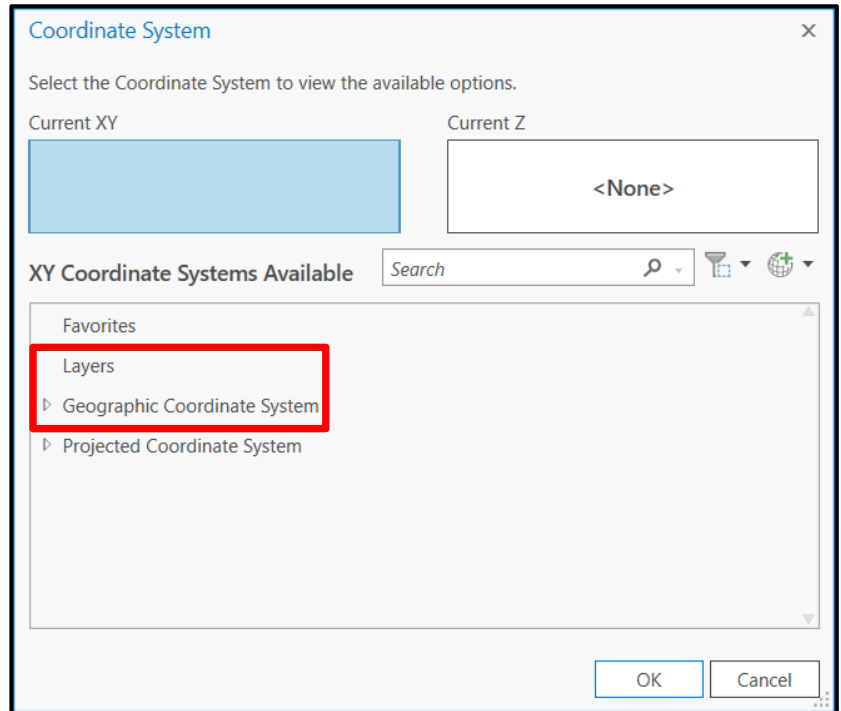


This should open a window in which you specify the target coordinate system. The window looks like the one used to specify a map coordinate system.

You use the caret (▾) to drop down lists, until you eventually select a specific output projection.

The geographic caret accesses all **Geographic Coordinate Systems (GCS)**, meaning you would project to a lat/lon, spherical system.

The projected caret accesses all **Projected Coordinate Systems (PCS)**, mean common Cartesian projections.



To select the Albers projection for this map, you will need to **left click** on **Projected Coordinate System**.

Then click on **Continental**

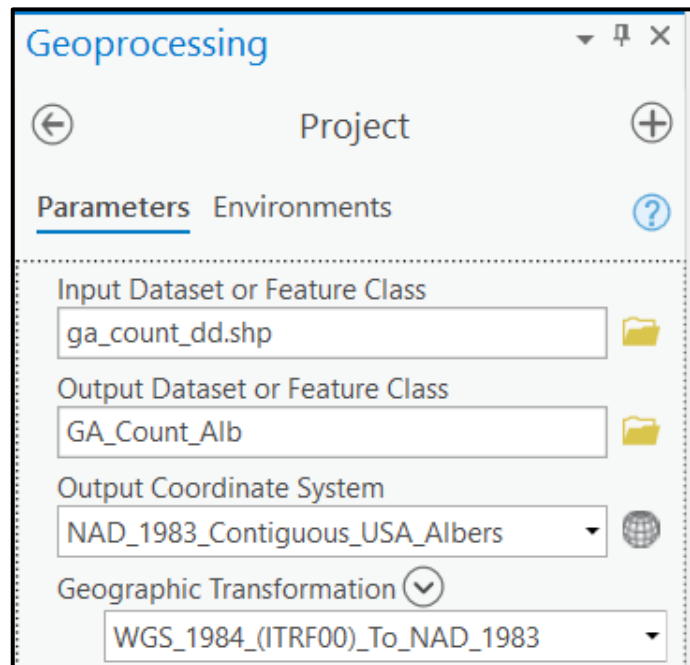
Next, click on **North America**

Select **NAD 1983 Contiguous USA Albers**

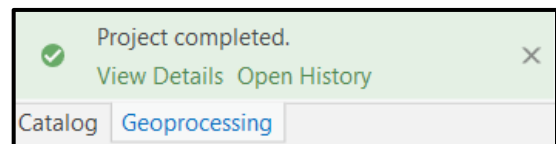
And click on **OK** at the bottom of the window.

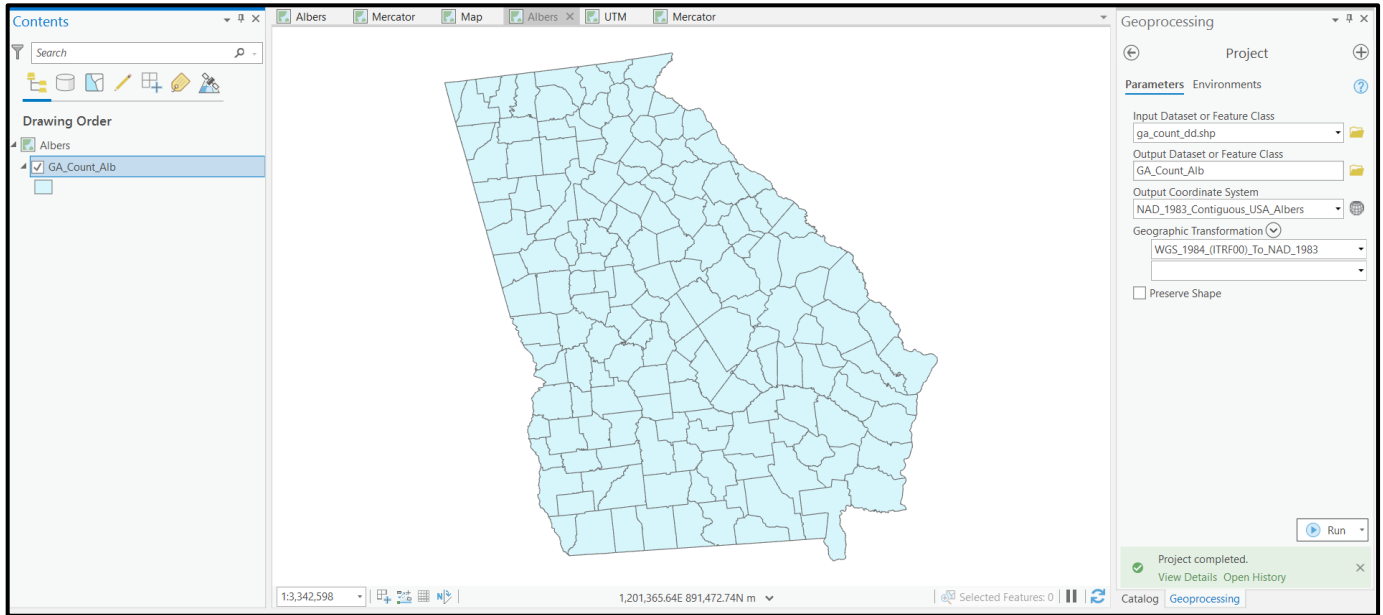
This should automatically choose the appropriate Geographic Transformation of **WGS84(ITRF00)_To_NAD_1983**:

Finally, click on the **Run** button in the lower right corner of the Geoprocessing column.



After a bit of processing, a message should show across the bottom of the Geoprocessing column indicating successful completion, and the projected data should be placed in your active map window (that you named Albers).

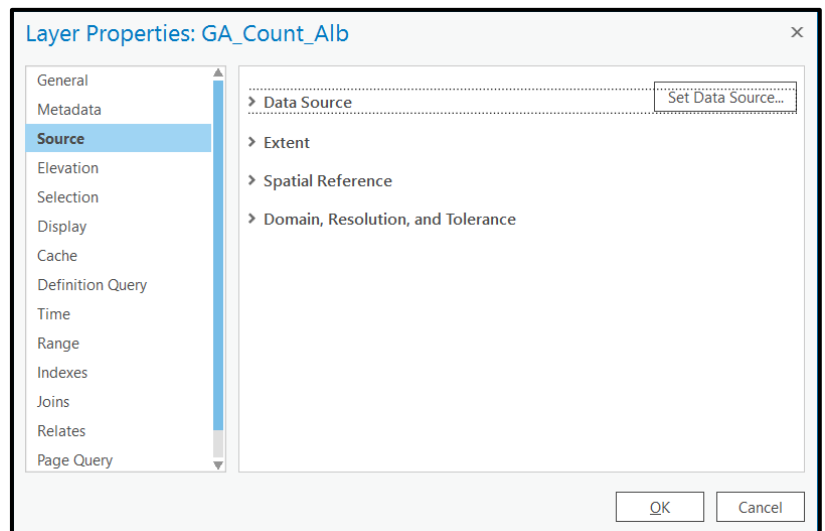




Note: If your newly created projected file does not appear on your Albers map, you may need to add the data layer (**Map** tab > **Layer** group > **Add Data** icon) to it.

Next, inspect the coordinate system of the **GA_Count_Alb** data layer you just created. Remember by first right clicking on the name in the *Table of Contents*, then examine the following **layer properties**:

- Data Source
- Spatial Reference



This should display the spatial reference information for the layer, showing NAD 1983 Contiguous USA Albers as the **projected coordinate system**:

Layer Properties: GA_Count_Alb



General

Metadata

Source

Elevation

Selection

Display

Cache

Definition Query

Time

Range

Indexes

Joins

Relates

Page Query

▼ Data Source

Set Data Source...

Data Type	Shapefile Feature Class
Shapefile	G:\Lab9\LastName_Lab9\GA_Count_Alb.shp
Geometry Type	Polygon
Coordinates have Z value	No
Coordinates have M value	No
Vertical Units	Meter

► Extent

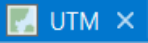
▼ Spatial Reference

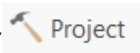
Projected Coordinate System	NAD 1983 Contiguous USA Albers
Projection	Albers
WKID	5070
Authority	EPSG
Linear Unit	Meters (1.0)
False Easting	0.0
False Northing	0.0
Central Meridian	-96.0
Standard Parallel 1	29.5
Standard Parallel 2	45.5
Latitude Of Origin	23.0

Geographic Coordinate System	NAD 1983
WKID	4269
Authority	EPSG
Angular Unit	Degree (0.0174532925199433)
Prime Meridian	Greenwich (0.0)
Datum	D North American 1983

OK

Cancel

Once you have examined the data source and spatial reference of the Albers map, you will then activate the map named **UTM** () and then perform the same steps as described previously with the exception of selecting a coordinate system and naming of the new data layer.

Next, double click on the **Project** tool () within the **Toolbox** as shown in the previous figure.

This should open a **Geoprocessing** tab and menu in the right-most column of the main ArcGIS Pro window:

This allows you to specify the input and output files, the **Output Coordinate System**, and if needed you make need to perform a **Geographic Transformation**.

Click on the folders to the right of the input and output data set windows to specify the input and output files.

Use the **ga_count_dd.shp** as the **Input Dataset**.

Name the **Output Dataset** with the following name "**GA_Count_UTM17**" and place it in your Lab 10 folder with your input data and project.

To select the Albers projection for this map, you will need to **left click** on **Projected Coordinate System**.

Click on **UTM**

Select **NAD 1983**

And finally click on **NAD 1983 UTM Zone 17 N**

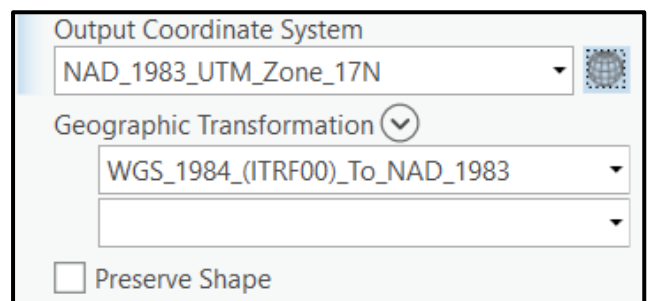
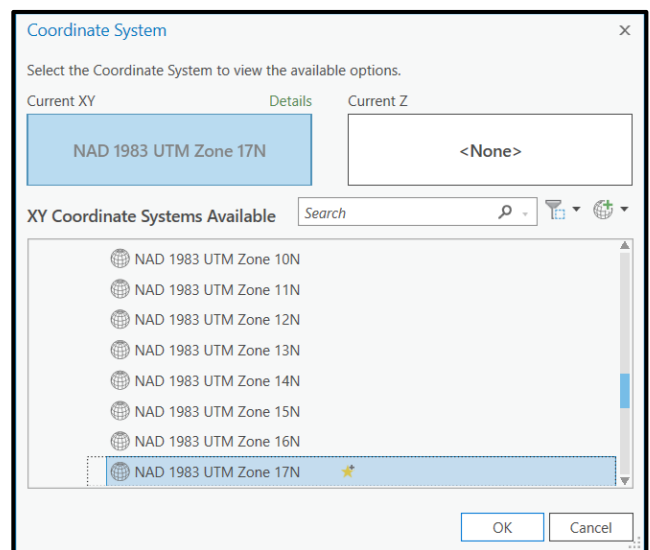
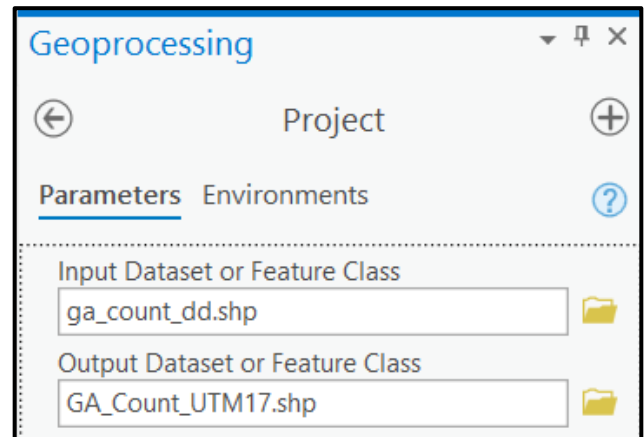
After selecting this projection click on **OK** at the bottom of the window.

This should automatically choose the appropriate Geographic Transformation of **WGS84(ITRF00)_To_NAD_1983**:

Finally, click on the **Run** button in the lower right corner of the Geoprocessing column.

After the transformation, your new layer (**GA_Count_UTM17**) should appear on your UTM data map.

Note: If your newly created projected file does not appear on your UTM map, you may need to add the data layer (**Map** tab > **Layer** group > **Add Data** icon) to it.



Again, verify that you have the correct output (**GA_Count_UTM17**) by inspecting the information on the layer.

Finally, you will project the last map of **Mercator**. Make sure your last map is activated before trying to project the data layer.

Use the **ga_count_dd.shp** as the **Input Dataset**.

Name the **Output Dataset** with the following name "**GA_Count_Mercator**" and place it in your Lab 10 folder with your input data and project.

To select the Albers projection for this map, you will need to **left click** on **Projected Coordinate System**.

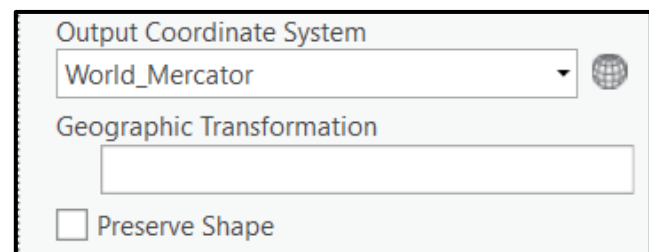
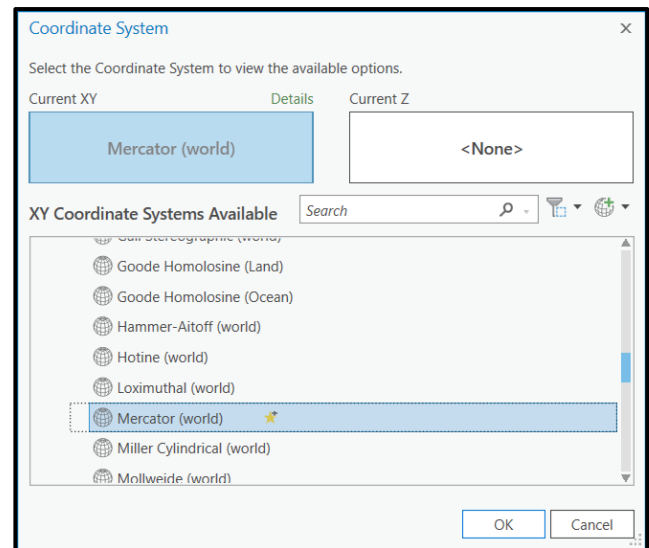
Select **World**

And finally click on **Mercator (world)**

After selecting this projection click on **OK** at the bottom of the window.

Finally, click on the **Run** button in the lower right corner of the Geoprocessing column.

After the transformation, your new layer (**GA_Count_Mercator**) should appear on your UTM data map.



Note: If your newly created projected file does not appear on your Mercator map, you may need to add the data layer (**Map** tab > **Layer** group > **Add Data** icon) to it.

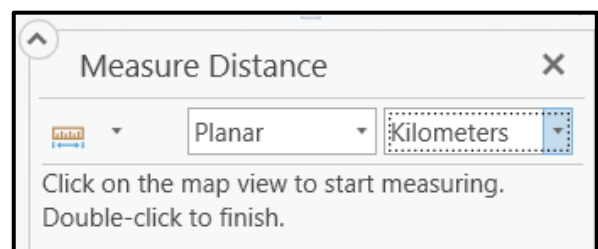
Again, verify that you have the correct output (**GA_Count_Mercator**) by inspecting the information on the layer.

Step 5: Measure Distance of Projected Maps

Now you should have THREE different maps, with three different versions of the Georgia counties – an **Albers**, a **UTM**, and a **Mercator**. Notice the shapes are different, not so much between the Albers and UTM, but noticeably so for the Mercator relative to the other two.

Go back to the **Albers** map and activate the **Measurement** tool (**Map** tab > **Inquiry** group > **Measure** tool).

Next, set Measure tools to the following: **Mode** to "**Planar**" and **Distance Units** to "**Kilometers**".





Measure the distance (in *kilometers*) from the [northeastern](#) most point of Georgia to the [southwestern](#) most point for the Albers map.

Do this as carefully as you can, it pays to expand the map window to as large as will fit on your screen.

Question 10.8. What is the distance (in kilometers) between the two locations on the projected ALBERS map of Georgia?


Repeat the same steps and determined the distance (in kilometer for the remaining two map projections (UTM and Mercator).

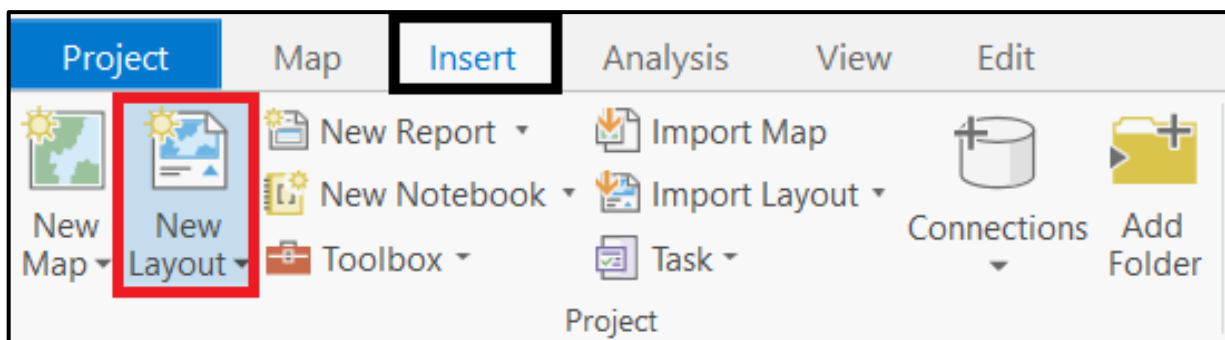
Question 10.9. What is the distance (in kilometers) between the two locations on the projected UTM map of Georgia?

Question 10.10. What is the distance (in kilometers) between the two locations on the projected MERCATOR map of Georgia?

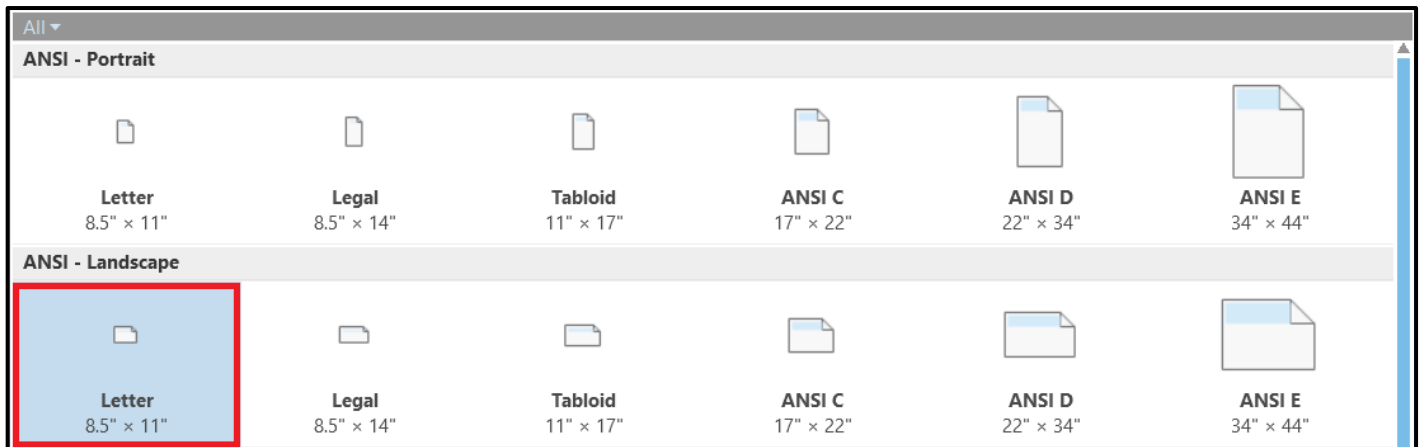
Step 6: Create a Layout Map of the Three Projections

After you have measured the distance for the three map projections, you will then create a final layout of Georgia projections.

On the ribbon, click the [Insert tab](#), if necessary. In the [Project](#) group, click [New Layout](#)  to show page size and orientation options.



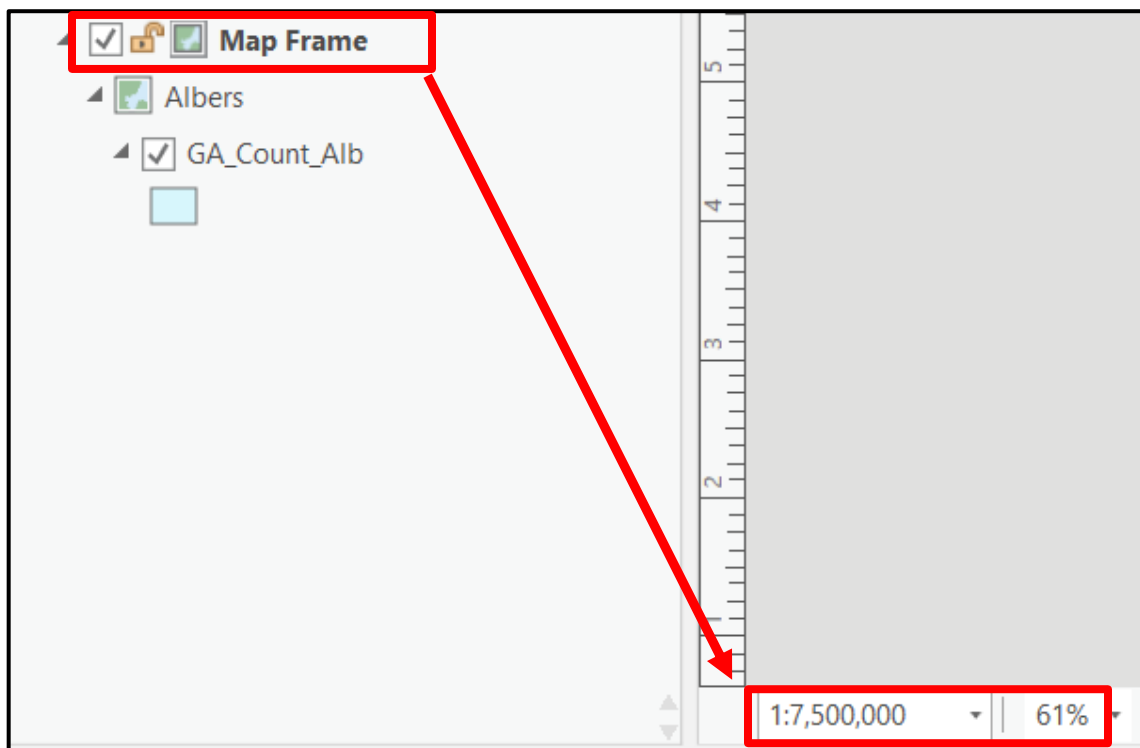
Under **ANSI - Landscape**, click **Letter 8.5" x 11"**.



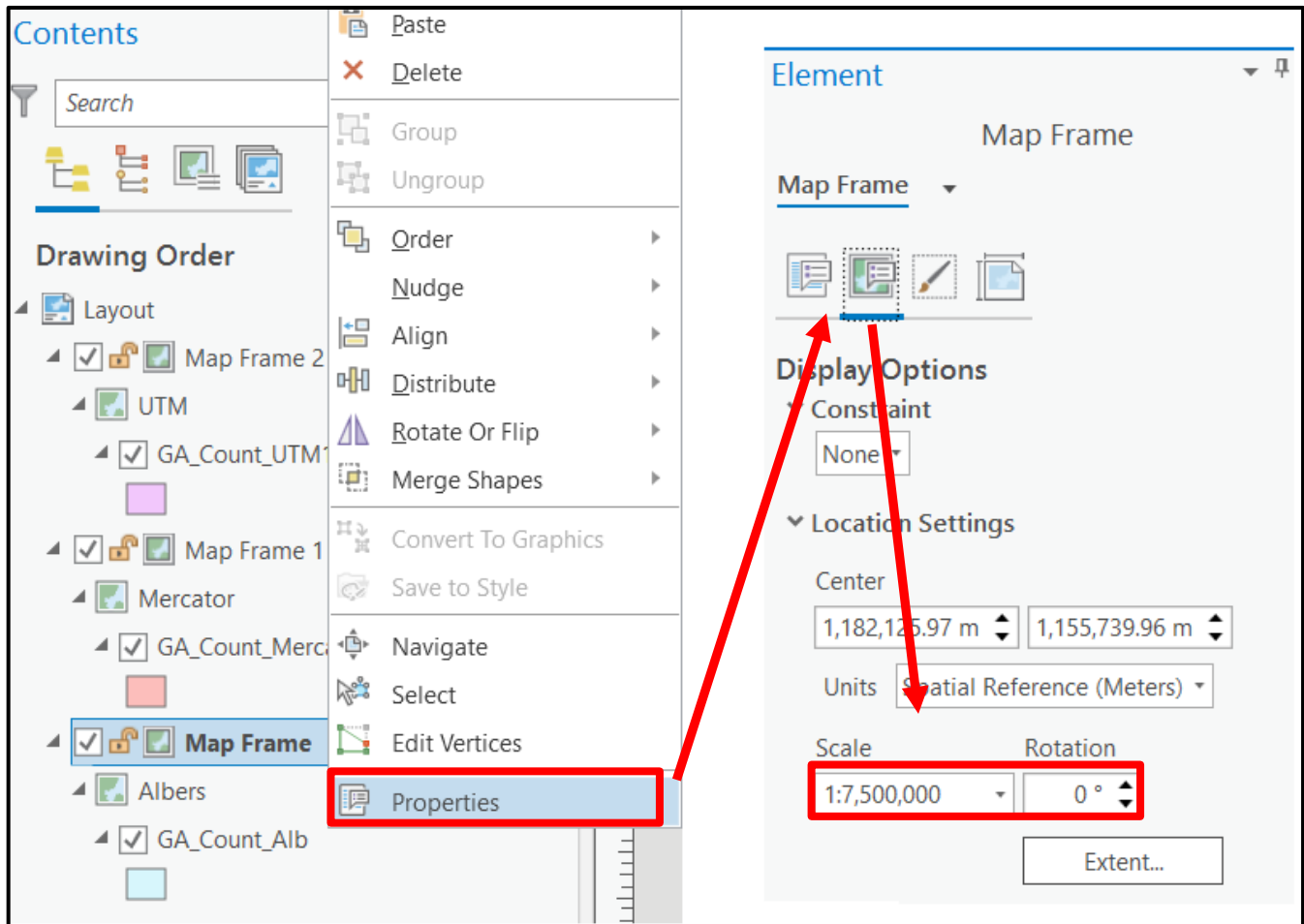
After you have created the layout map for your three projected layers. Please watch the following video **Set Layout Scale** (<https://www.youtube.com/embed/hsYyr-YHFLg>) to help you scale new projection correctly on your map. If you do NOT correctly scale the difference between each of the three projections your layout map will not look right.

Add adding THREE map frames (to your layout map and add the projection layers ([Albers](#), [UTM](#), and [Mercator](#)), you will need to scale each map frame, so they are consistent across the board.

In order to achieve this goal, look for the scale box at the bottom right side of the layout map (see below). For each map frame, you will need to adjust the [map scale](#) (see example below) and it set the scale of each map to the following scale (**1:7,500,000**).

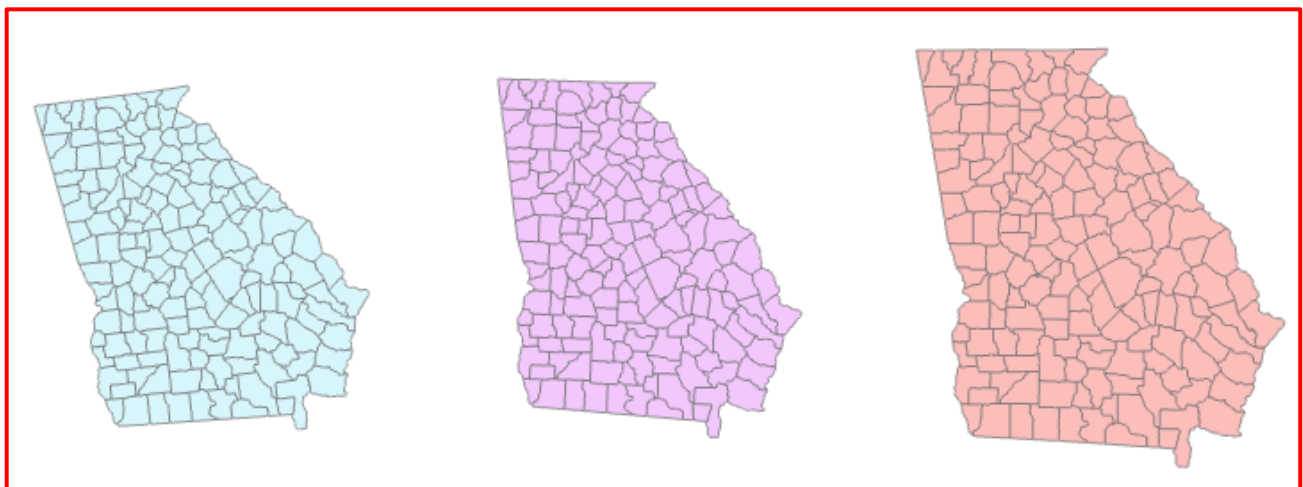


Or if you click on the **Map Frame** > **Properties** > **Elements** > **Scale** > **Set to 1:7,500,000** to change the map scale of each projection layer.



Perform the same step for each map frame of [Albers](#), [UTM](#), and [Mercator](#), and notice how the size of each projection changes

Once you adjust the scale of each map frame, your layout map should look like the one below.



When you have accomplished this task, you can continue to design and layout your map. As part of map you need to include the following information.

1. Titles

- **Main Title:** *Comparison of Three Map Projections*
- **Map Frame 1 Title:** *Albers*
- **Map Frame 2 Title:** *UTM Zone 17 North*
- **Map Frame 3 Title:** *Mercator*

2. Map Scale

- Add representative fraction - **1: 7,500,000** below the scale to depict the ratio used for each map layer.

3. North Arrow

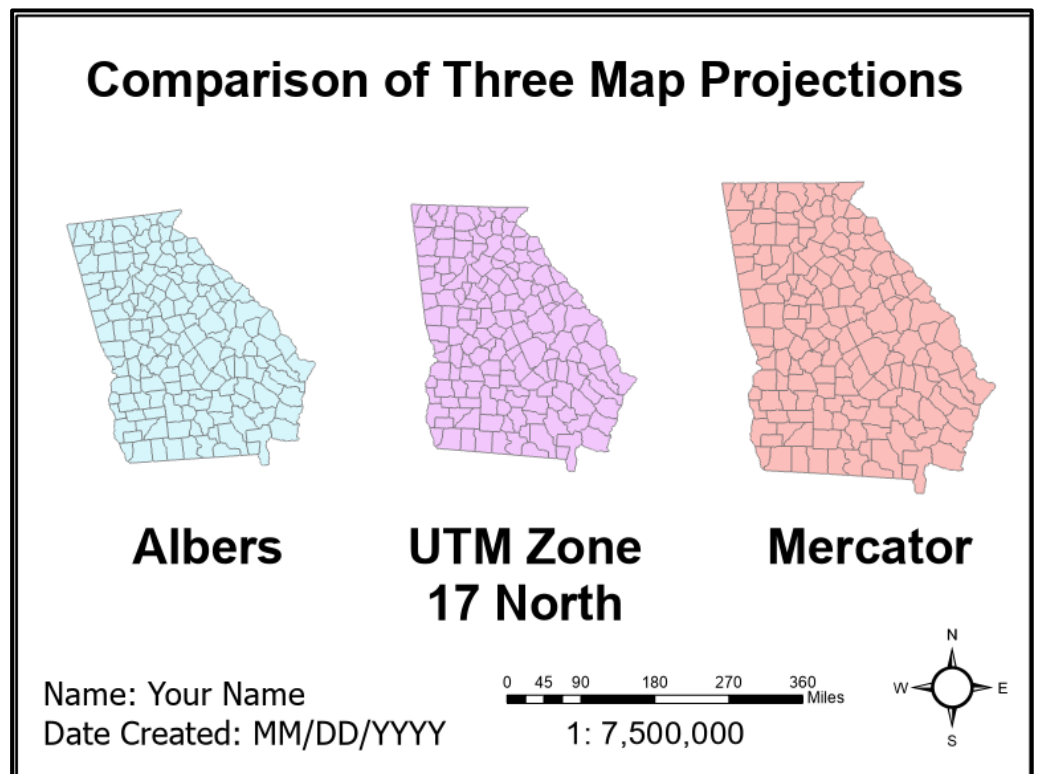
4. Metadata Information

- Your Name
- Date Created

5. Neatline (Border)

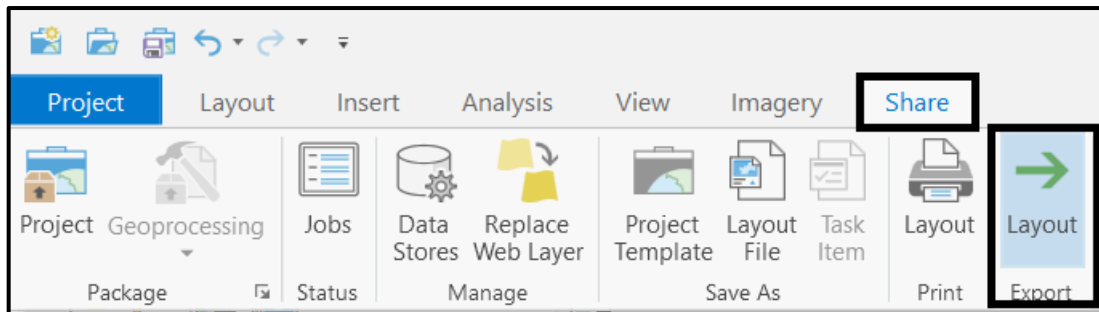
Note: For this lab exercise, you do NOT need to create a **legend**, since we are including titles for each map project.

Once you have included required information to your layout map, it should look like the one to the right.




Now that your layout is finished, you can print it out or export it to a file that can be easily shared. You will learn in this step how to export the layout of your map as a **PNG** file.

On the ribbon, click the **Share** tab. In the **Export** group, click **Layout** ➔.




The Export Layout pane appears. On the **Properties** tab, change **File Type** to **PNG**, if necessary. Also make sure the **Resolution** is set to **300 DPI**. This is the most common resolution used to export a map file from any GIS software.

In the **Name box**, name your map as “**YourLastName_Lab9**”. Then, click the **Browse** button  and browse to the location (working direction – e.g., GIS Fileshare) where you want to save the file.

After accepting the other default PNG settings, click on the bottom of the pane, **Export**.

When the export is completed, click **View** exported file at the bottom of the pane.

The file opens in your default image viewing application. If you want to print the layout, on the **Share** tab, in the Print group, click **Layout** . You may need to change some printer settings, such as the page orientation, before you send the layout to the printer.

After you have exported your map as a PNG file, please make sure to save your work!

Step 7: Save Your Work

Click on the **Project** tab, and then click on the **Save As** icon. A new window will appear on your screen.

Now save your file. Find the directory where you want to save your work from lab exercise 10. Name the file as “**YourLastName_Lab9**”.

The file will save as an **APRX** Project, this is a new format type of saving files and other related materials in ArcGIS Pro, which is different if you have used ArcGIS Map previously. To learn more about the terminology commonly used in the software of ArcGIS Pro, please visit the following website url: <https://www.esri.com/library/brochures/pdfs/arcgis-pro-terminology-guide.pdf>.

Final Note: After you have completed this step, you have finished this portion of the lab exercise. Please make sure to upload the [PNG file](#) and [questions from the worksheet](#) to receive credit. Finally, close out of ArcGIS Pro.

----- End of Lab Exercise 9 -----