Introduction to ArcGIS

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Goals of the Exercise

This exercise introduces you to ArcGIS Pro. You use these applications to create a map of pan evaporation stations in Texas, and to draw a graph of monthly pan evaporation data measured at these stations. The relationship between ArcGIS and MS Word and Excel is demonstrated so that you can create graphs in Excel, maps in ArcGIS and place the result in a Word file as a report for this homework. In this way, you link the spatial location of the observation sites, with the time variation of the water observations data at those sites. You will also upload your results as a web map of evaporation data so that it can be publicly viewed.

Computer and Data Requirements

To carry out this exercise, you need to have a computer which runs ArcGIS Pro version 1.2. You will also need an ArcGIS Organizational Account to enable you to login to ArcGIS Online.

In the first part of this exercise using ArcGIS Pro, you will be working with the following spatial datasets:

1. A polygon shapefile of the counties of Texas, called **Counties**
2. A point shapefile of pan evaporation stations, called **Evap**
3. A polygon shapefile of the state of Texas, called **Texas**

These shapefiles consist of several files (e.g. **evap.dbf, evap.shp, evap.shx).** You can get them from this zip file: http://www.caee.utexas.edu/prof/maidment/giswr2016/Ex1/Ex1Data.zip

You need to establish a working folder to do the exercise on. This can be in any convenient location on the computer you are working on (e.g. C:\pjruess\giswr2016\Ex1).

After you have downloaded the zip file **Ex1Data.zip** double click on the file and you should see Winzip or other zip utility to open the file on your computer (if it doesn't open you'll have to unzip this file on a computer that has a zip utility installed). Extract all files from the zip file to the working folder that you've set up to do this exercise. You should end up with a file list that looks something like this. You may see these data within a sequence of folder names, and if so, click on each folder down through the sequence until you locate the required files.

Name	Date modified	Type	Size
Counties.dbf	9/5/2012 11:41 AM	DBF File	47 KB
Counties	9/5/2012 11:41 AM	PRJ File	1 KB
Counties.sbn	9/5/2012 11:41 AM	SBN File	3 KB
Counties.sbx	9/5/2012 11:41 AM	SBX File	1 KB
Counties.shp	9/5/2012 11:41 AM	SHP File	8,450 KB
Counties.shp	9/5/2012 11:41 AM	XML Document	22 KB
Counties.shx	9/5/2012 11:41 AM	SHX File	3 KB
Evap.dbf	9/5/2012 11:33 AM	DBF File	30 KB
Evap	9/5/2012 11:33 AM	PRJ File	1 KB
Evap.sbn	9/5/2012 11:33 AM	SBN File	1 KB
Evap.sbx	9/5/2012 11:33 AM	SBX File	1 KB
Evap.shp	9/5/2012 11:33 AM	SHP File	2 KB
Evap.shx	9/5/2012 11:33 AM	SHX File	1 KB
Texas.dbf	9/5/2012 11:44 AM	DBF File	1 KB
Texas	9/5/2012 11:44 AM	PRJ File	1 KB
Texas.sbn	9/5/2012 11:44 AM	SBN File	1 KB
Texas.sbx	9/5/2012 11:44 AM	SBX File	1 KB
Texas.shp	9/5/2012 11:44 AM	SHP File	1,058 KB
Texas.shp	9/5/2012 11:44 AM	XML Document	20 KB
Texas.shx	9/5/2012 11:44 AM	SHX File	1 KB

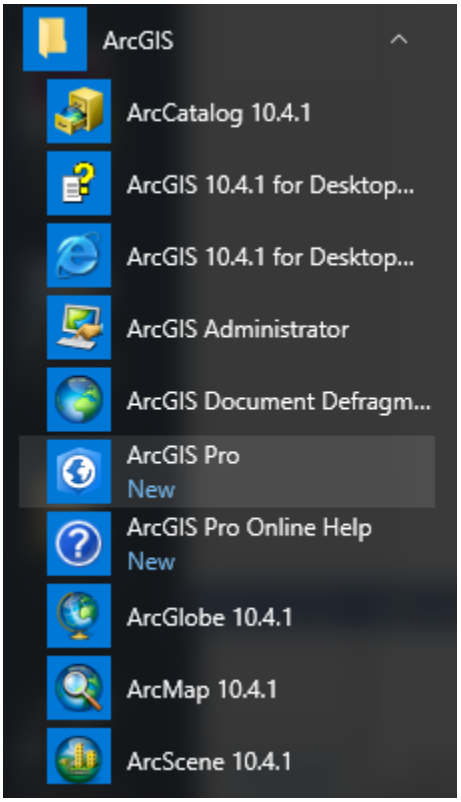
Procedure

Please note that the following procedure is a general outline, which can be followed to complete this lesson. However, you are encouraged to experiment with the program and to be creative.

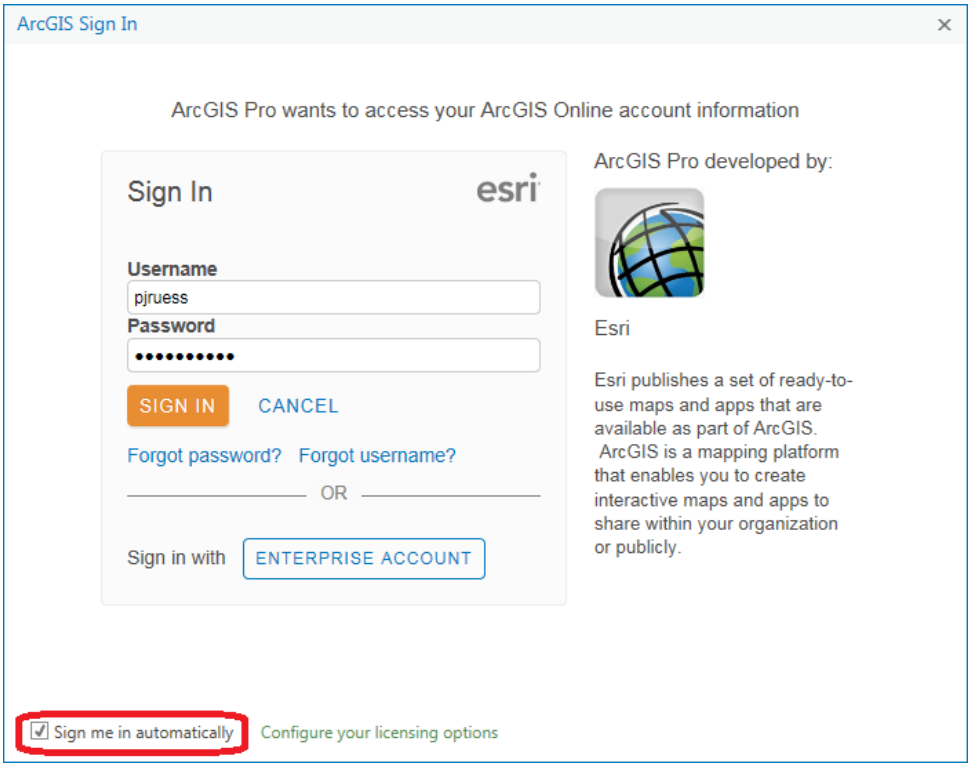
1. Viewing Shapefiles in ArcMap

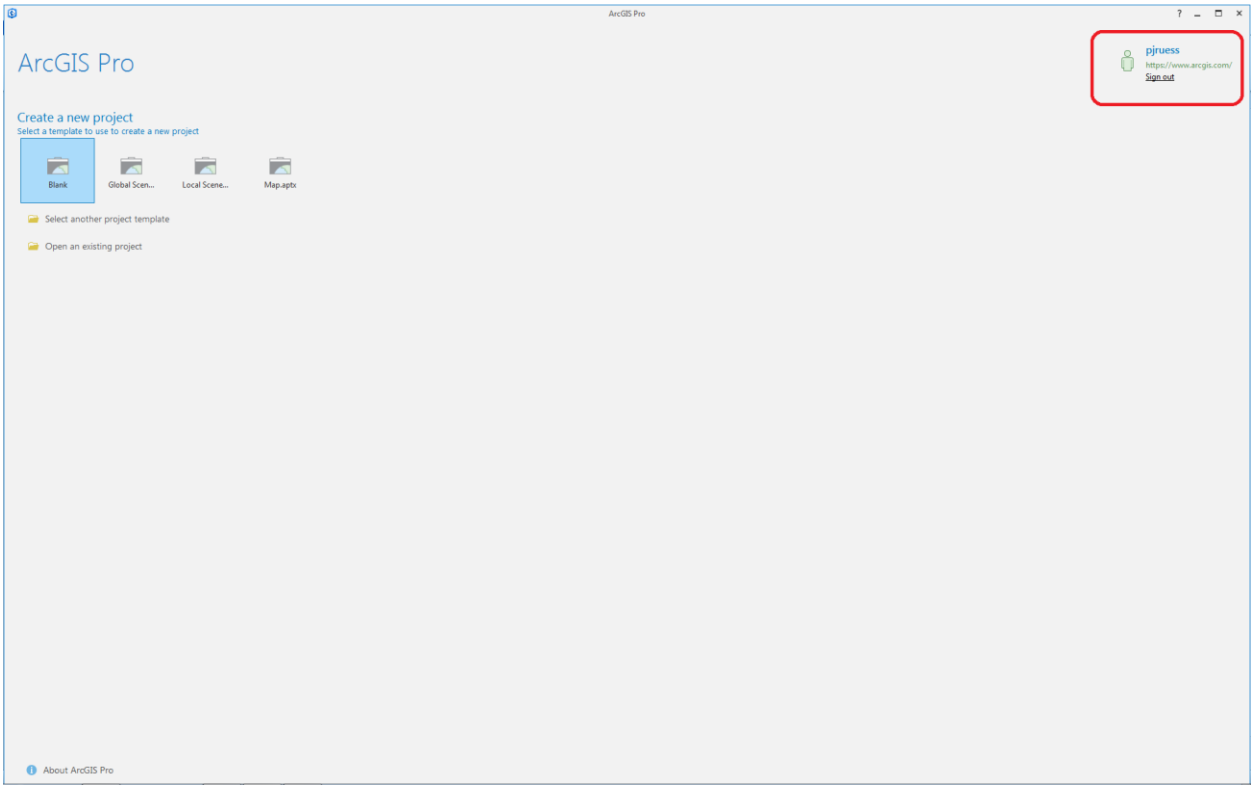
A *shapefile* is a homogenous collection of simple features that includes geometry and feature attributes. The attributes are contained in a dBase table, which allows for the joining with a feature based on the attribute key.

Open **ArcGIS Pro**

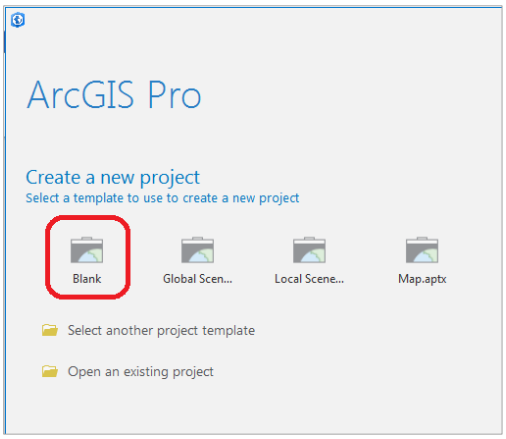


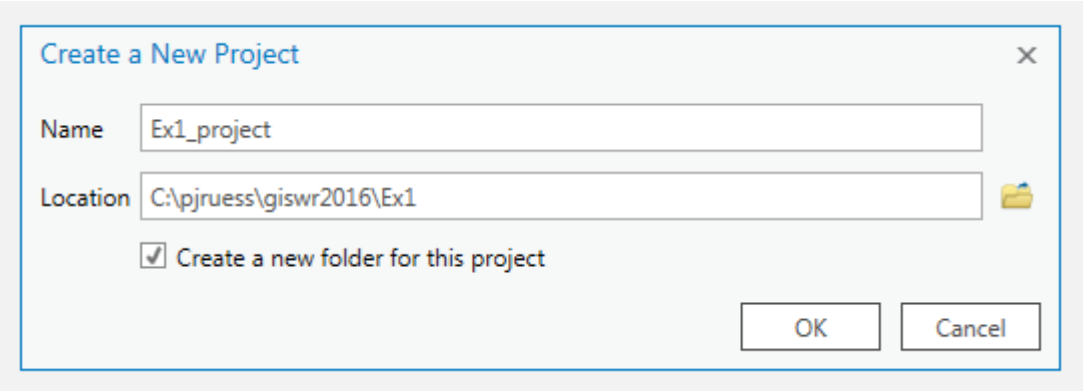
The first time you open ArcGIS Pro, you will need to sign in using your ArcGIS Online account. For convenience, you may want to leave the "Sign me in automatically" checkbox selected. Once in ArcGIS Pro, you can check whether you are logged in or not in the upper right-hand corner.


ArcGIS Sign In
ArcGIS Pro wants to access your ArcGIS Online account information
Sign In
esri
Username
pjruess
Password
SIGN IN
CANCEL
Forgot password?
Forgot username?
OR
Sign in with
ENTERPRISE ACCOUNT
ArcGIS Pro developed by:
Esri
Esri publishes a set of ready-to-use maps and apps that are available as part of ArcGIS. ArcGIS is a mapping platform that enables you to create interactive maps and apps to share within your organization or publicly.
Sign me in automatically
Configure your licensing options

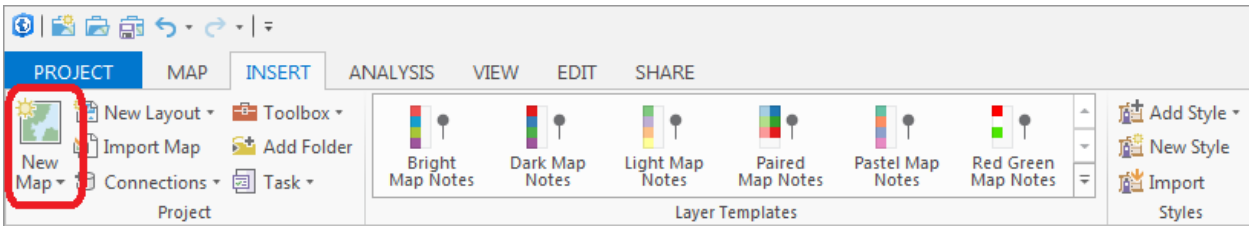

ArcGIS Pro
pjruess
Sign out
Create a new project
Select a template to use to create a new project
Blank
Global Scen...
Local Scene...
Map.aptx
Select another project template
Open an existing project
About ArcGIS Pro

Once you are in ArcGIS Pro, you will want to start with a **Blank** template.

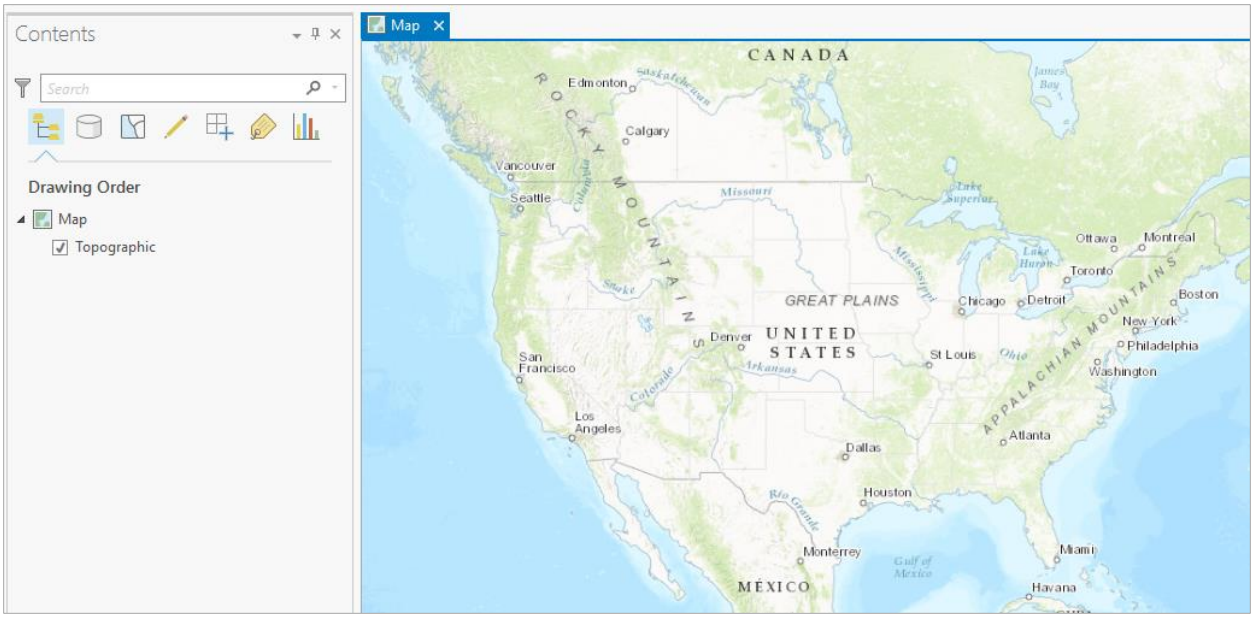




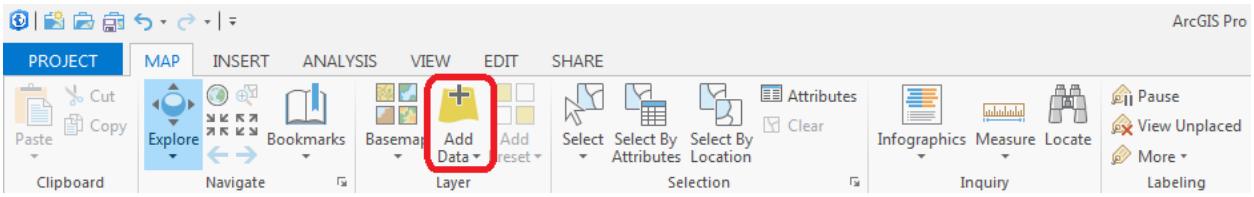
Click the **New Map** button in the *Insert* tab to create a map.



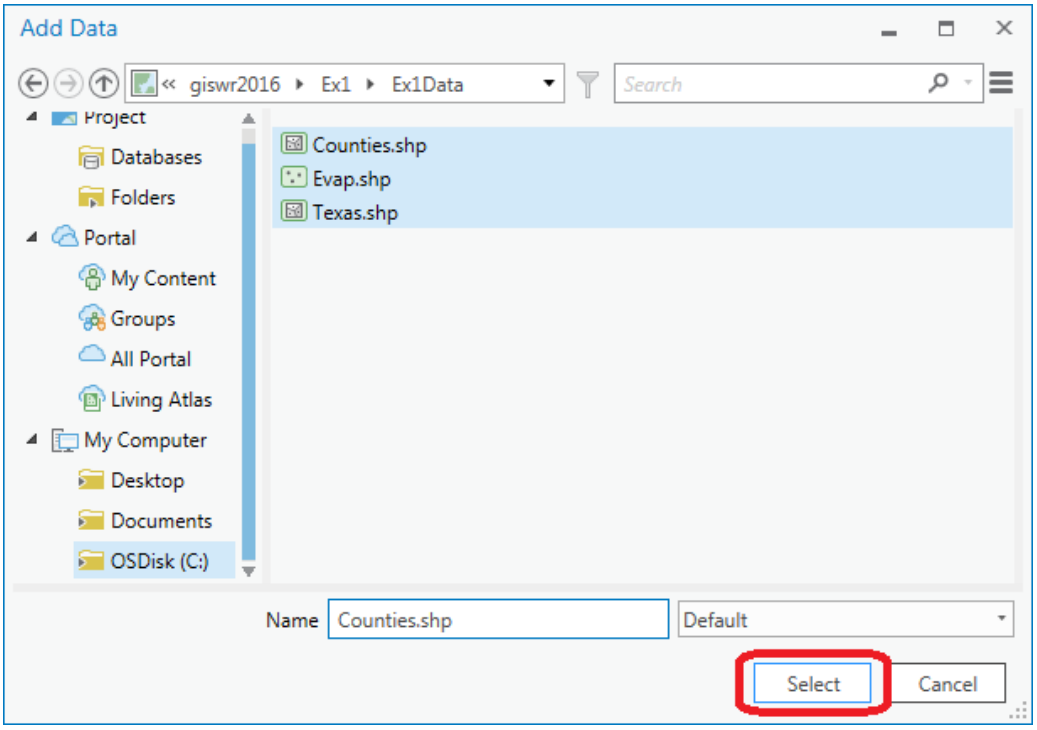
And you'll see a map display open with a nice map of the United States. Pretty cool!



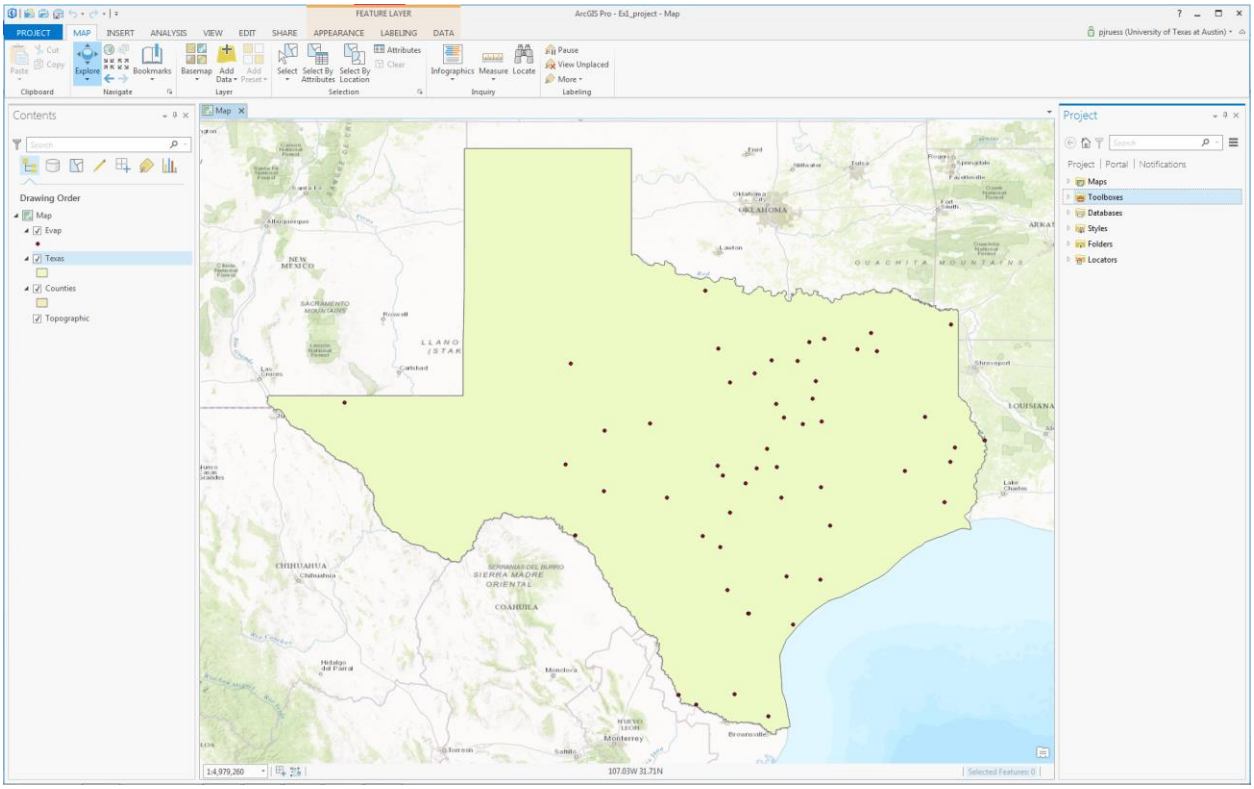
Use the **Add Data** button in the *Map* tab to add the data for this exercise to the map display.



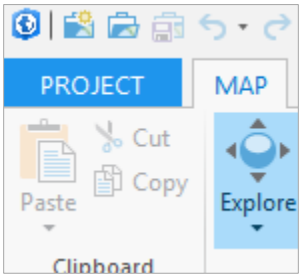
Navigate to the folder containing the exercise data and select all three files at once by using the shift key. Click the Add button to add the data to your ArcMap display.

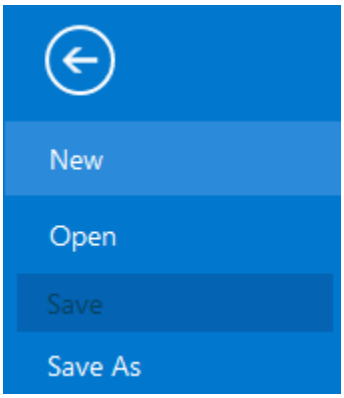


The display should look something like the following.

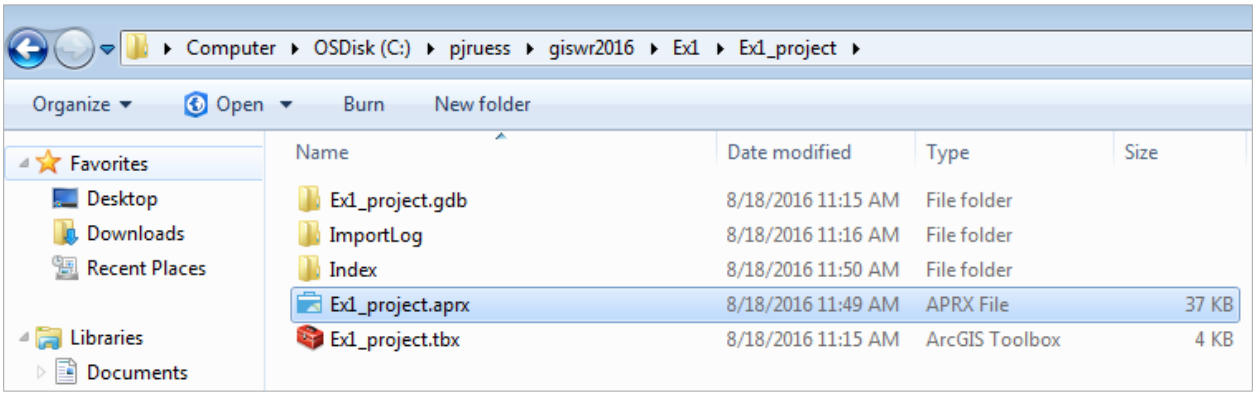


Let's make sure that we can retrieve the results of these actions if we inadvertently make a mistake and close the application. Use **Project/Save** to save the contents of the current project.



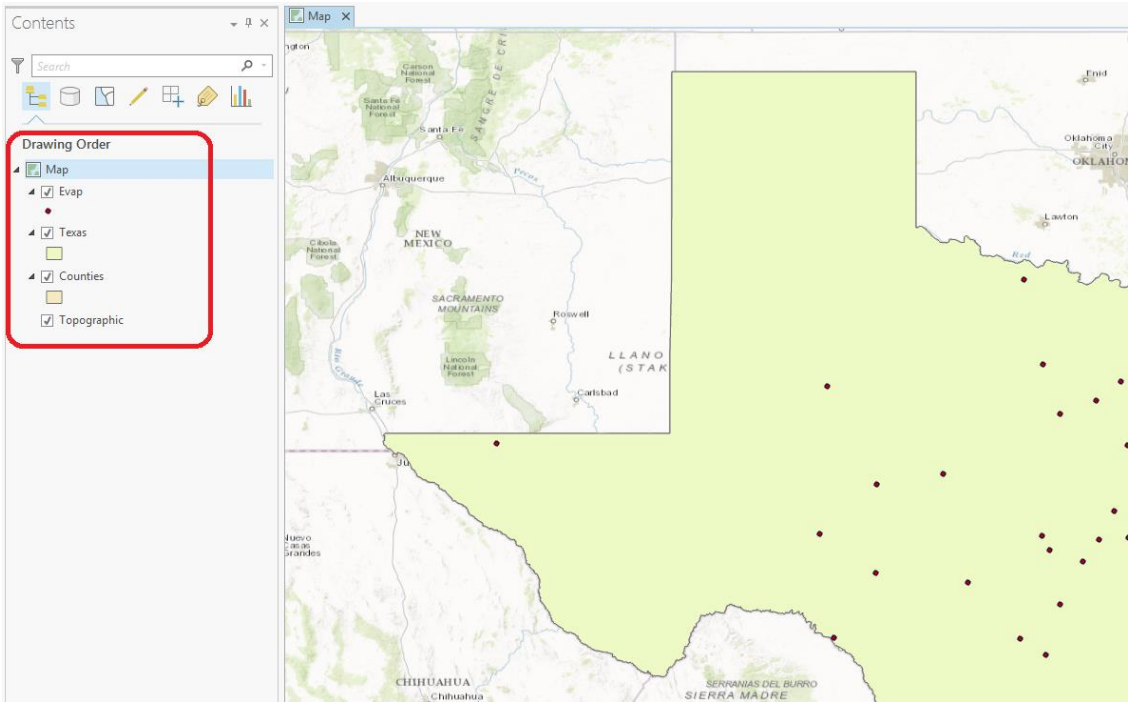


The project will save in the initial destination provided when you created the project (**Ex1_project** for this example). There is an **Ex1_project.aprx** file within the project folder that contains the table of contents and symbology information for your map. You can shut down ArcGIS Pro and reload the same map display by clicking on **Ex1_project.aprx**.

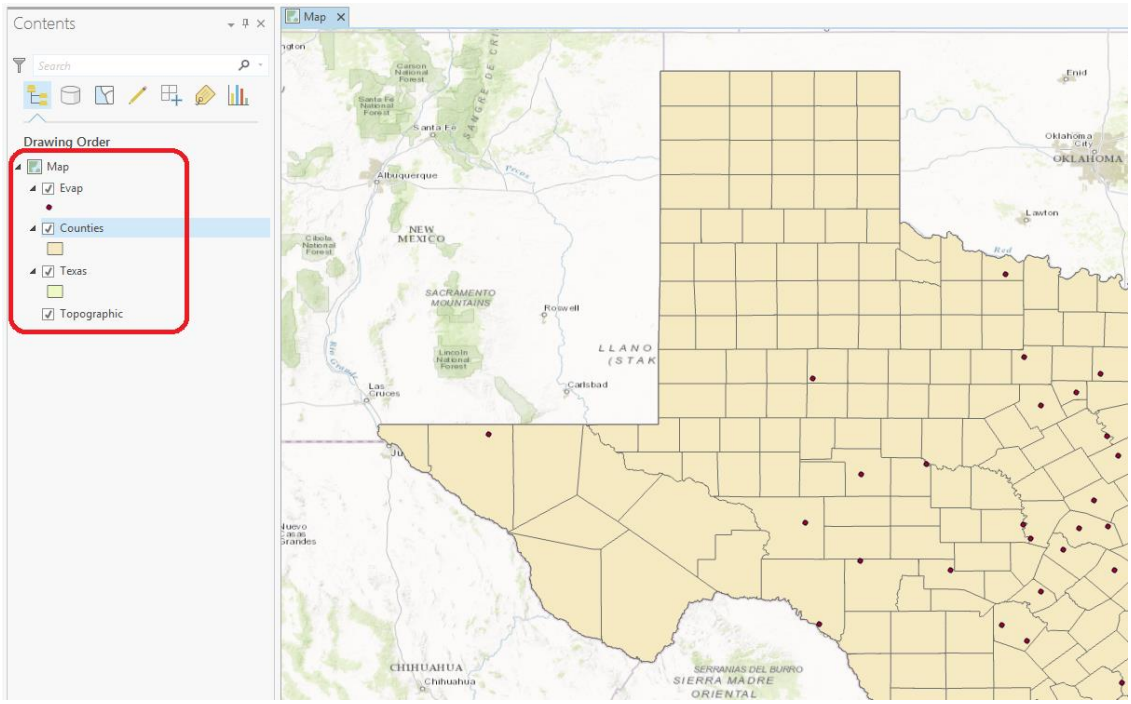


Note that the .aprx file that is saved does not contain the map data, rather it contains references to the data. This means that if you move the data files and then try and load the map document, ArcGIS Pro may not be able to find the data. We'll deal with how to fix this later.

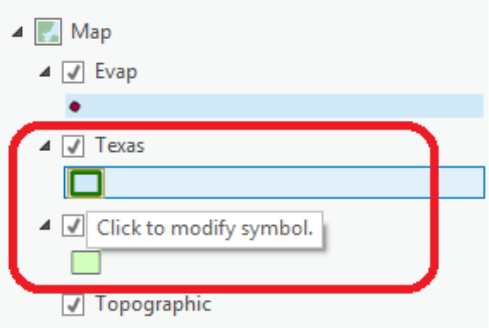
Depending on the order in which themes were added the **Texas** theme may lie above the **Counties** theme so you cannot see the **Counties** theme.



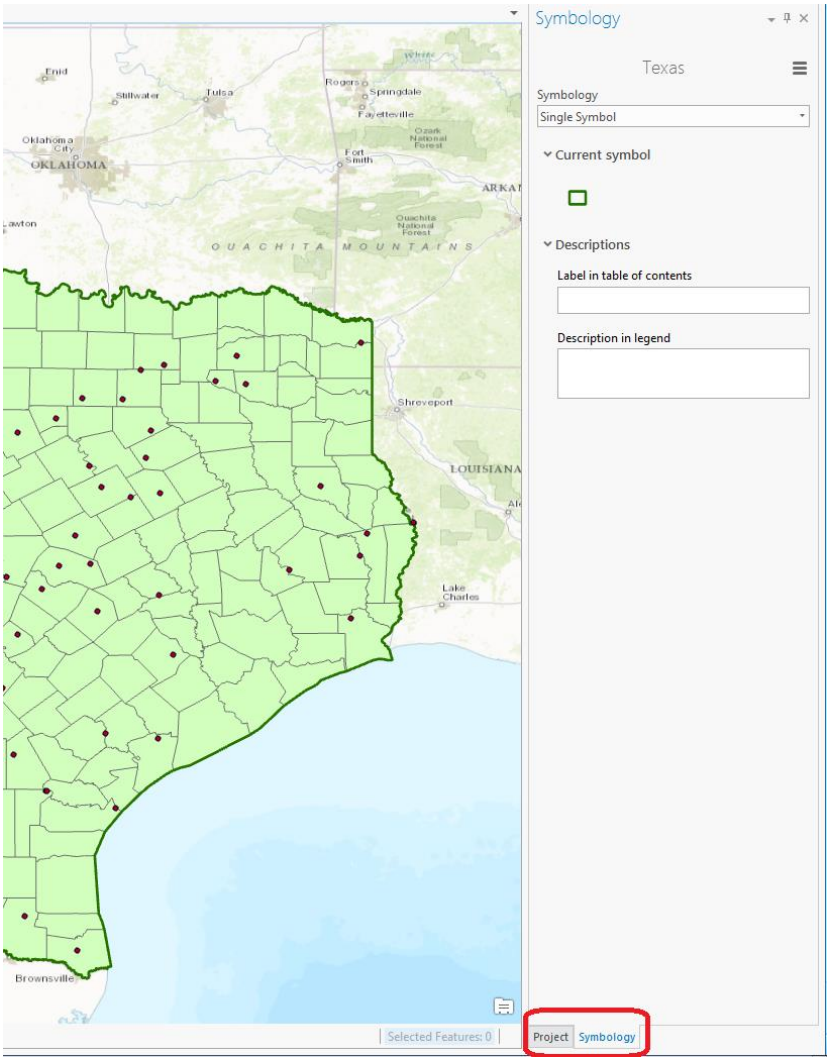
Click on the **Counties** theme and drag it up so that it is located above the **Texas** theme. You'll then get a display showing the counties.

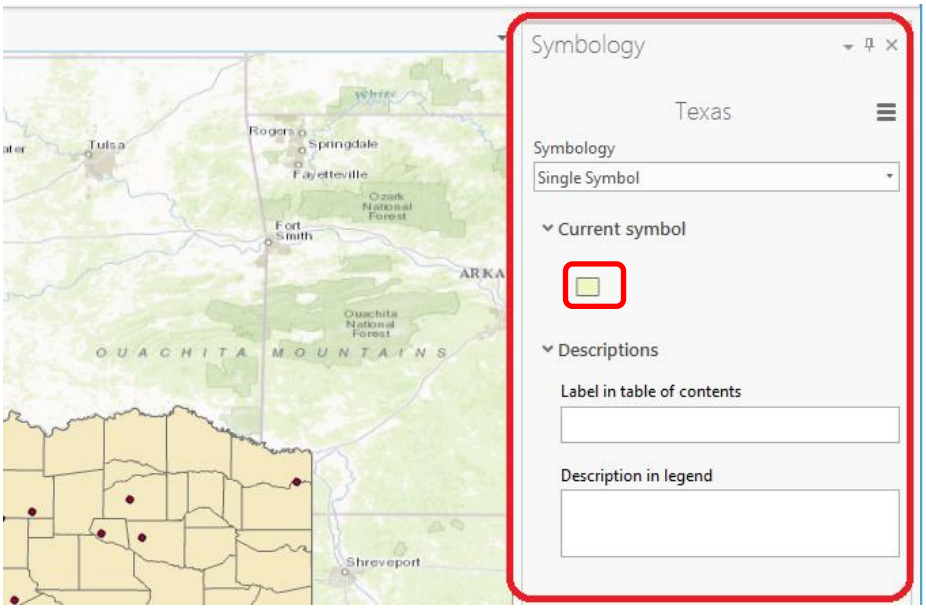


To change the appearance of a map display, you can access the **Symbology** menu by selecting the Symbol displayed in the ArcGIS Pro table of contents and the **Symbology** information will open on the right side of the screen. Alternately, you may right-click on the layer name (ie. “Texas”) and select **Symbology**.

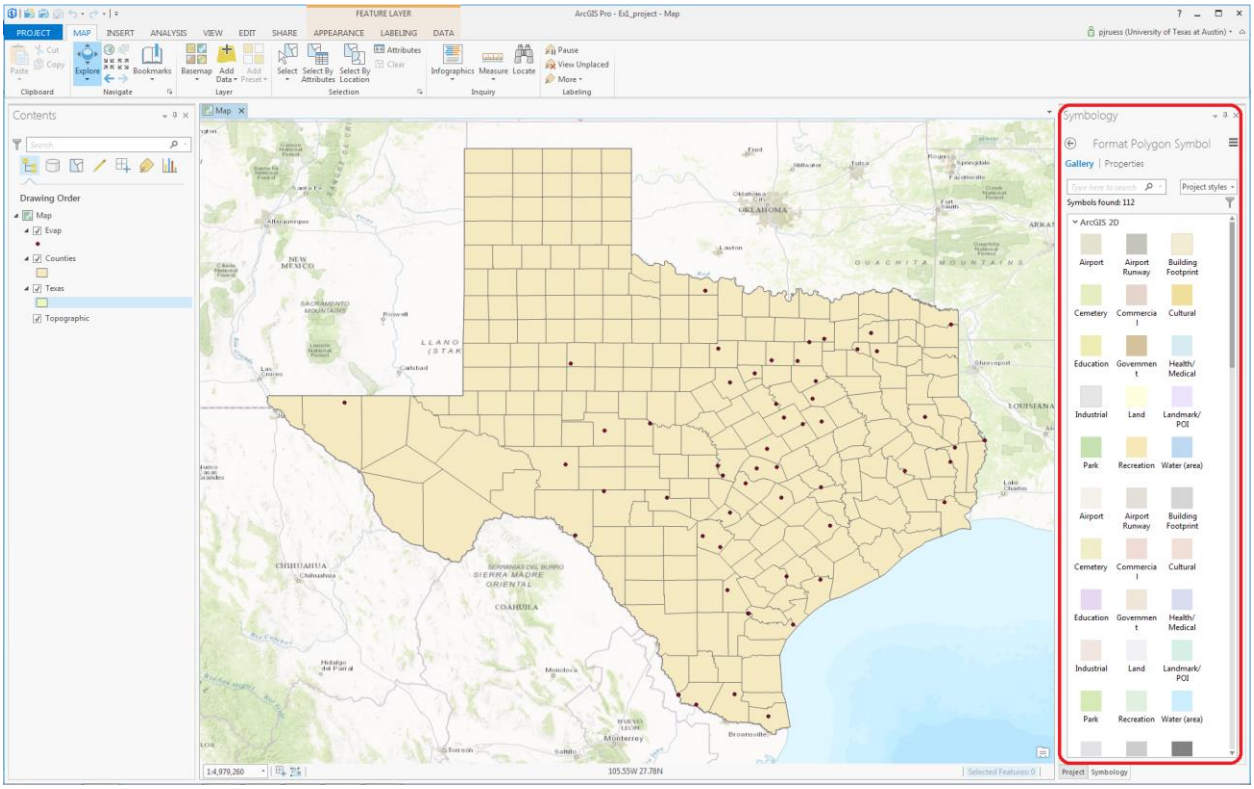


Note that clicking anywhere on the blue band in the above image will work, though this will require selecting the **Symbology** tab on the bottom right portion of the screen.

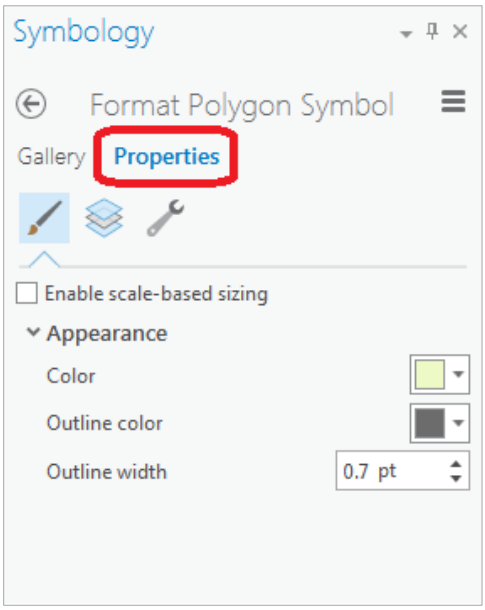




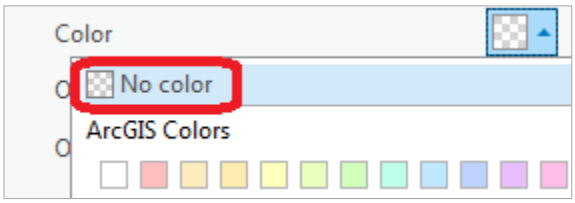
Click on the colored square under “Current Symbol” to enable the **Format Polygon Symbol** options.



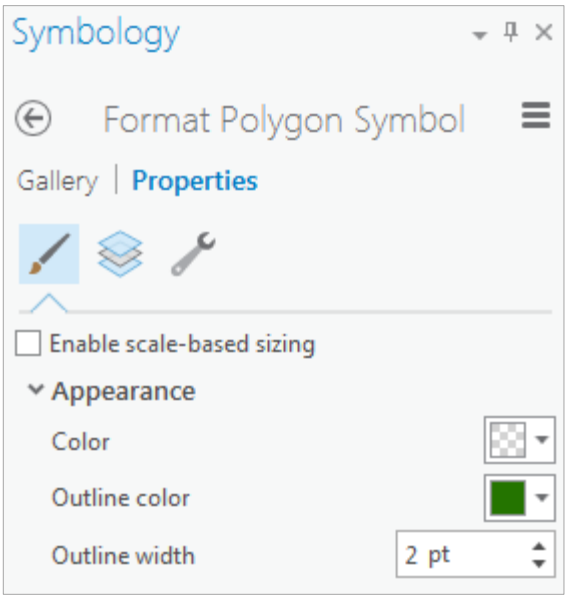
Select **Properties**.



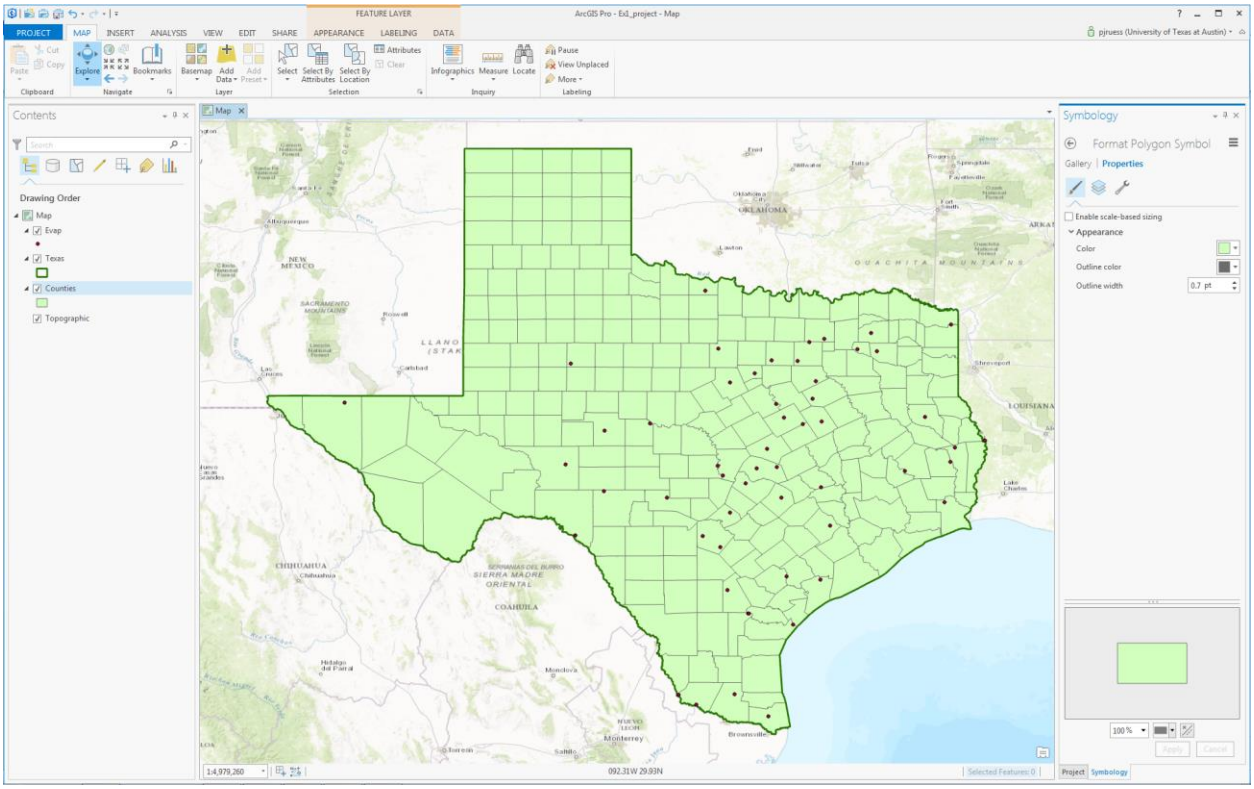
Now make your selections for the **Color**, **Outline Color**, and **Outline Width**, and click **Apply** at the bottom of the screen when finished. You can show the outline of the State of Texas more distinctly by using the **No Color**



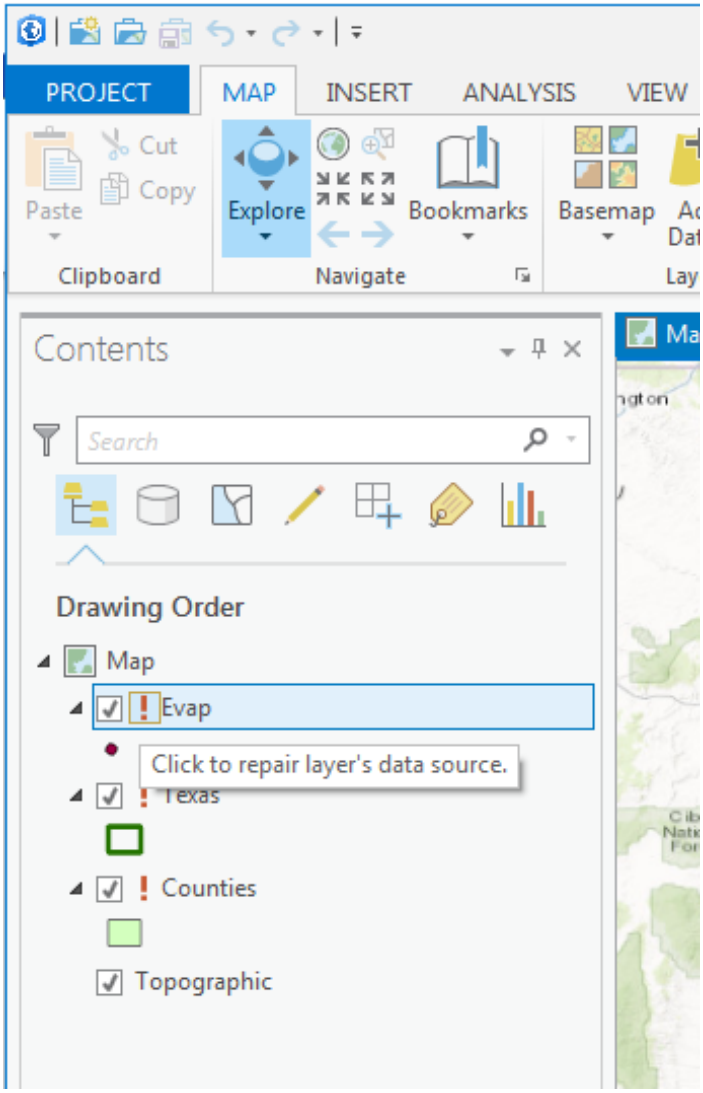
symbology for the Fill Color and then changing the Outline Color to Green and the **Outline Width** to 2.



Drag the **Texas** layer above the **Counties** layer, and you'll see that the Counties are not obscured as they were before, and the State of Texas is highlighted with a nice Green outline! We are green in Texas! If you have another color for your Counties, then click on the Counties symbol in the Legend and in the **Symbol Selector** window that appears select a nice green color and hit Ok to recolor your counties.



Helpful Tips: *If you* move your project folder and ***open your ArcGIS Pro*** *Ex1_project.aprx* ***file later from another location in your file system, you may see a red exclamation points beside your feature classes. If this happens,*** click on the red exclamation point and ***relocate the file location where the corresponding data are now stored, and your map will display correctly again.***

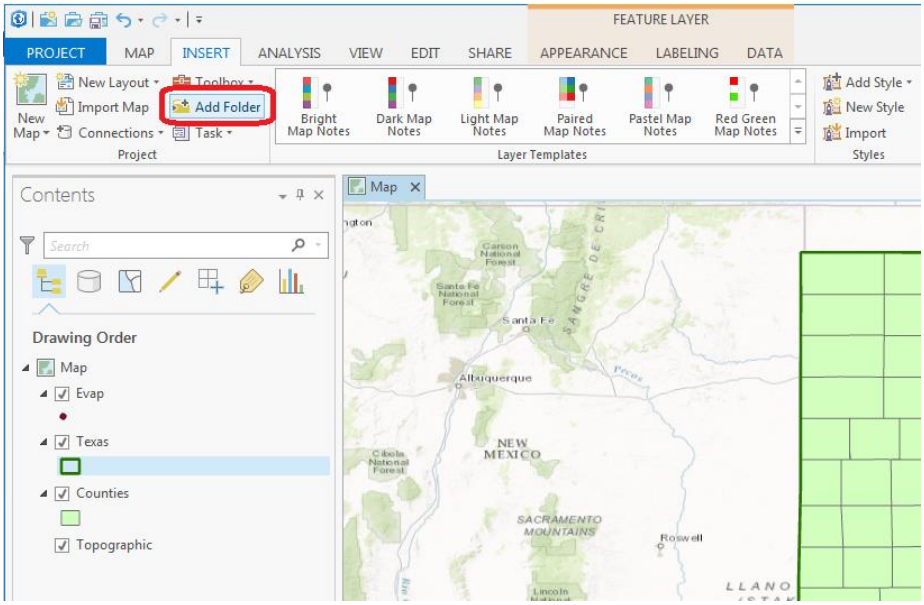


Note that these repairs will need to be made manually for all shapefiles within the .aprx file.

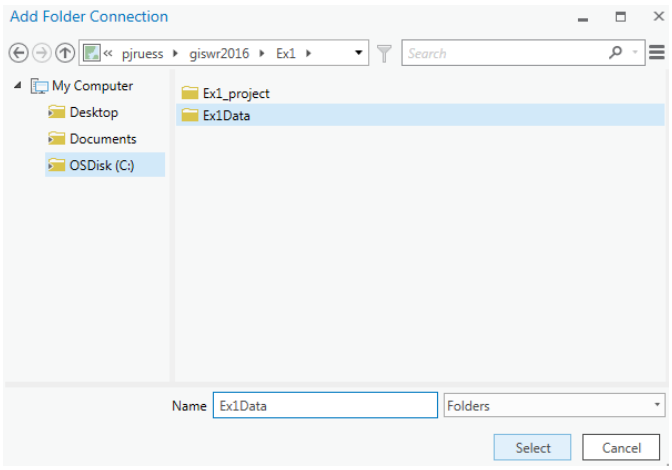
2. Using the Project tab

Return to the **Project** view by clicking on the **Project** tab on the lower right-hand side of the window.

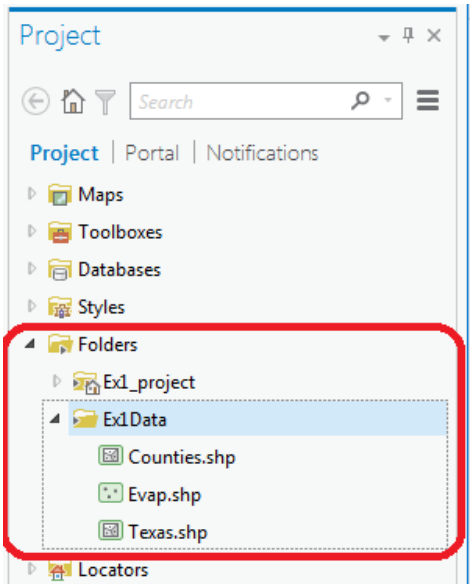
Add your data to the project folder using the **Add Folder** button under the *Insert* tab.



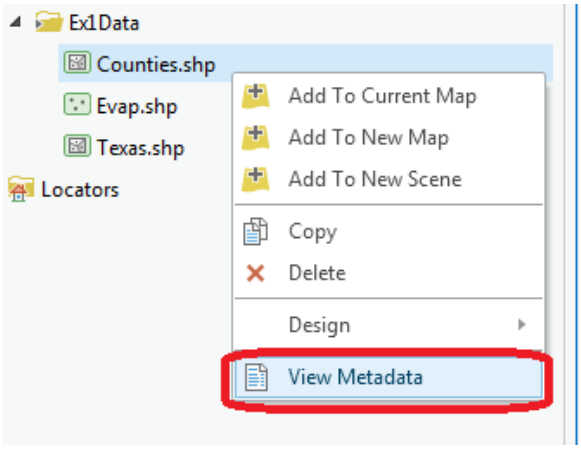
Navigate to the Ex1Data folder and add the folder.



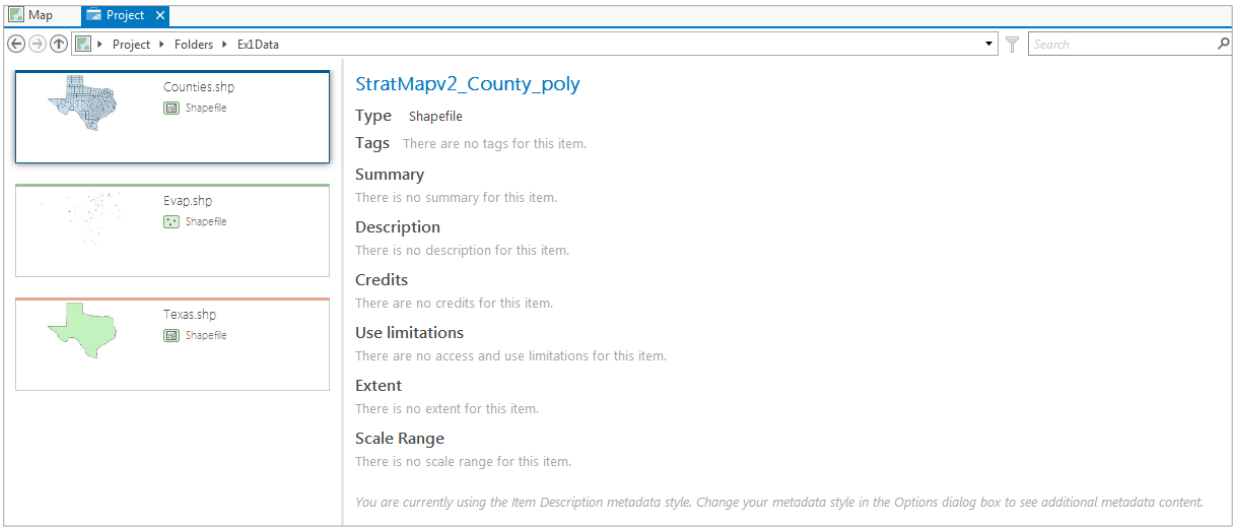
Click on the **Folders** button and navigate to where your data are stored.



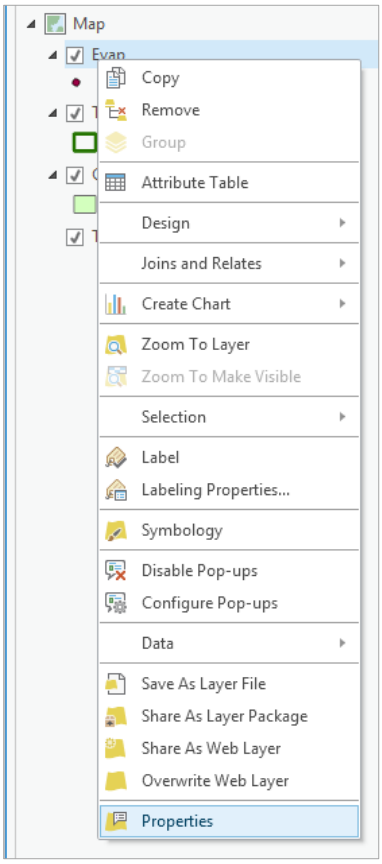
If you right click on a data layer, you can **View Metadata** for an item description.



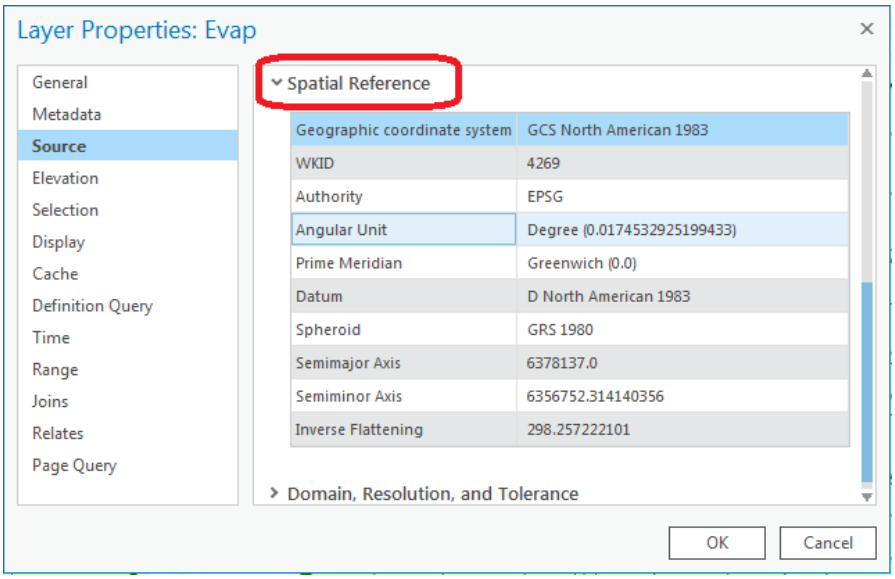
A geographic preview of the data layer is shown for each dataset on the left-hand side of the screen, with additional data listed on the right-hand side. Note that for these dataset there are no Item Description metadata.



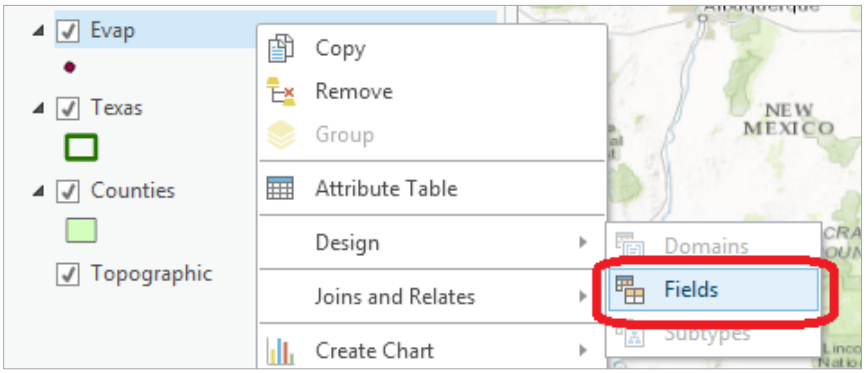
Select the **Map** tab instead of the **Project** tab and you'll get your map back again. Now, if you right click on a feature class and select **Properties**.



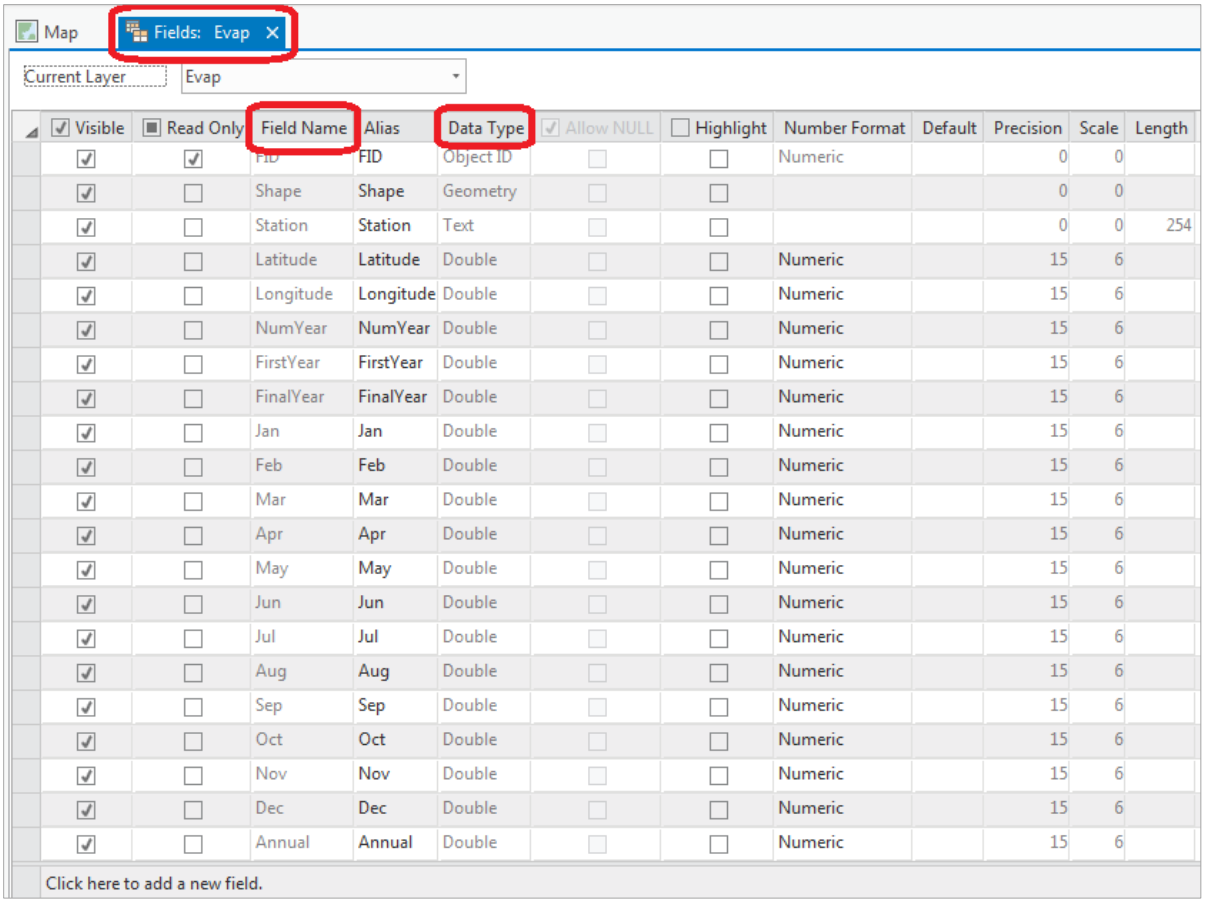
Then navigate to **Source** and **Spatial Reference** to view the parameters of the coordinate system of the data selected, in this case **NAD83**, or the North American Datum of 1983. This provides a rather complicated set of parameters that we'll learn more about later.



Close **Properties**, right click on a feature class, and select **Design/Fields** to open the Fields tab.



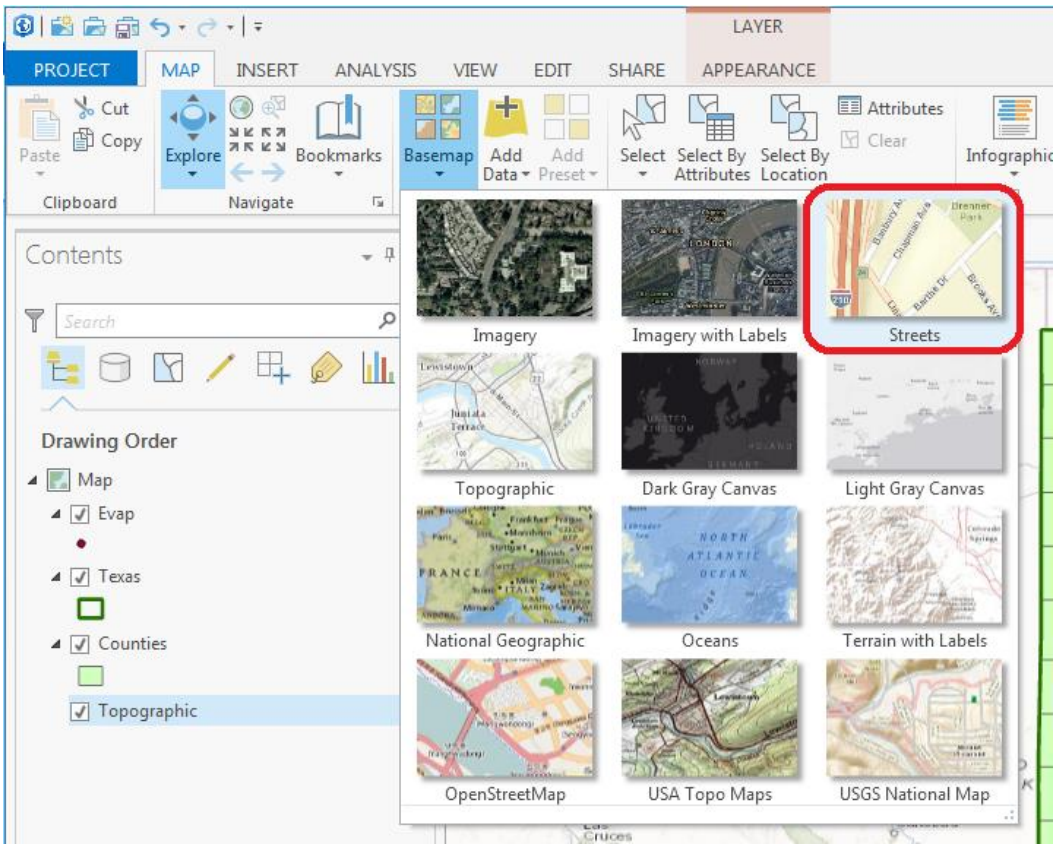
Here you'll see a formal definition of each attribute field with its **Field Name** and **Data Type**. In this case, **ObjectID** means a special data type that indexes each feature as an object in the GIS, **Geometry** means that the Shape field has geographical coordinates stored in it, and **Float** and **Double** mean decimal numbers in single or double precision, respectively. There are some other data types such as Short and Long integers, Text and Date types that we'll encounter later in the course. The attributes **Jan** through **Dec** refer to the pan evaporation in inches during that month, and **Annual** is the total annual evaporation for the year in inches. These values are averages compiled over a number of years (**NumYear**) of data between **FirstYear** and **FinalYear.** The data were compiled by the Texas Water Development Board.



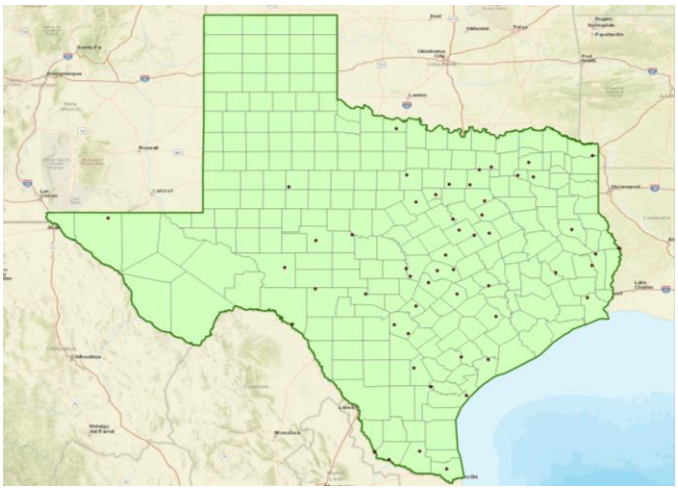
Click on the other two data layers**, Evap** and **Texas,** to preview them also.

3. Using Base Maps from ArcGIS Online

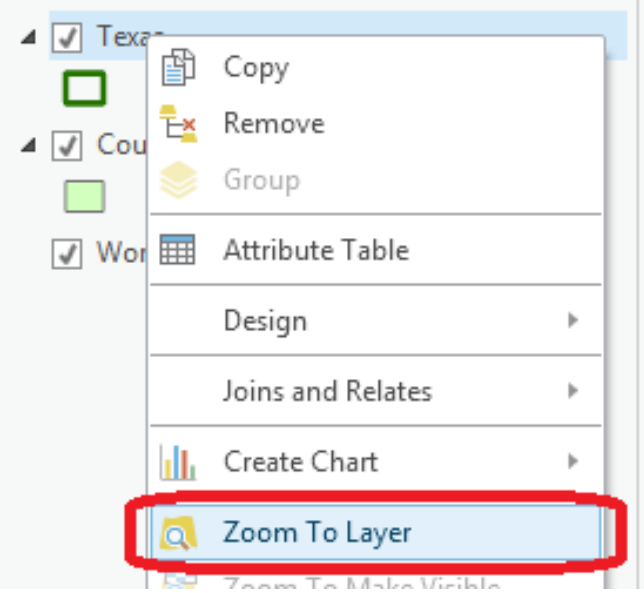
You may have noticed the topographic map that automatically loaded on start-up. This topographic map is an example of an ArcGIS Online basemap, which supplements the local GIS data we have been adding up to this point.



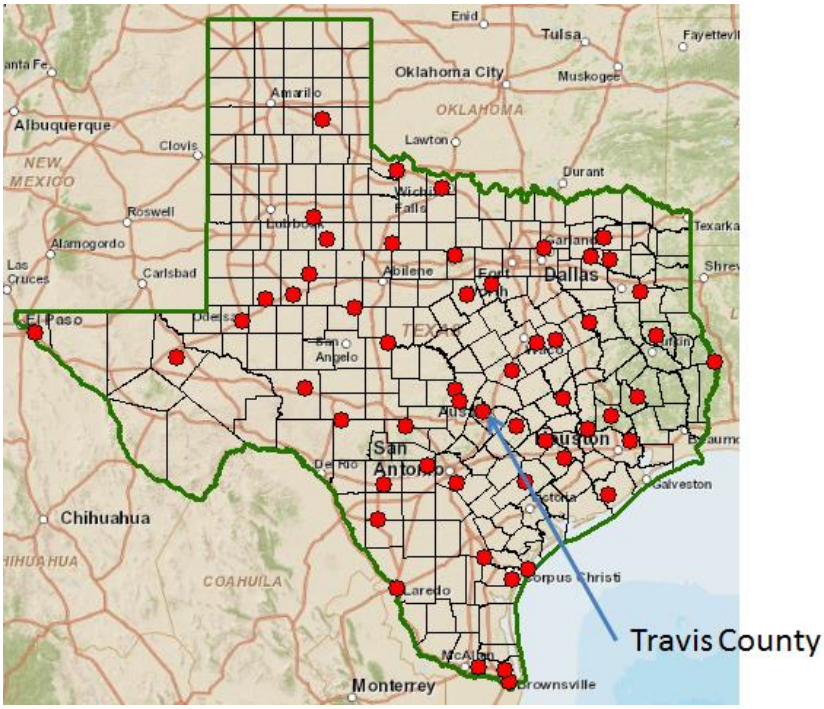
Use **Add Basemap** in the *Map* tab to add the **Streets** basemap, and you should see a background map change from the default topography basemap to your Texas display like that shown below. Pretty cool!



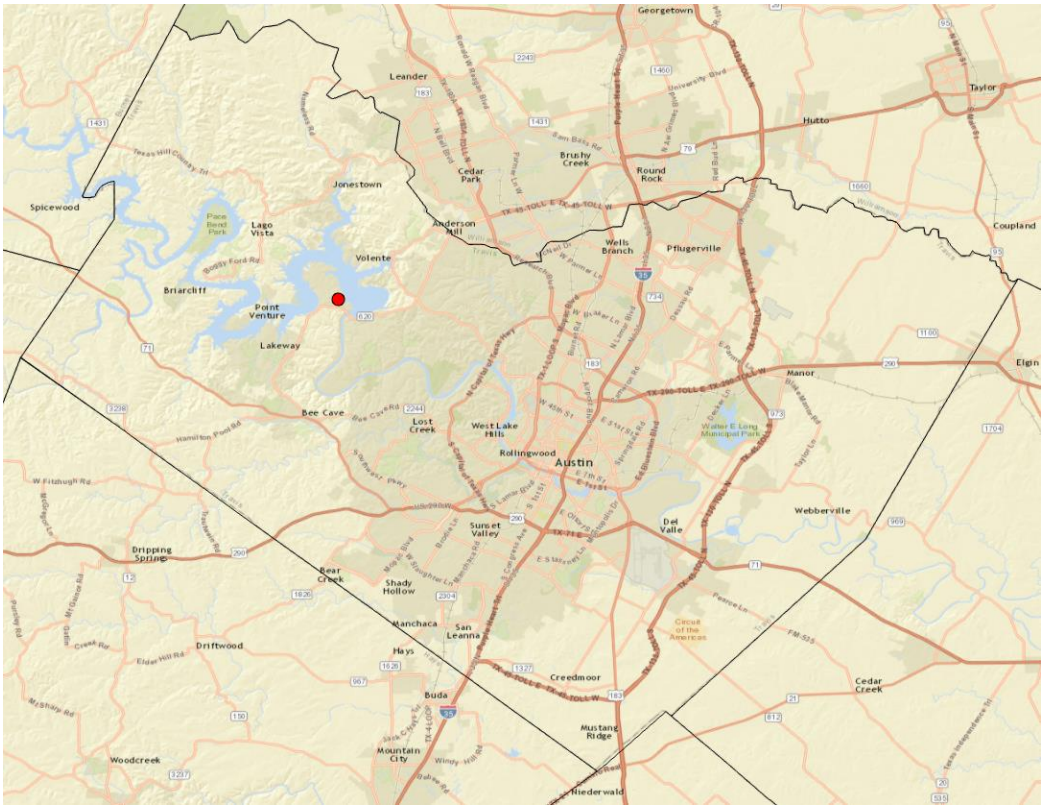
To quickly get the map to center on Texas, right click on the Texas layer and select **Zoom to Layer**



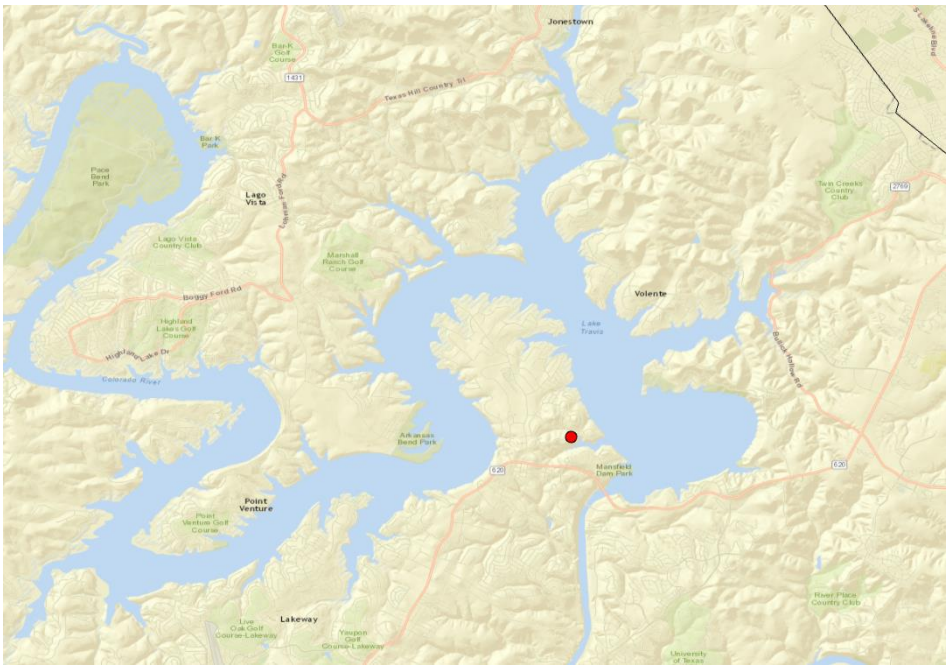
Click on the **Counties** theme and use the Symbol Selector to change the Fill Color to "No Color" so we can see through it to the background map, change the border color to black, and change the border thickness to 1. Click on the symbol for the Evap points and use the Symbol Selector to change the size of the points to 10 and the color to Red. Let's examine Travis County.



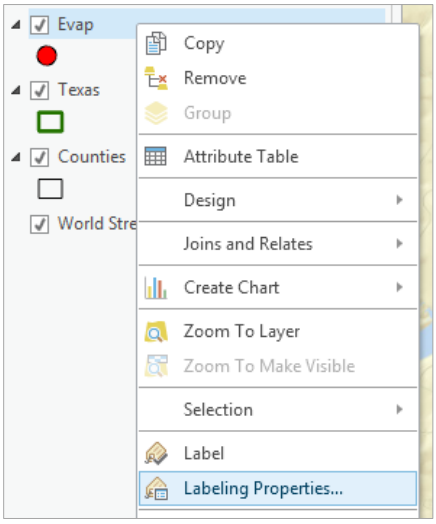
Zoom in to Travis County using the *scroll wheel* or *right-click and pan* (up zooms in, down zooms out).



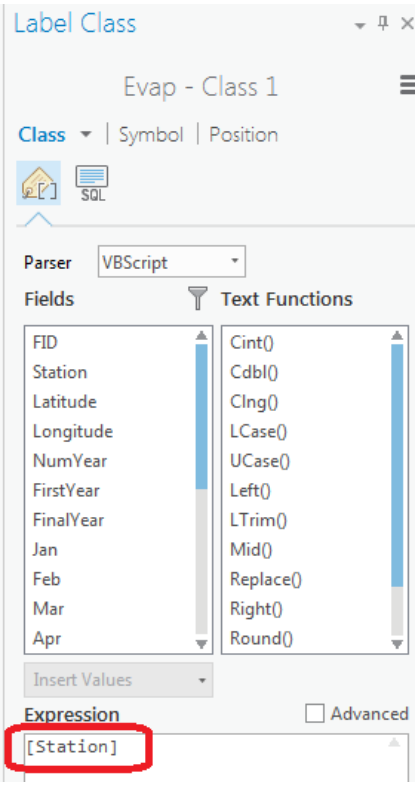
Zoom in to Travis County by Austin in the center of Texas, and let's examine the evaporation site by Lake Travis to the Northwest of the city. Notice how more detailed information appears as you zoom in.



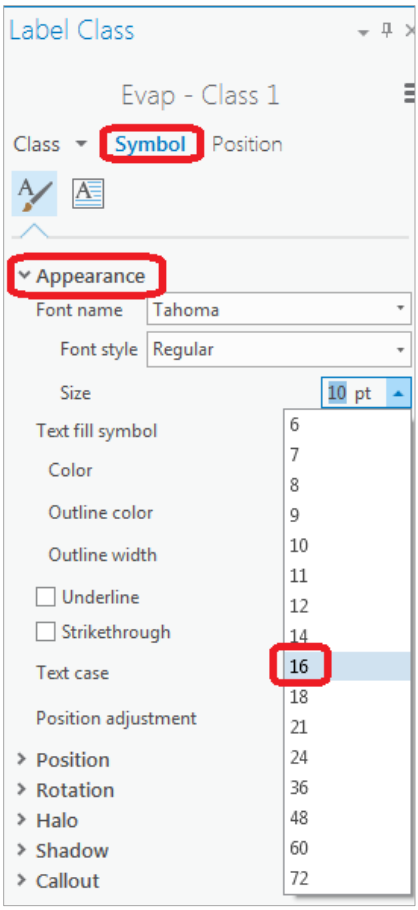
Let's label the sites with their names. To create a label, right click on Evap and select **Labeling Properties** from the menu to open the **Label Class** options on the right side of the screen.



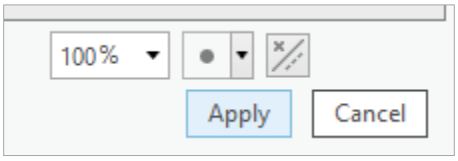
Verify that **Station** is selected as the **Label Field**.



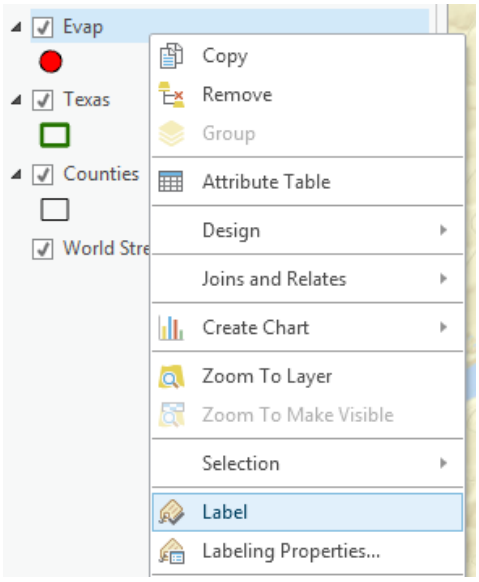
At the top of the **Label Class**, select **Symbol** and **Appearance**, then select **16** point as the type size. Hit Apply at the bottom of the screen to accept changes.



Hit **Apply** to confirm these selections



Now, to display the label, right click on the **Evap** theme and select **Label** from the menu.



Now we've got a nice map that shows the location of our observation site labeled with its name.

If you zoom in a bit closer, you can see just where the site is located near Lake Travis. You can even see the access roads you'd use to go to this site.

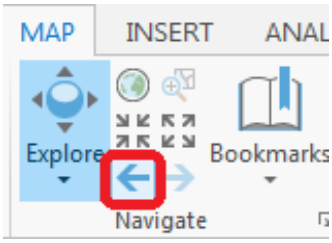
Now, let's look at some imagery for this location. Proceeding as you did before to get the Street map, use the **BaseMap** button to add data for **Imagery**.

And now you'll see the same information displayed against a background map of orthoimagery, and let's zoom in a bit to see more detail. For the **Evap** theme, I have used the **Properties/Label** to change the color of my site labels from black to blue to make them easier to see against the image background. This is really cool stuff! You can really get a sense of context about where this observation site is located.

Use **File/Save** to save this map display as **Ex1_project.aprx** so that you can get it back later.

4. Accessing and Querying Attribute Data

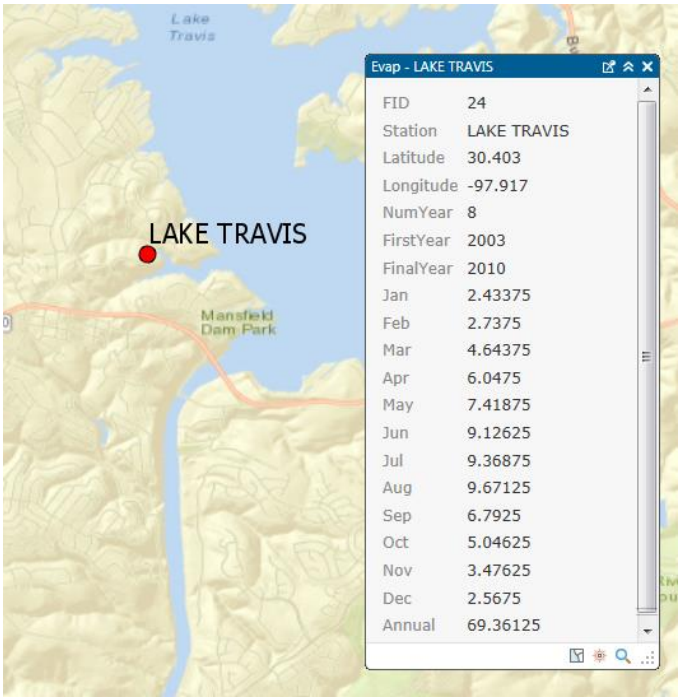
Let's go back to the view we had earlier of Travis County. Use the Go Back to Previous Extent arrow



to step back through the views we have just been working on, and switch back to the **Streets** basemap again. Change the Label color for the **Evap** sites back to Black.

Numerical and text information stored in the fields of the shapefile tables are called **attributes**. To access attribute data of the feature at a specific location, simply click on the feature in the map you are interested in. In this case, click on the Lake Travis evaporation site symbology (the red point).

In the window that pops up you'll see the attributes of that particular feature. In this instance, what you see is that the data for Lake Travis cover the range from 2003 to 2010, the latitude and longitude are 30.403 and -97.917, and the values from Jan through Dec are the mean monthly evaporation recorded at this location, in inches, whose annual total is an Annual of 69.36 inches.

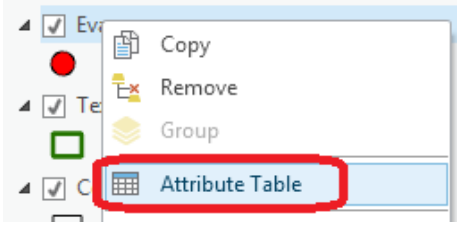


These are pan evaporation data recorded using an instrument like that shown below. The evaporation data were obtained from the Texas Water Development Board. Only data from 2001 onwards is used since the TWDB has quality control checked that information. Monthly evaporation is found by averaging the daily

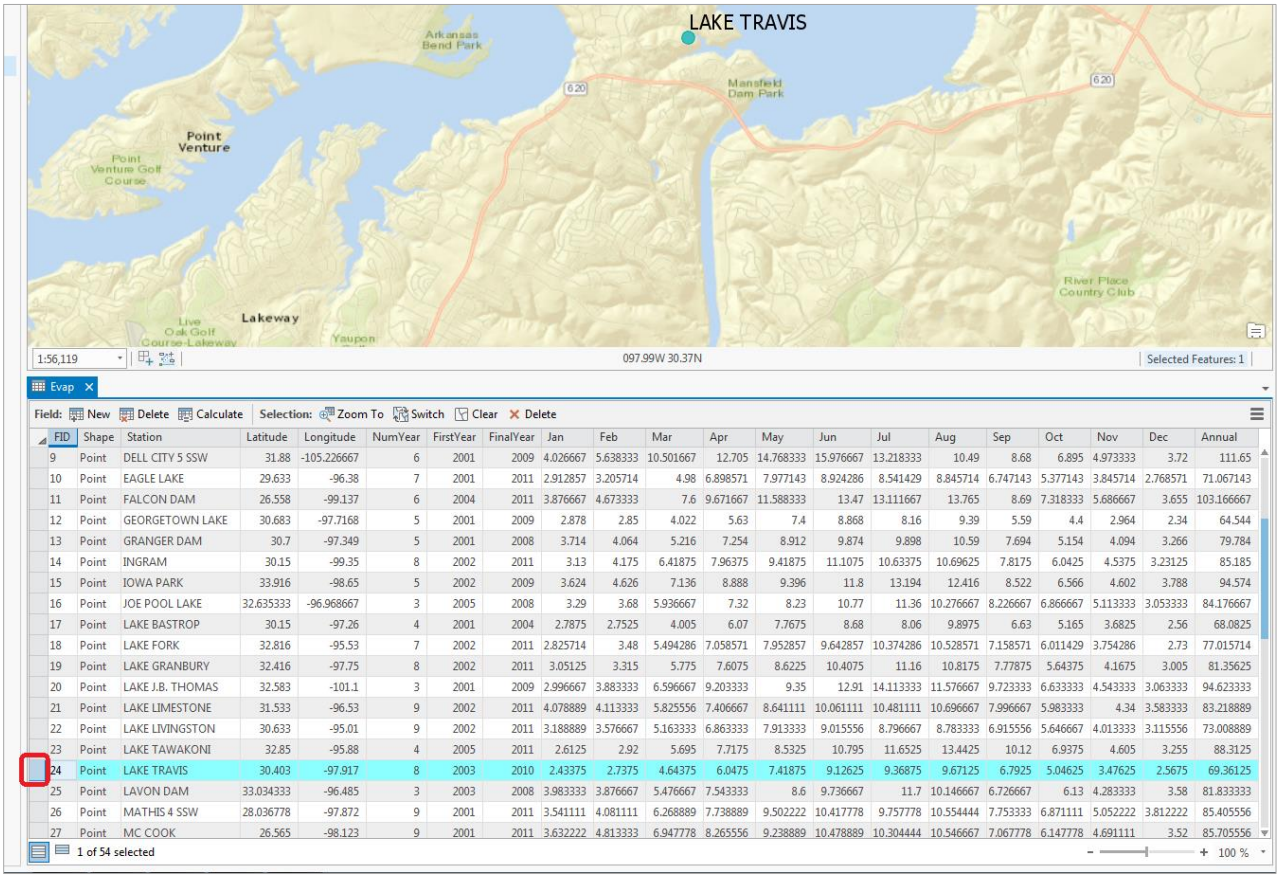
values of evaporation read from the pan, and multiplying by the number of days in the month. If a month has fewer than 20 daily values recorded, it is excluded from the dataset. Only years with valid monthly data for all 12 months are used in computing the mean monthly and mean annual pan evaporation data shown in the attribute table.

Viewing an Attribute Table

To access attribute data of an entire layer in ArcGIS Pro: right click on the **Evap** layer name in the table of contents, and select **Attribute Table**:

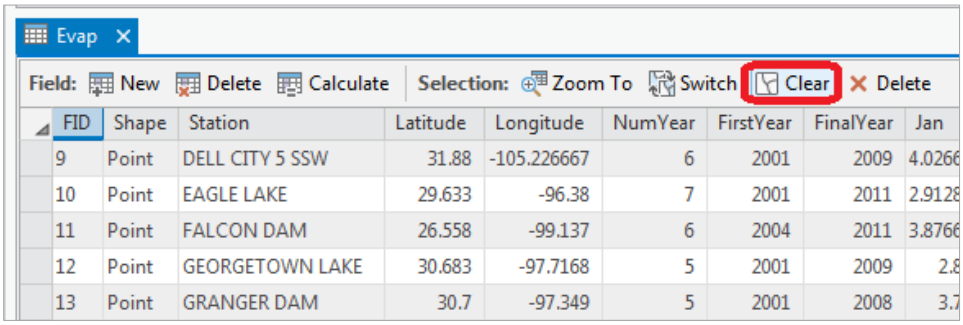


If you scroll down the resulting **Table** and click on the box to the left of **FID 24**, you'll see the record that contains the attributes of the Lake Travis station that you identified earlier. You may have noticed that once you selected the row, the corresponding point was selected in the map – this is a key idea of GIS – map features are described by records in attribute tables.



FID	Shape	Station	Latitude	Longitude	NumYear	FirstYear	FinalYear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9	Point	DELL CITY 5 SSW	31.88	-105.226667	6	2001	2009	4.026667	5.638333	10.501667	12.705	14.768333	15.976667	13.218333	10.49	8.68	6.895	4.973333	3.72	111.65
10	Point	EAGLE LAKE	29.633	-96.38	7	2001	2011	2.912857	3.205714	4.98	6.898571	7.977143	8.924286	8.541429	8.845714	6.747143	5.377143	3.845714	2.768571	71.067143
11	Point	FALCON DAM	26.558	-99.137	6	2004	2011	3.876667	4.673333	7.6	9.671667	11.588333	13.47	13.111667	13.765	8.69	7.318333	5.686667	3.655	103.166667
12	Point	GEORGETOWN LAKE	30.683	-97.7168	5	2001	2009	2.878	2.85	4.022	5.63	7.4	8.868	8.16	9.39	5.59	4.4	2.964	2.34	64.544
13	Point	GRANGER DAM	30.7	-97.349	5	2001	2008	3.714	4.064	5.216	7.254	8.912	9.874	9.898	10.59	7.694	5.154	4.094	3.266	79.784
14	Point	INGRAM	30.15	-99.35	8	2002	2011	3.13	4.175	6.41875	7.96375	9.41875	11.1075	10.63375	10.69625	7.8175	6.0425	4.5375	3.23125	85.185
15	Point	IOWA PARK	33.916	-98.65	5	2002	2009	3.624	4.626	7.136	8.888	9.396	11.8	13.194	12.416	8.522	6.566	4.602	3.788	94.574
16	Point	JOE POOL LAKE	32.635333	-96.968667	3	2005	2008	3.29	3.68	5.936667	7.32	8.23	10.77	11.36	10.276667	8.226667	6.866667	5.113333	3.053333	84.176667
17	Point	LAKE BASTROP	30.15	-97.26	4	2001	2004	2.7875	2.7525	4.005	6.07	7.7675	8.68	8.06	9.8975	6.63	5.165	3.6825	2.56	68.0825
18	Point	LAKE FORK	32.816	-95.53	7	2002	2011	2.825714	3.48	5.494286	7.058571	7.952857	9.642857	10.374286	10.528571	7.158571	6.011429	3.754286	2.73	77.015714
19	Point	LAKE GRANBURY	32.416	-97.75	8	2002	2011	3.05125	3.315	5.775	7.6075	8.6225	10.4075	11.16	10.8175	7.77875	5.64375	4.1675	3.005	81.35625
20	Point	LAKE J.B. THOMAS	32.583	-101.1	3	2001	2009	2.996667	3.883333	6.596667	9.203333	9.35	12.91	14.113333	11.576667	9.723333	6.633333	4.543333	3.063333	94.623333
21	Point	LAKE LIMESTONE	31.533	-96.53	9	2002	2011	4.078889	4.113333	5.825556	7.406667	8.641111	10.061111	10.481111	10.696667	7.996667	5.983333	4.34	3.583333	83.218889
22	Point	LAKE LIVINGSTON	30.633	-95.01	9	2002	2011	3.188889	3.576667	5.163333	6.863333	7.913333	9.015556	8.796667	8.783333	6.915556	5.646667	4.013333	3.115556	73.008889
23	Point	LAKE TAWAKONI	32.85	-95.88	4	2005	2011	2.6125	2.92	5.695	7.7175	8.5325	10.795	11.6525	13.4425	10.12	6.9375	4.605	3.255	88.3125
24	Point	LAKE TRAVIS	30.403	-97.917	8	2003	2010	2.43375	2.7375	4.64375	6.0475	7.41875	9.12625	9.36875	9.67125	6.7925	5.04625	3.47625	2.5675	69.36125
25	Point	LAVON DAM	33.034333	-96.485	3	2003	2008	3.983333	3.876667	5.476667	7.543333	8.6	9.736667	11.7	10.146667	6.726667	6.13	4.283333	3.58	81.833333
26	Point	MATHIS 4 SSW	28.036778	-97.872	9	2001	2011	3.541111	4.081111	6.268889	7.738889	9.502222	10.417778	9.757778	10.554444	7.753333	6.871111	5.052222	3.812222	85.405556
27	Point	MC COOK	26.565	-98.123	9	2001	2011	3.632222	4.813333	6.947778	8.265556	9.238889	10.478889	10.304444	10.546667	7.067778	6.147778	4.691111	3.52	85.705556

To Clear a Selected feature and select a new one, click on **Clear** at the top of the **Attribute Table**.

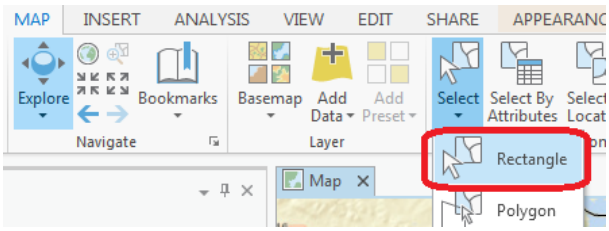


FID	Shape	Station	Latitude	Longitude	NumYear	FirstYear	FinalYear	Jan
9	Point	DELL CITY 5 SSW	31.88	-105.226667	6	2001	2009	4.0266
10	Point	EAGLE LAKE	29.633	-96.38	7	2001	2011	2.9128
11	Point	FALCON DAM	26.558	-99.137	6	2004	2011	3.8766
12	Point	GEORGETOWN LAKE	30.683	-97.7168	5	2001	2009	2.8
13	Point	GRANGER DAM	30.7	-97.349	5	2001	2008	3.7

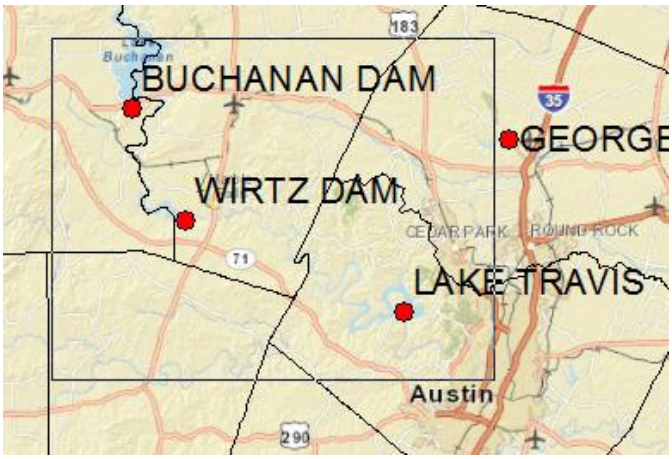
5. Selecting features from a feature class

Selecting features from a feature class involves choosing a subset of all the features in the class for a specific purpose. Feature selection can be made from a map by identifying the geometric shape or from an attribute table by identifying the record. Regardless of how you select an object, both the shape in the map

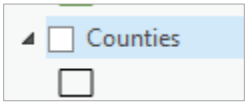
and the record in the attribute table will be selected. Click on the **Select/Select Features by Rectangle** tool in the *Map* tab.



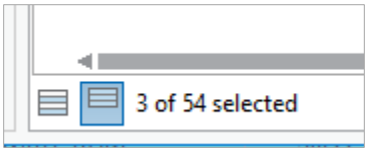
Zoom back a bit and drag a box over the three evaporation sites in the Highland Lakes reservoir system.

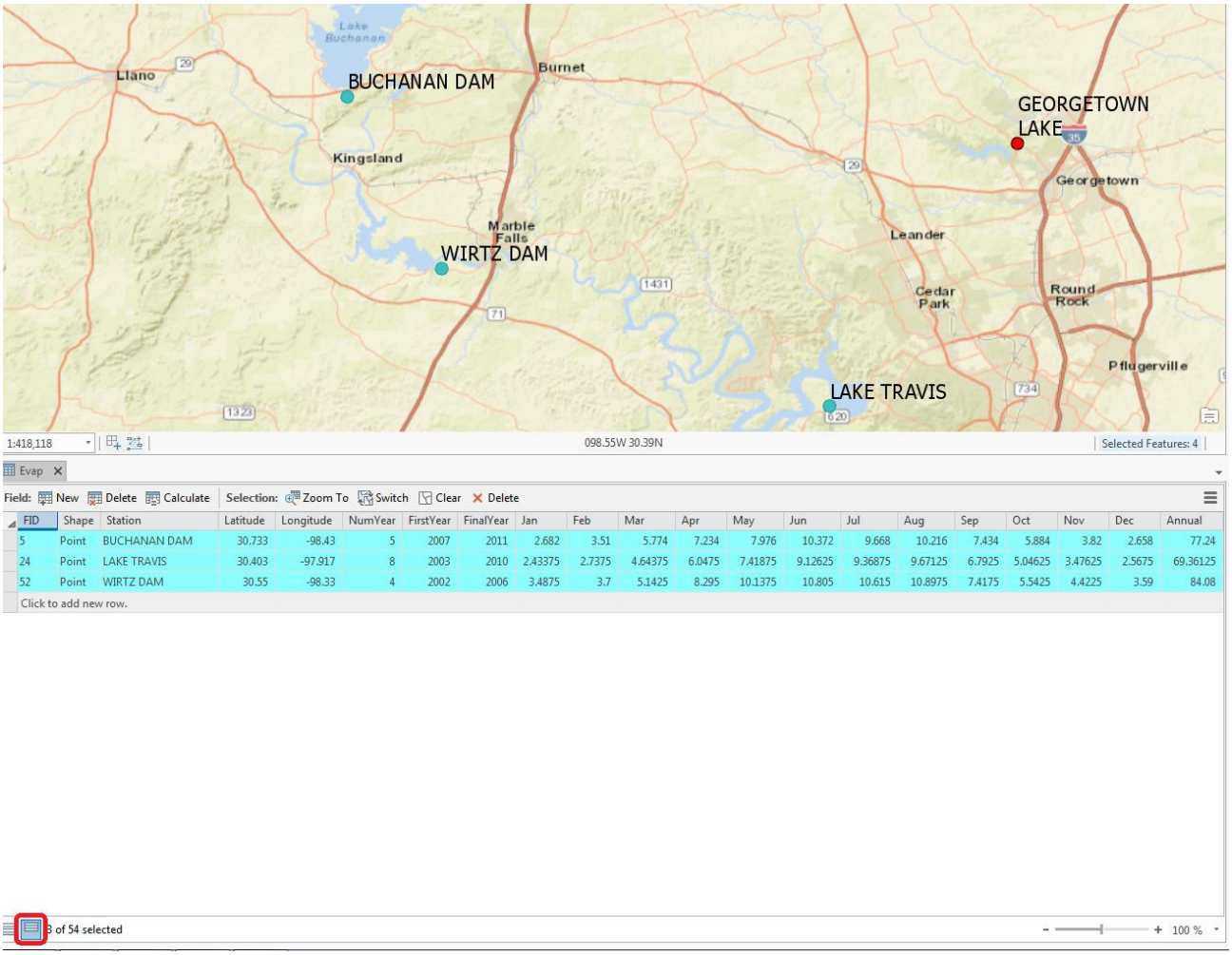


you'll see both records highlighted on the map and in the attribute table. I've turned off the Counties layer (click off the check box in the map Legend)

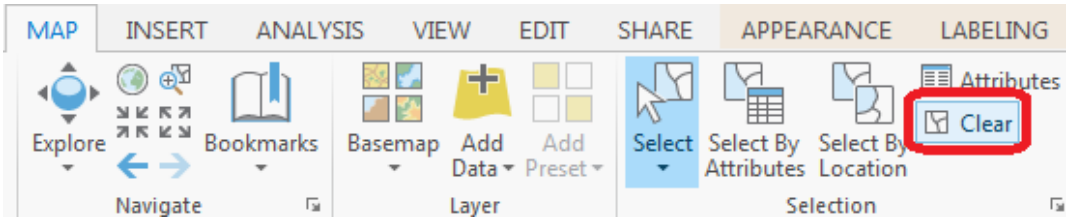


and used **Show selected records** at the bottom of the Attribute Table to just show the three highlighted stations.

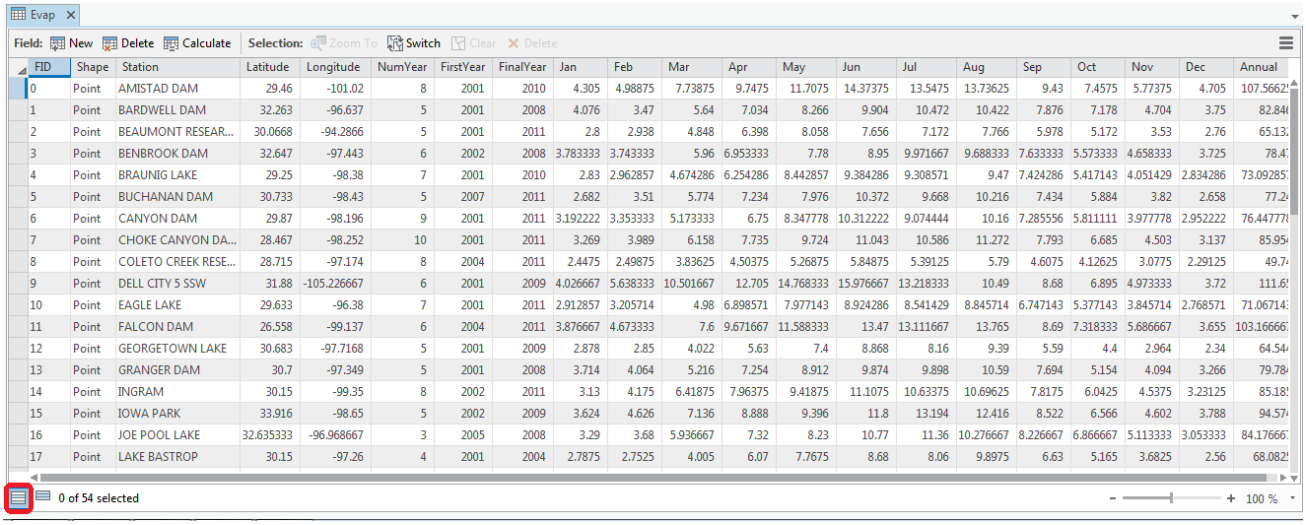




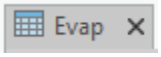
To clear your selection, choose **Clear**.



Clicking on Show all records, then displays all the records in the attribute table again.

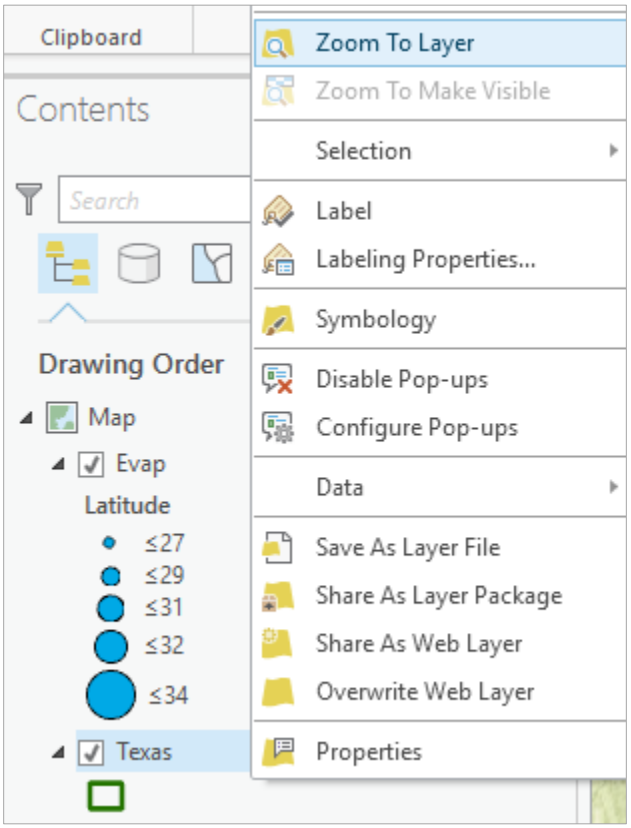


FID	Shape	Station	Latitude	Longitude	NumYear	FirstYear	FinalYear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0	Point	AMISTAD DAM	29.46	-101.02	8	2001	2010	4.305	4.98875	7.73875	9.7475	11.7075	14.37375	13.5475	13.73625	9.43	7.4575	5.77375	4.705	107.5662
1	Point	BARDWELL DAM	32.263	-96.637	5	2001	2008	4.076	3.47	5.64	7.034	8.266	9.904	10.472	10.422	7.876	7.178	4.704	3.75	82.84
2	Point	BEAUMONT RESEAR...	30.0668	-94.2866	5	2001	2011	2.8	2.938	4.848	6.398	8.058	7.656	7.172	7.766	5.978	5.172	3.53	2.76	65.13
3	Point	BENBROOK DAM	32.647	-97.443	6	2002	2008	3.783333	3.743333	5.96	6.953333	7.78	8.95	9.971667	9.688333	7.633333	5.573333	4.658333	3.725	78.4
4	Point	BRAUNIG LAKE	29.25	-98.38	7	2001	2010	2.83	2.962857	4.674286	6.254286	8.442857	9.384286	9.308571	9.47	7.424286	5.417143	4.051429	2.834286	73.09285
5	Point	BUCHANAN DAM	30.733	-98.43	5	2007	2011	2.682	3.51	5.774	7.234	7.976	10.372	9.668	10.216	7.434	5.884	3.82	2.658	77.2
6	Point	CANYON DAM	29.87	-98.196	9	2001	2011	3.192222	3.353333	5.173333	6.75	8.347778	10.312222	9.074444	10.16	7.285556	5.811111	3.977778	2.952222	76.44777
7	Point	CHOKE CANYON DA...	28.467	-98.252	10	2001	2011	3.269	3.989	6.158	7.735	9.724	11.043	10.586	11.272	7.793	6.685	4.503	3.137	85.95
8	Point	COLETO CREEK RESE...	28.715	-97.174	8	2004	2011	2.4475	2.49875	3.83625	4.50375	5.26875	5.84875	5.39125	5.79	4.6075	4.12625	3.0775	2.29125	49.7
9	Point	DELL CITY 5 SSW	31.88	-105.226667	6	2001	2009	4.026667	5.638333	10.501667	12.705	14.768333	15.976667	13.218333	10.49	8.68	6.895	4.973333	3.72	111.6
10	Point	EAGLE LAKE	29.633	-96.38	7	2001	2011	2.912857	3.205714	4.98	6.898571	7.977143	8.924286	8.541429	8.845714	6.747143	5.377143	3.845714	2.768571	71.06714
11	Point	FALCON DAM	26.558	-99.137	6	2004	2011	3.876667	4.673333	7.6	9.671667	11.588333	13.47	13.111667	13.765	8.69	7.318333	5.686667	3.655	103.16666
12	Point	GEORGETOWN LAKE	30.683	-97.7168	5	2001	2009	2.878	2.85	4.022	5.63	7.4	8.868	8.16	9.39	5.59	4.4	2.964	2.34	64.54
13	Point	GRANGER DAM	30.7	-97.349	5	2001	2008	3.714	4.064	5.216	7.254	8.912	9.874	9.898	10.59	7.694	5.154	4.094	3.266	79.78
14	Point	INGRAM	30.15	-99.35	8	2002	2011	3.13	4.175	6.41875	7.96375	9.41875	11.1075	10.63375	10.69625	7.8175	6.0425	4.5375	3.23125	85.18
15	Point	IOWA PARK	33.916	-98.65	5	2002	2009	3.624	4.626	7.136	8.888	9.396	11.8	13.194	12.416	8.522	6.566	4.602	3.788	94.57
16	Point	JOE POOL LAKE	32.635333	-96.968667	3	2005	2008	3.29	3.68	5.936667	7.32	8.23	10.77	11.36	10.276667	8.226667	6.866667	5.113333	3.053333	84.17666
17	Point	LAKE BASTROP	30.15	-97.26	4	2001	2004	2.7875	2.7525	4.005	6.07	7.7675	8.68	8.06	9.8975	6.63	5.165	3.6825	2.56	68.082

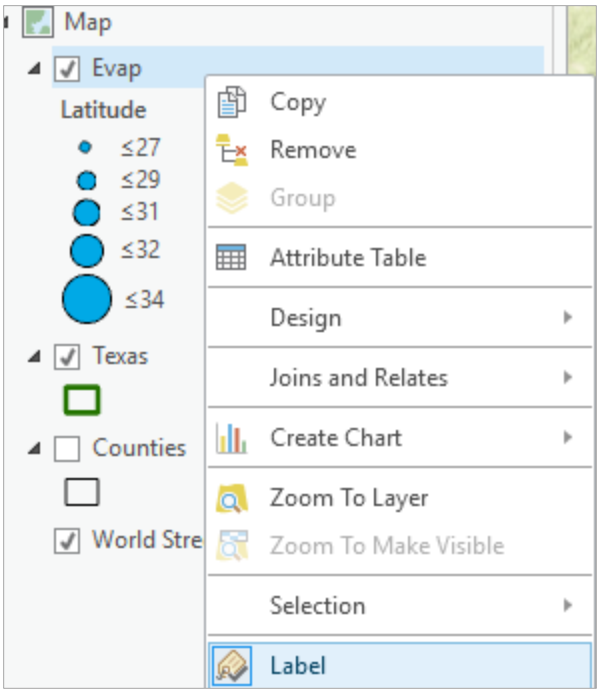


6. Mapping Annual Evaporation

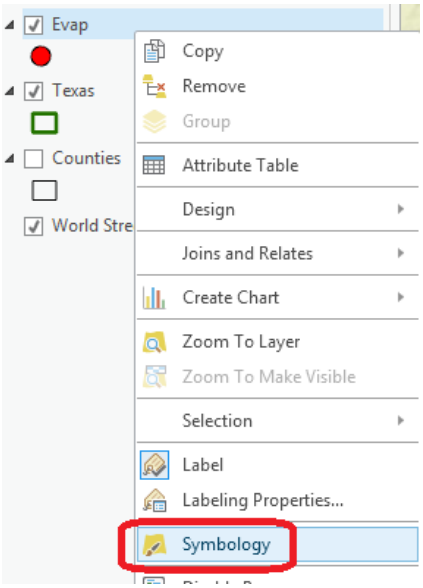
Let's suppose we want to map the values of annual evaporation recorded at the stations, rather than just symbolizing them by their location. Let's zoom out to the state of Texas again. Right click on the **Texas** feature class and select **Zoom to Layer**



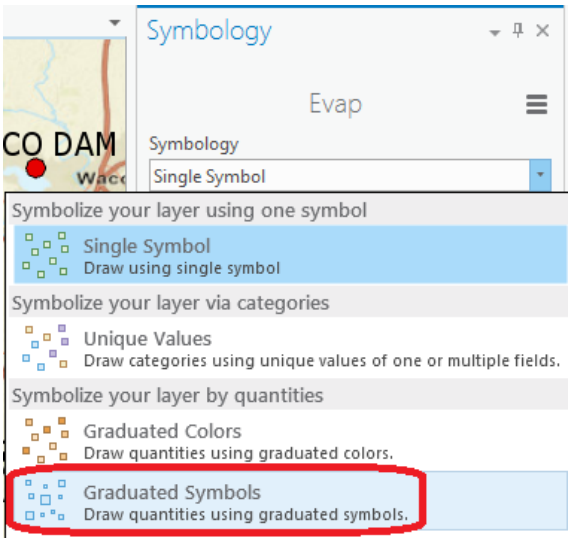
You'll see that there are a lot of labels showing up large in your new map. Get rid of these by right clicking on the Evap layer and toggling the Label entry so that the Labels are turned off.

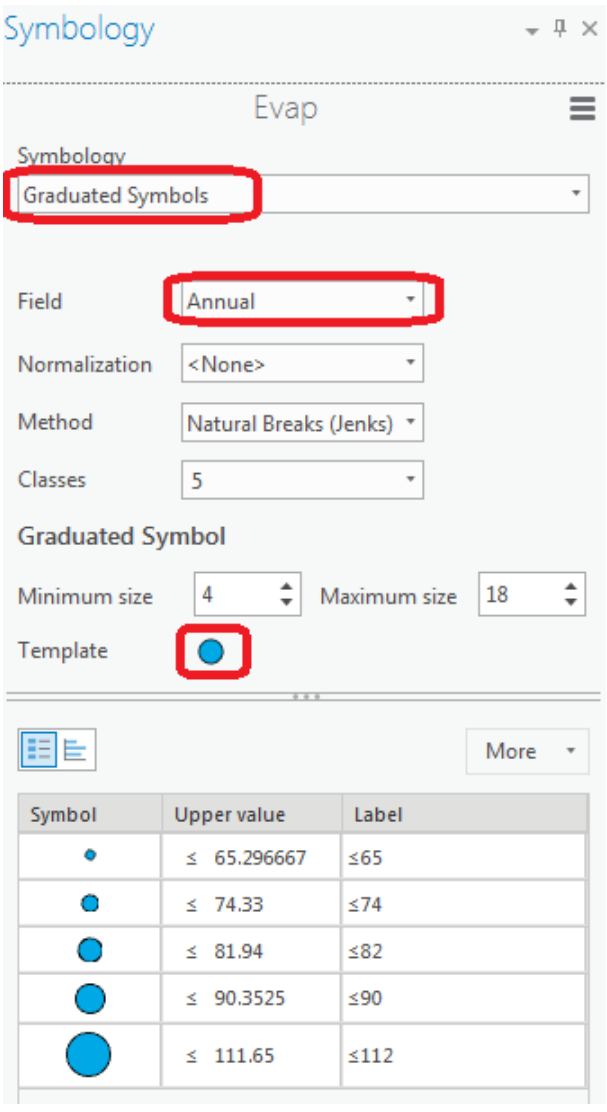


Right click on the **Evap** layer and select **Symbology**.

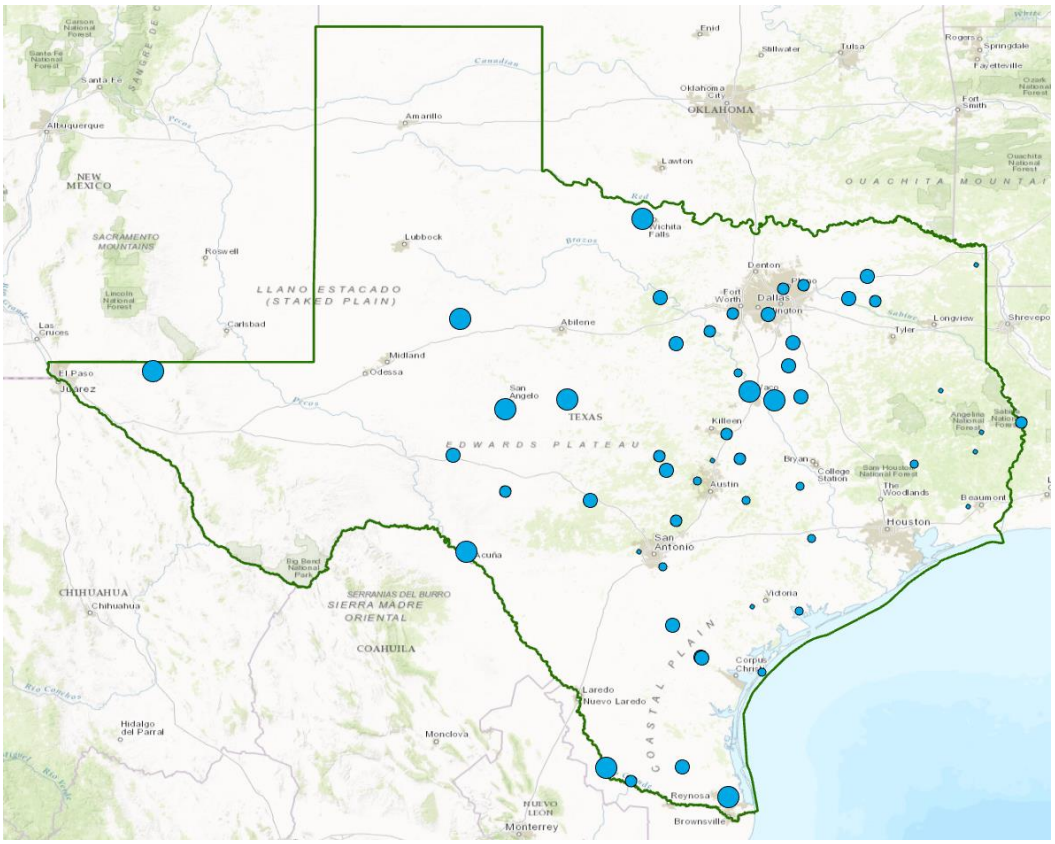


In the Symbology section on the right-hand side, click on “Single Symbol” and change to “Graduated Symbols”. Change **Value** to “Annual” and make the **Template** color blue.


Symbology
Evap
Symbology
Single Symbol
Symbolize your layer using one symbol
Single Symbol
Draw using single symbol
Symbolize your layer via categories
Unique Values
Draw categories using unique values of one or multiple fields.
Symbolize your layer by quantities
Graduated Colors
Draw quantities using graduated colors.
Graduated Symbols
Draw quantities using graduated symbols.

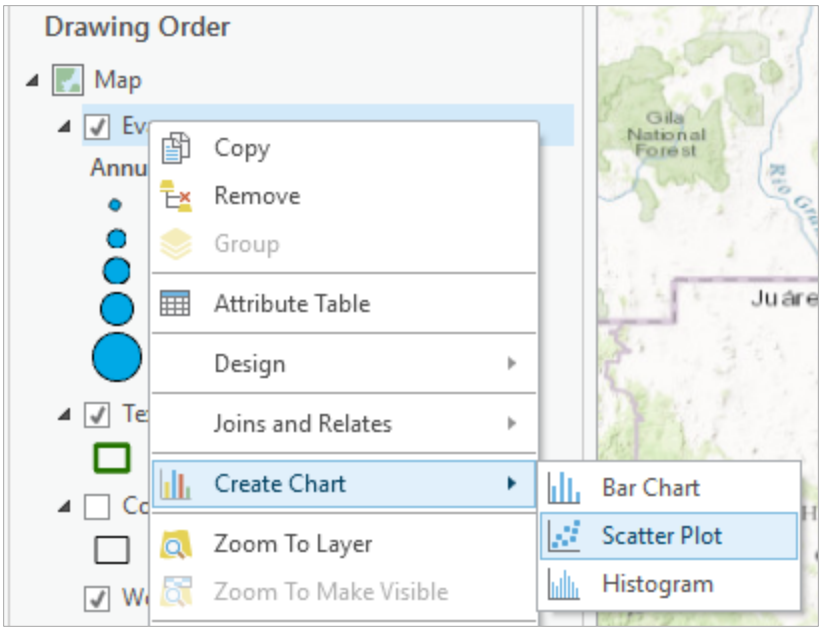

Symbology
Evap
Symbology
Graduated Symbols
Field
Annual
Normalization
<None>
Method
Natural Breaks (Jenks)
Classes
5
Graduated Symbol
Minimum size
4
Maximum size
18
Template
More
Symbol
Upper value
Label
≤ 65.296667
≤65
≤ 74.33
≤74
≤ 81.94
≤82
≤ 90.3525
≤90
≤ 111.65
≤112

I have turned off all the other layers and added the **Topographic** base map to get the image below. Very cool!

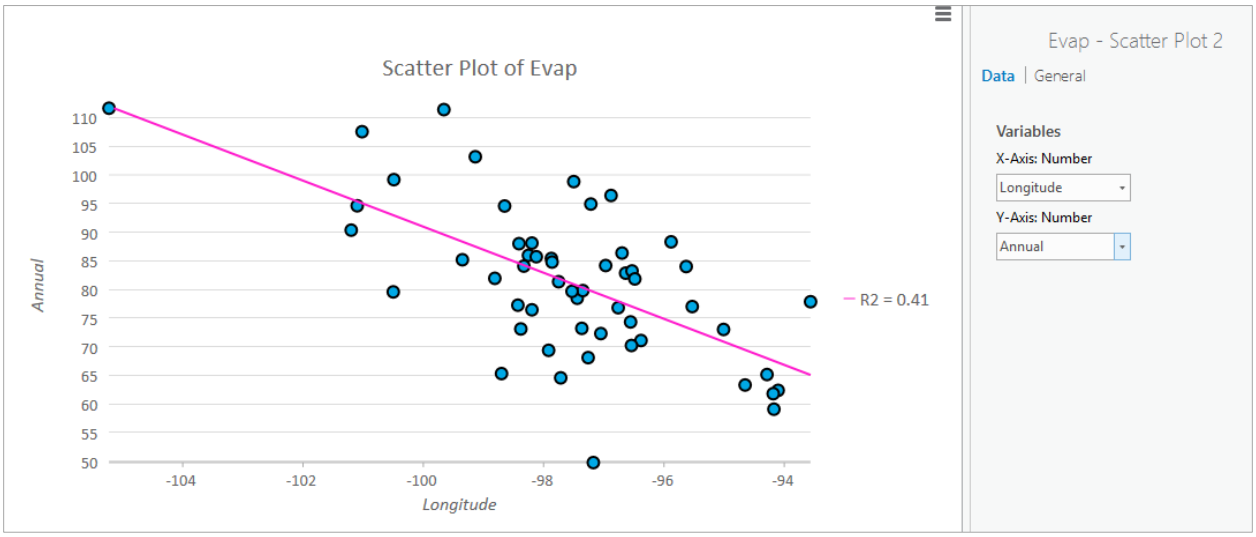


7. Making a Chart

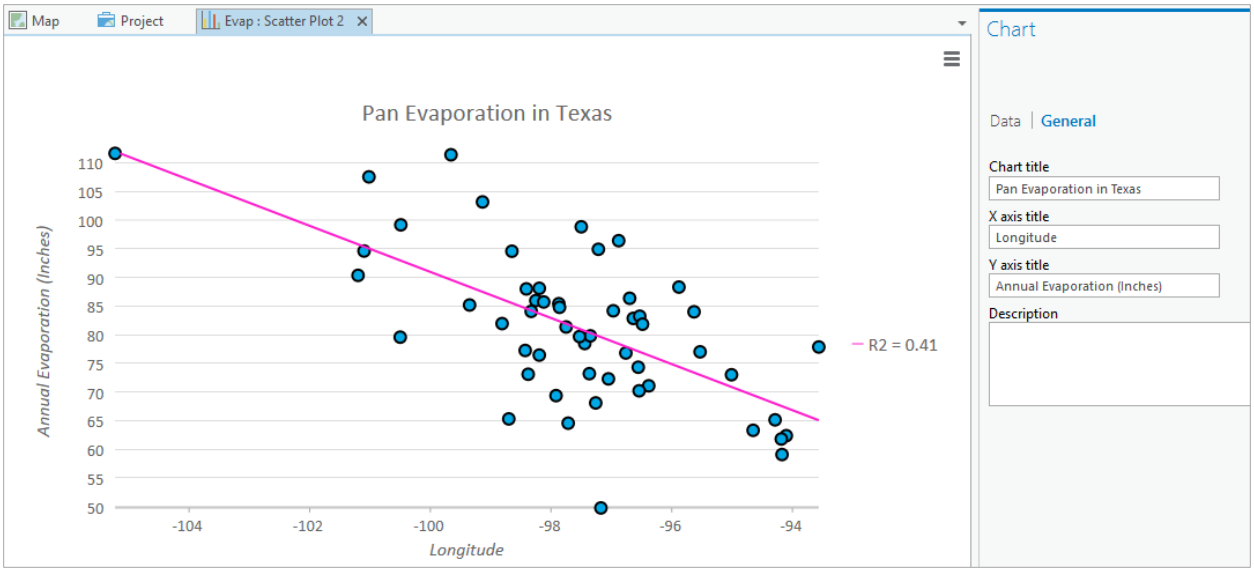
You can see from the map that there is some tendency for lower evaporation values near the coast and to the East and higher values to the West. Charts are useful because they allow you to visualize trends in data. Open the Evap layer attribute table. Right-click on **Evap**, hover over **Create Chart**, and select **Scatter Plot.**



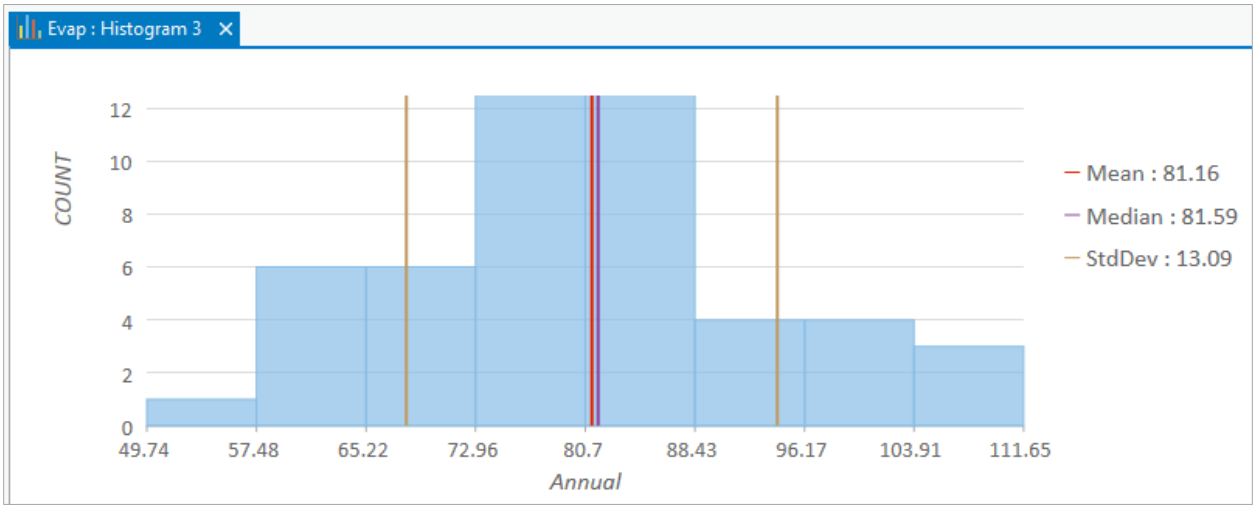
The next screen will allow you to indicate the data to be used in the graph. Here is a graph of the Annual Evaporation (**Annual**) of all the stations plotted against the **Longitude** of the station. You can see that there is a general trend of the evaporation increasing as you go from East to West in Texas. The color of the chart points is blue, the same as the map points.



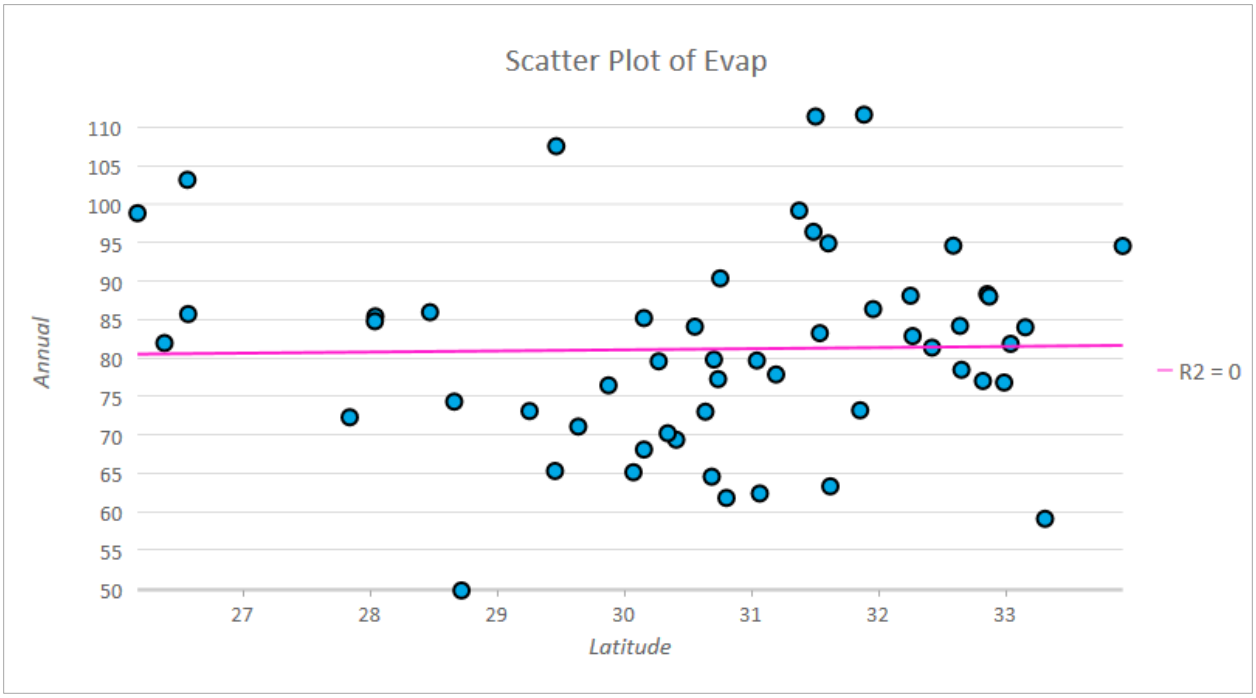
Hit **General** and edit the graph properties to make them nicer. Add a title **Pan Evaporation in Texas** and relabel the vertical axis **Annual Evaporation (Inches)**.



Try some different kinds of charts, such as Bar Charts and Histograms. Note that ArcGIS Pro automatically sorts bar charts from highest to lowest from left to right. See http://pro.arcgis.com/en/pro-app/help/analysis/geoprocessing/charts/bar-chart.htm for more details. Here is a pretty cool histogram of the pan evaporation data, with statistical properties of the data as well.



If you create the same kind of graph for Evaporation and Latitude, you can see that there isn't a tendency for evaporation to vary with latitude in Texas, as there is for variation of evaporation with longitude.

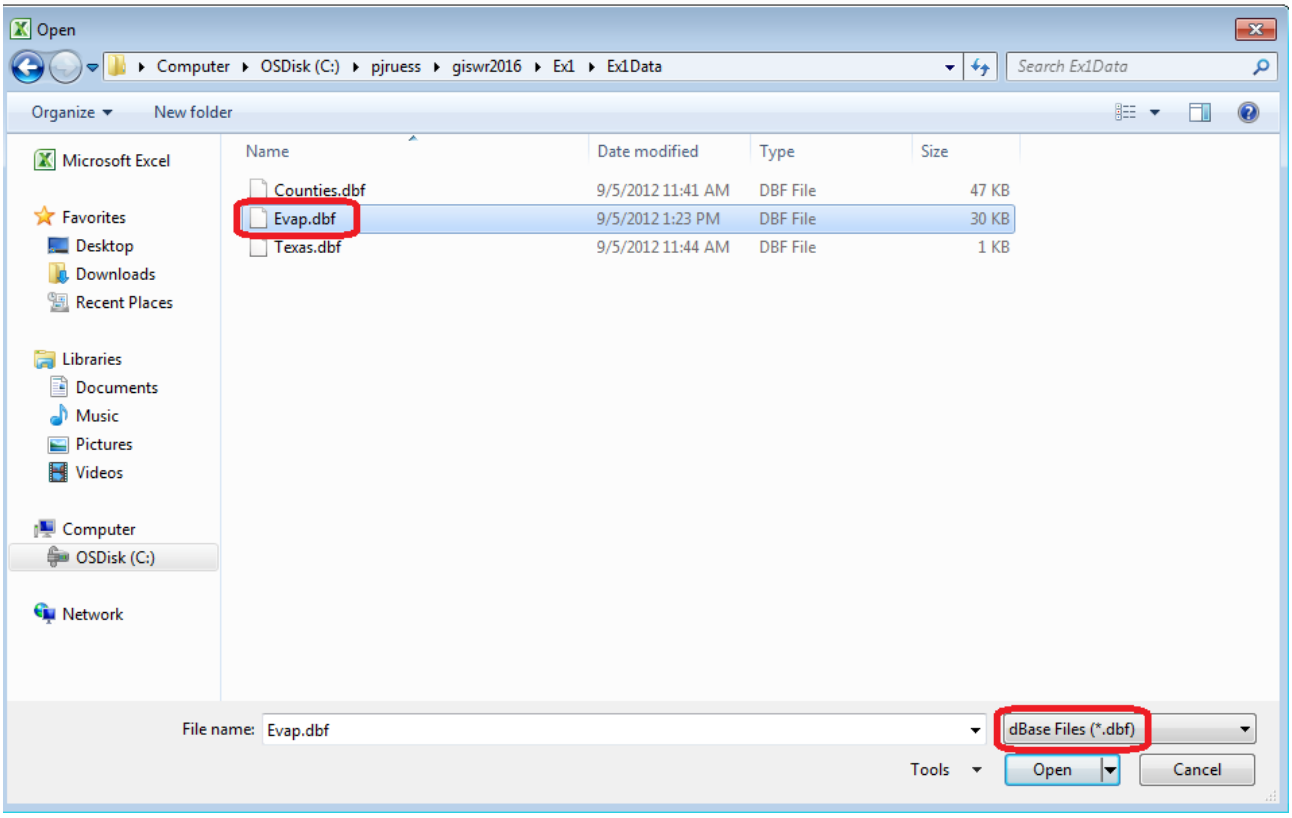


Notice how with some very simple charting steps, we've been able to get some interesting insight into the character of pan evaporation in Texas.

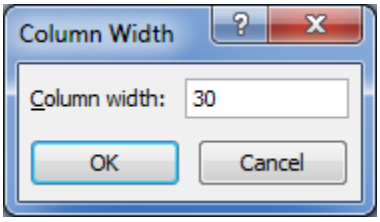
Save your ArcGIS Pro document **Ex1_project.aprx** so that you can retain this display.

Graphing in Excel

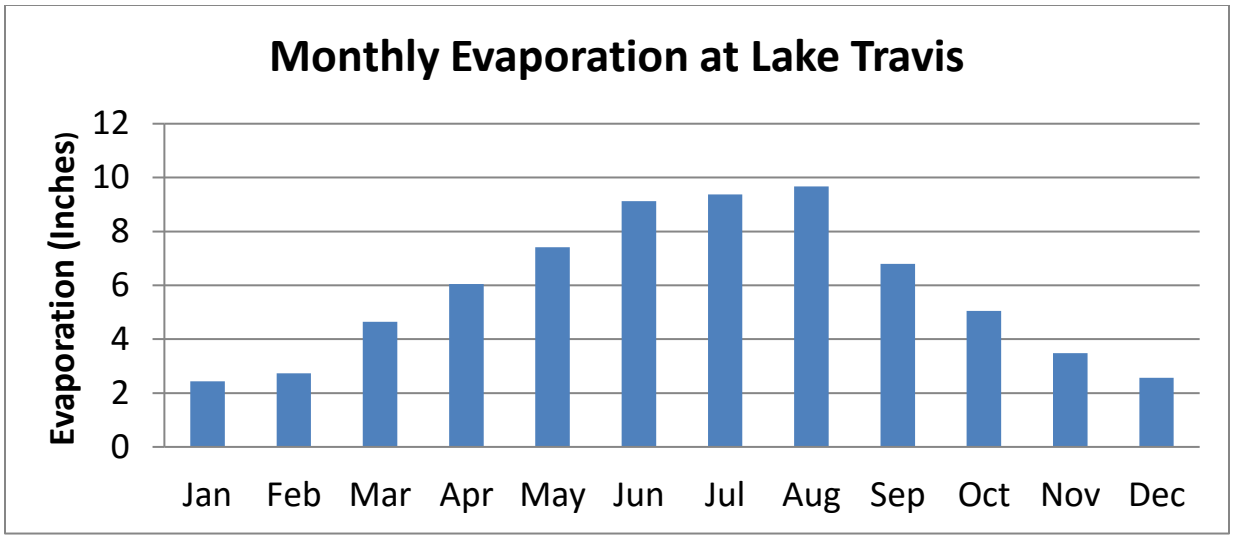
Another graphing option is to make a chart in Excel using the dBase tables given by the evaporation shapefile. Open the evaporation attributes table **Evap.dbf** as a table in **Excel**. Use **Files of Type: dBase files** in Excel to focus only on .dbf tables when you open the table.



When you open the file, you'll see that the Station name is very wide (254 characters). Right click on this column in Excel and select Column width of 30 characters to correct this.



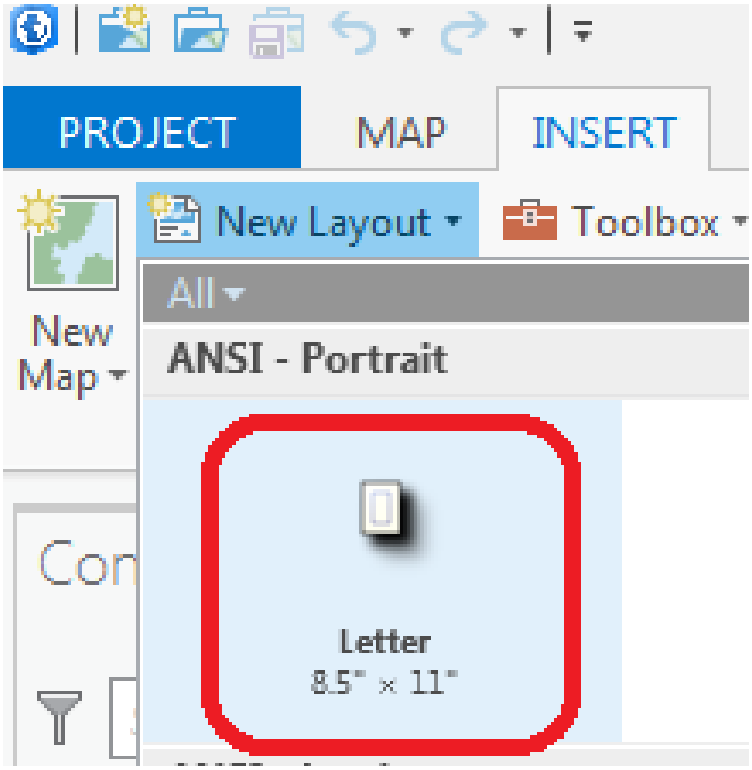
Select the stations you want to plot, copy their records to a new worksheet, delete the columns you don't need there, and then create a chart. Here is an example chart created this way.



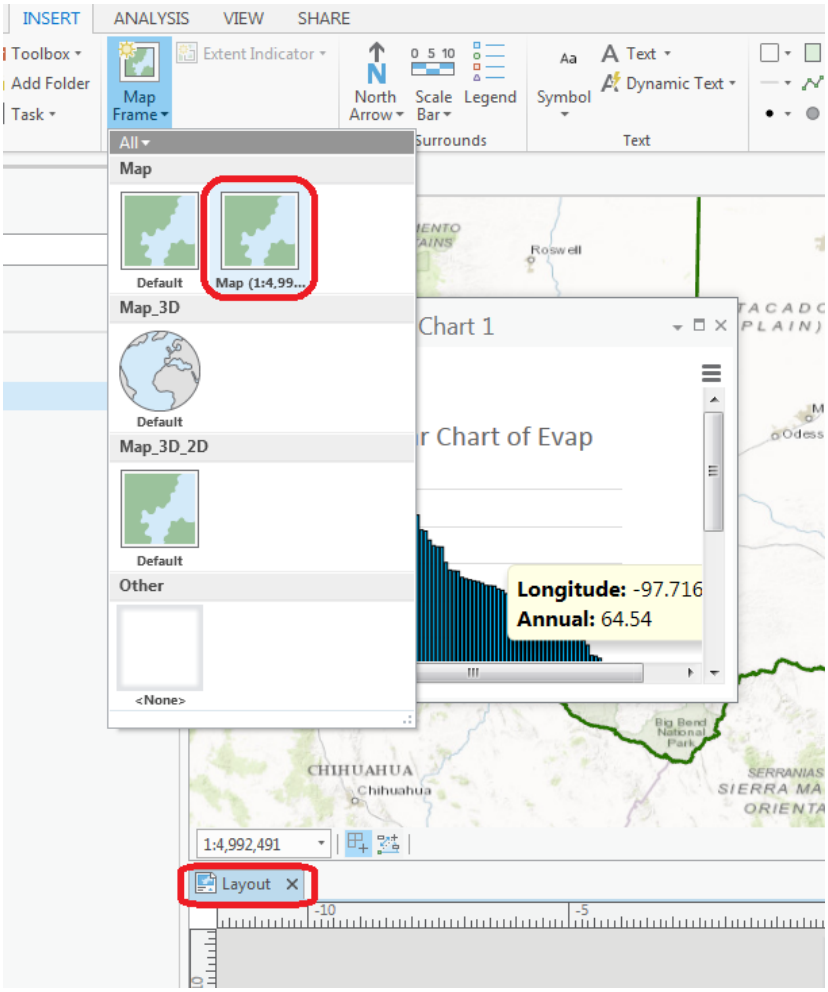
8. Creating a Map Layout

Now we are going to create a formal map of evaporation in Texas that includes the charts that we've created.

Under the *Insert* tab, select **New Layout** and pick the "Letter" layout.

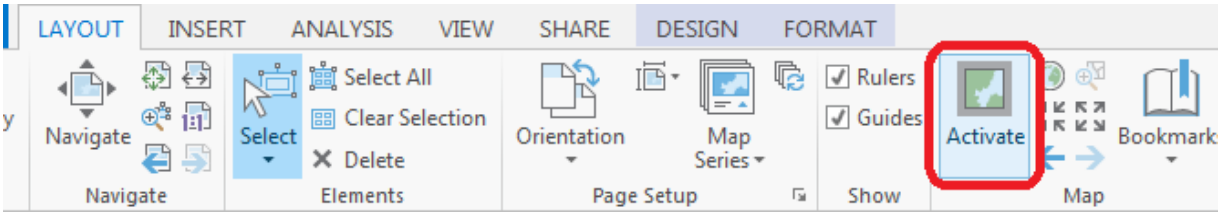


You should now see the layout frame on the bottom portion of the screen. Add a Map Frame to your layout by making sure the Layout is selected and then going to *Insert*, Map Frame/Map (the name of your current map).

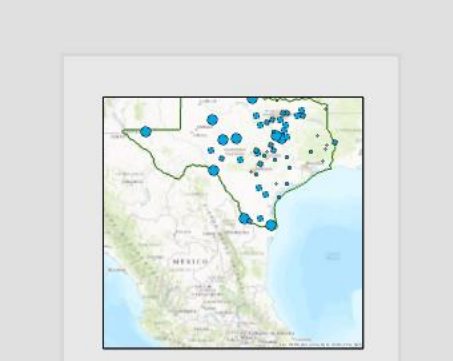


Reduce the size of the data frame in the layout (i.e., rectangle where the spatial data is contained) -- to make room for the graph -- by clicking on the map and moving its handlers.

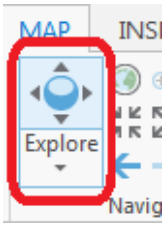
Now, in order to center your map within the map data reference, first select **Layout**, then click **Activate**.



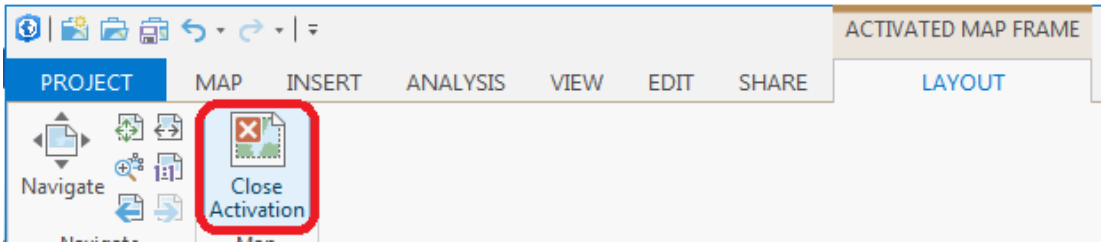
Once **Activate** has been clicked, the **Layout** display region should have a faded paper background as shown in the following image.



Next, select the **Explore** key and pan/zoom over the map until it is centered over Texas.

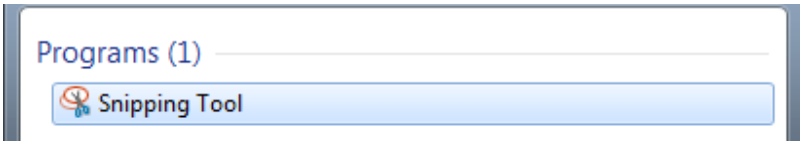


When you are finished editing the map, go to *Layout* and select **Close Activation**.

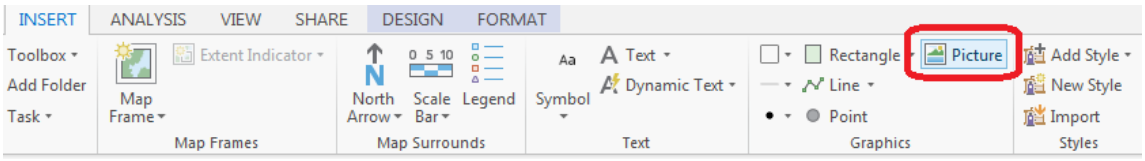


Now we would like to add a chart to the layout, in the empty space below the map. Note that at this time ArcGIS Pro does not support the addition of charts to a Layout. See https://pro.arcgis.com/en/pro-app/help/analysis/geoprocessing/charts/share-a-chart.htm for details.

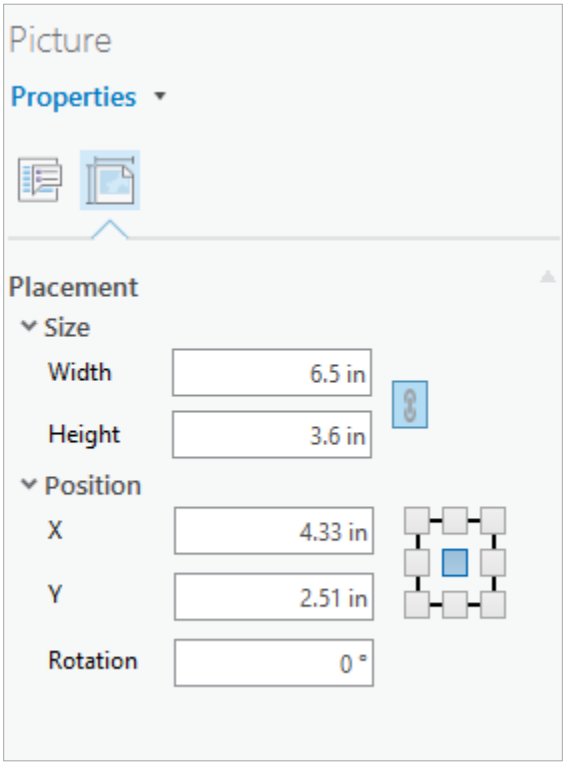
Instead, you should snip or printscreen to capture your chart image. For details see the Helpful Tip at the end of this section.



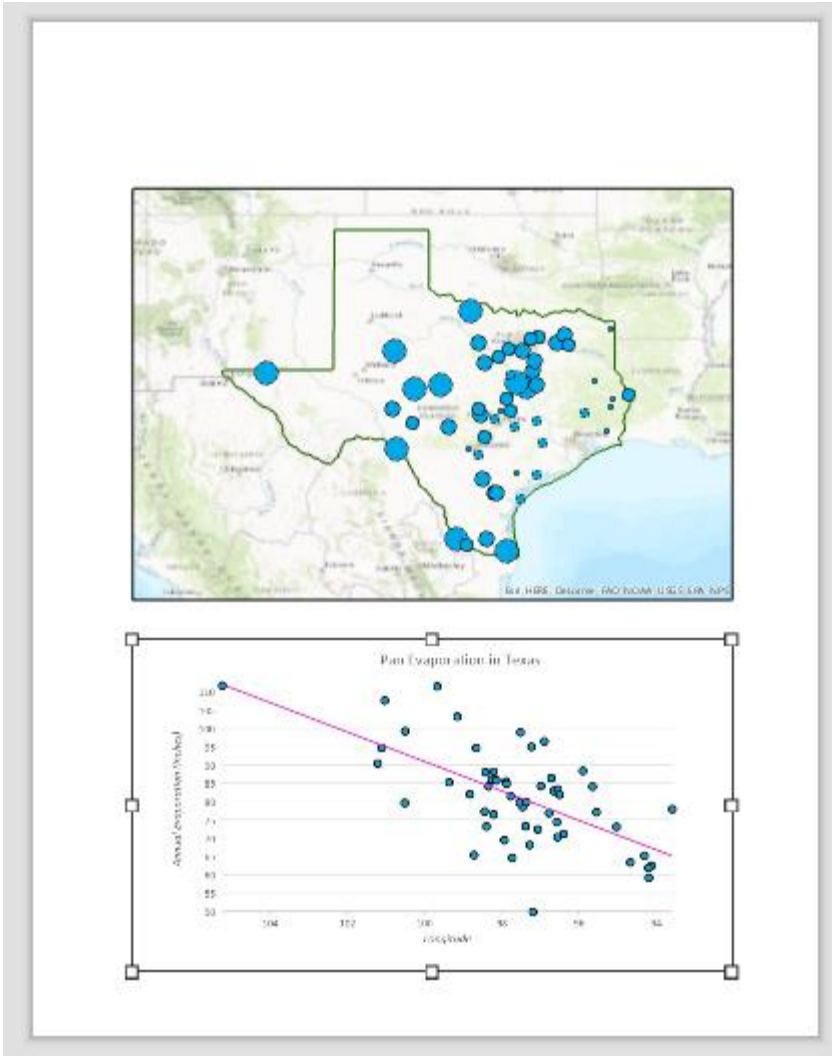
Save the chart image, then add the image using the **Picture** tool in ArcGIS Pro. To do this, click the **Picture** button (**Layout** must be selected), then (once Picture has been selected) click on the layout where you would like the picture to be placed. Navigate to your picture and resize the same way you modified the map data frame.



You can center your chart in the Picture window using the Picture **Properties**

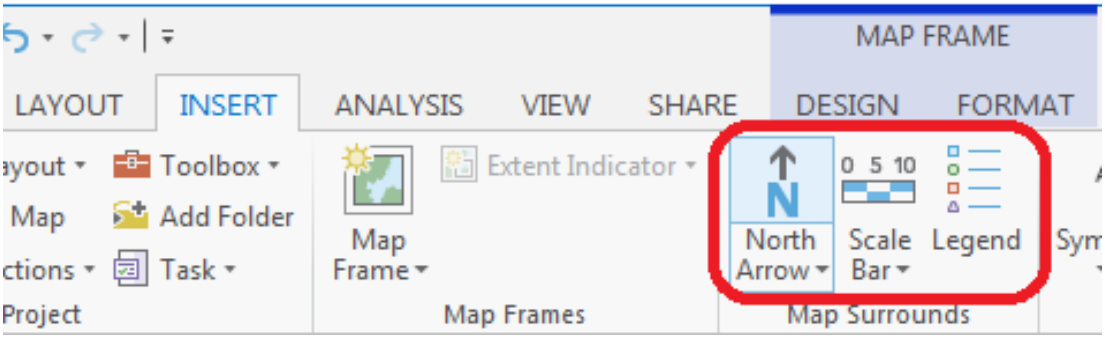


The map is shown below in ArcGIS Pro with the chart below it. It may seem as if some of your lines have disappeared in the chart image but that is just because of the scale of the display.

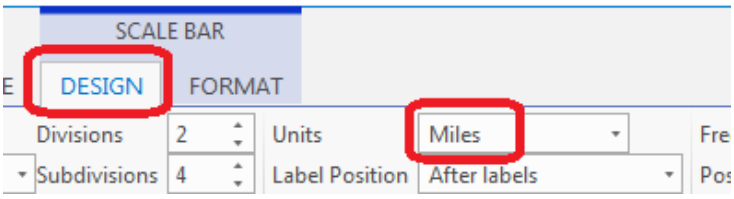


Keep saving your ArcGIS Pro document as you proceed through the map making steps so that if you mess up something you can get back the work you've already done.

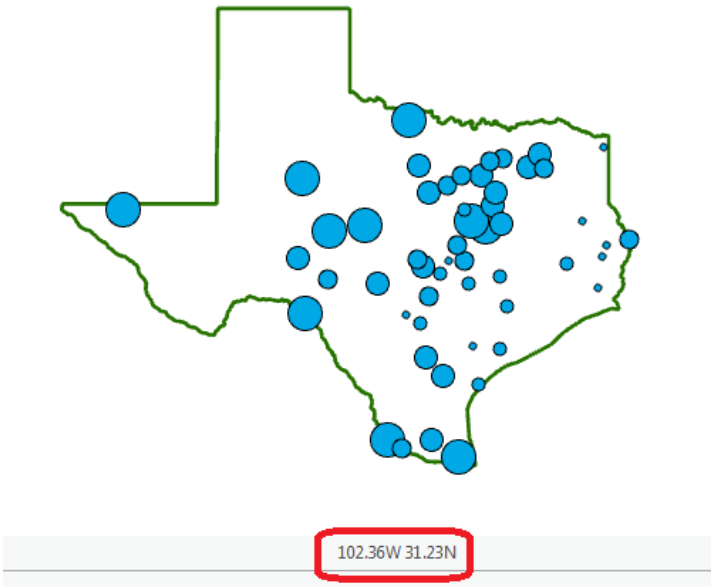
You can also insert a **North Arrow** and a **Scale Bar** under the *Insert* tab.



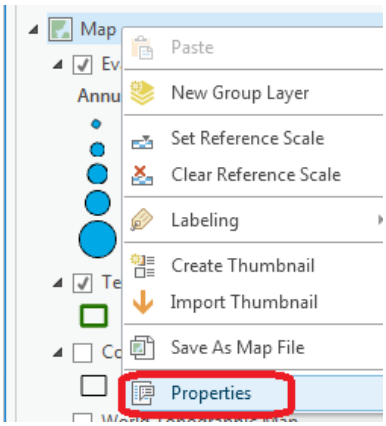
When you put up the scale bar you can select the distance units to be displayed. I have used miles.



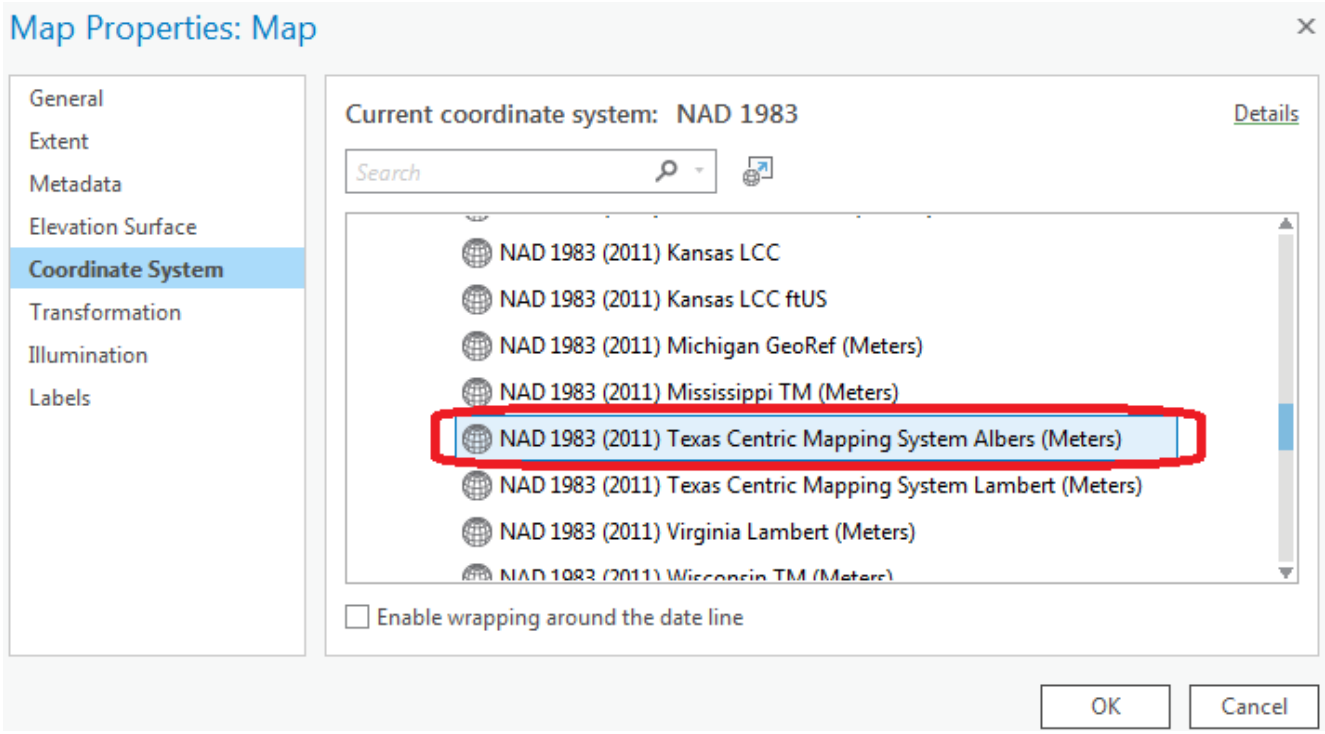
Note that if you look at the bottom right of ArcMap in Data View you see coordinates in Longitude and Latitude. This is an indication that the map is being displayed using geographic coordinates. It is not strictly correct to use a length scale when data is displayed in geographic coordinates as lengths are different in the North-South and East-West directions. You will learn more about this in future classes.



To change the coordinate system, right-click on the **Map** entry in the table of contents and select properties.

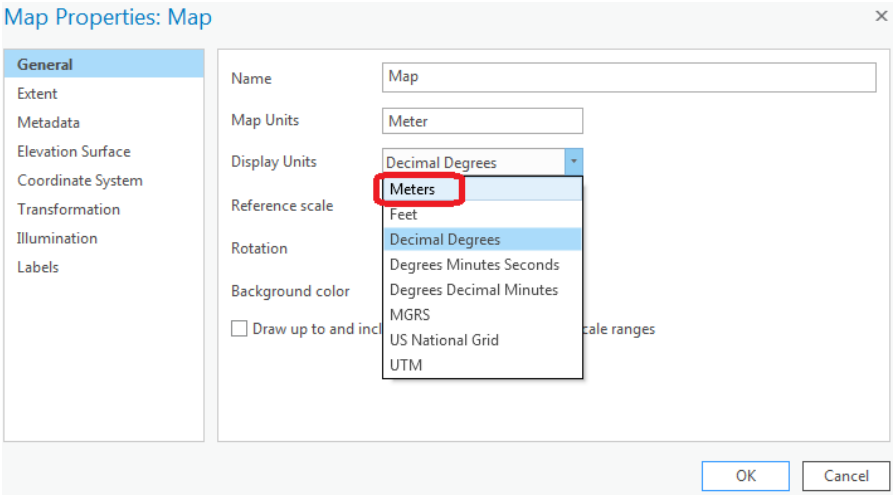


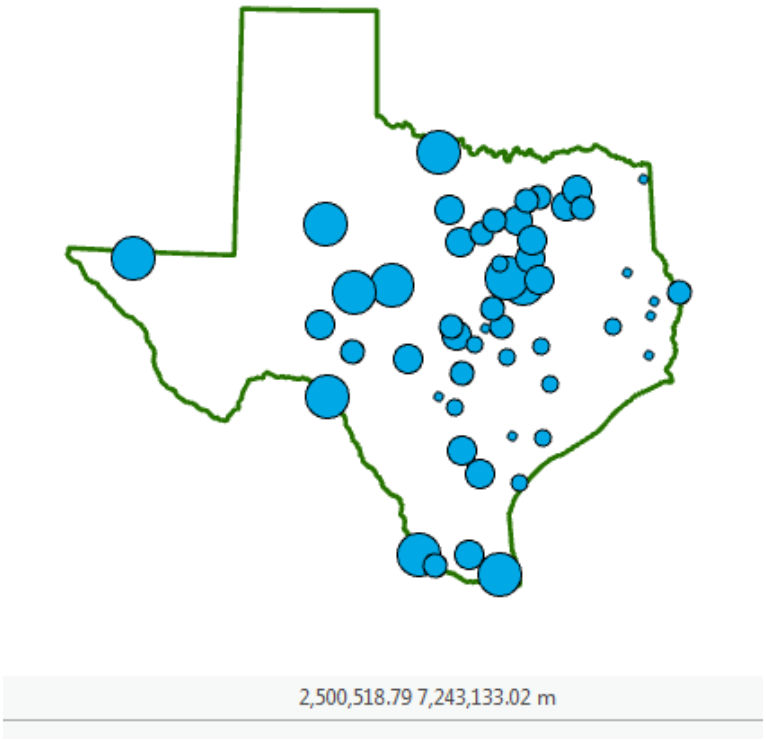
Map is the name of the **Data Frame** used to display information in ArcGIS Pro. In **Map Properties** click on **Coordinate System** and navigate to **Projected Coordinate Systems -> State Systems -> NAD 1983 Texas Centric Mapping System Albers (Meters)**. Click OK.



Note that for this exercise it does not really matter which coordinate system we select, but we need a projected coordinate system so that the scale bar is correct. Note that the display of Texas is adjusted according to the new projection.

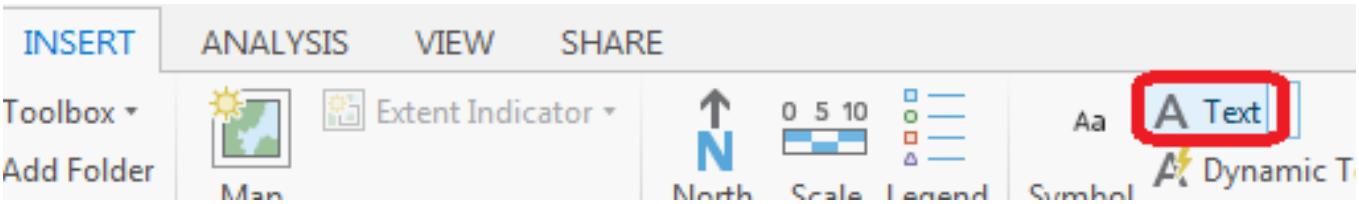
To change the display units, select the **General** tab in the **Map Properties** and change "Display Units" from Decimal Degrees to Meters.



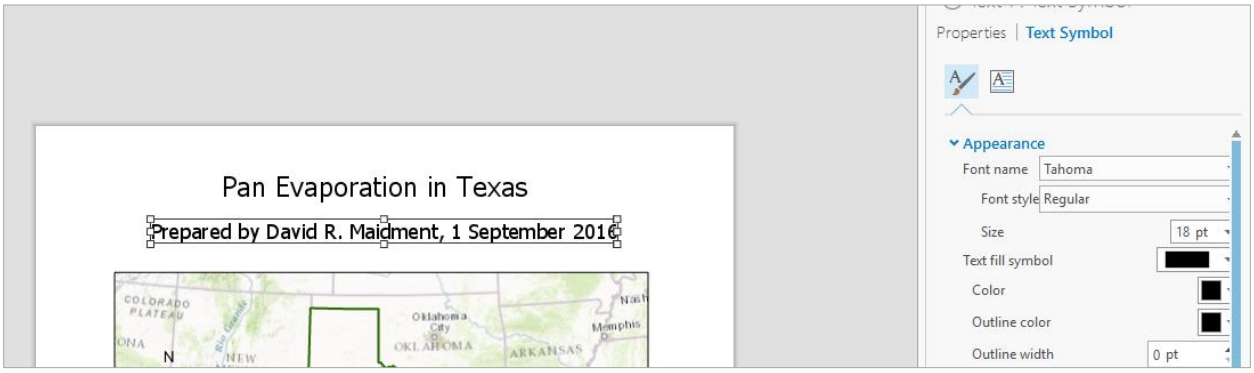


The above map shows corrected display units as well as a Texas map corrected to a more appropriate coordinate system (note the slight tilt).

Select **Text** from the *Insert* tab to insert a Title.



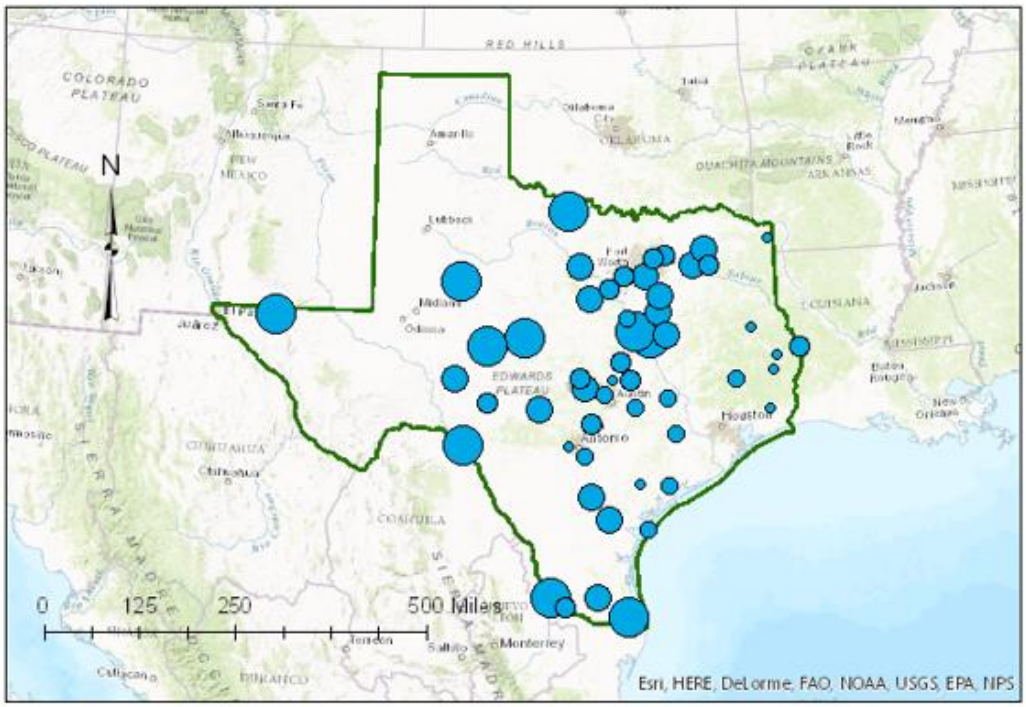
Type the text you would like for your title, and resize the window to automatically resize the font size. Add a second title including your name and the date.

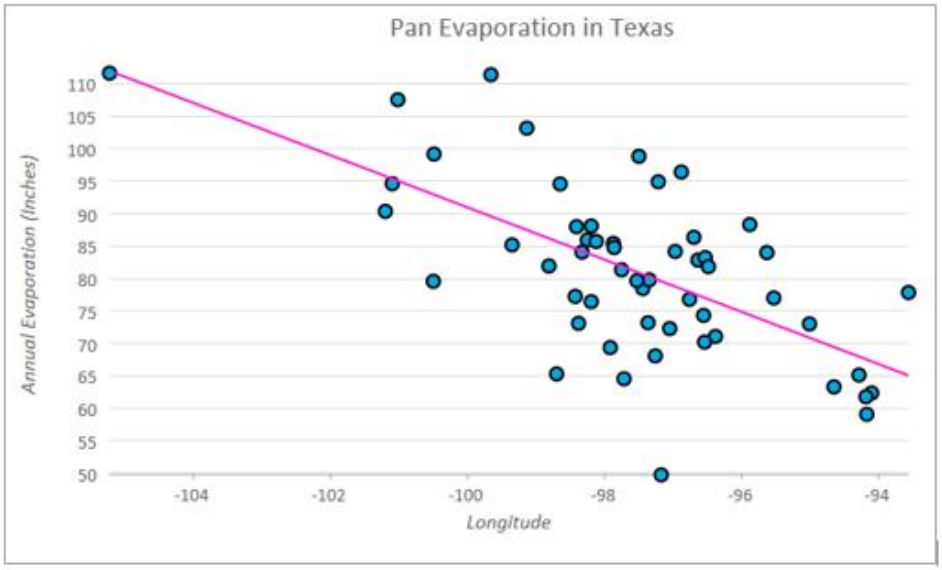


Here is the resulting completed map and chart combination

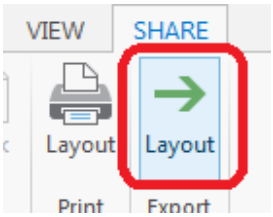
Pan Evaporation in Texas

Prepared by David R. Maidment, 1 September 2016





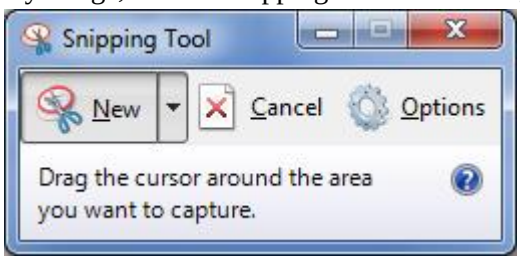
You can export your map from ArcGIS Pro using by clicking **Layout** in the "Export" section under the *Share* tab. Use the TIFF option so that you have a detailed graphic image. You can store this file as **Ex1.TIFF** in your data file.



Then you can add it to a Word document using **Insert/Picture** and loading this **.tiff** file. This preserves the crisp resolution of the ArcMap display in a word document.

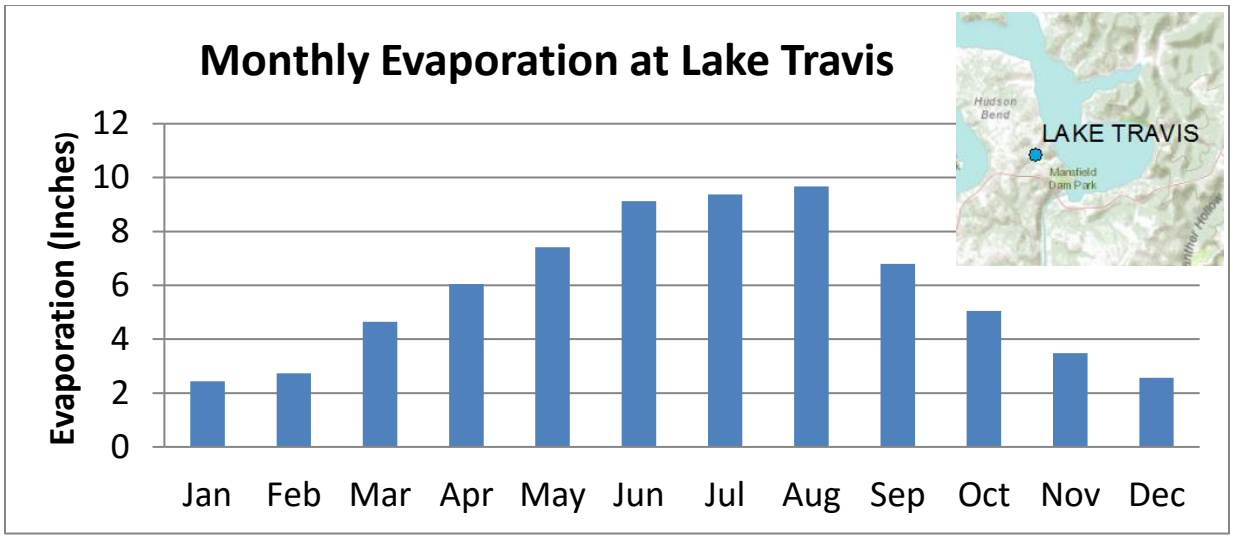
Helpful Tip:

A more general procedure is to simply copy the screen to the clipboard and crop out the part that you want, saving it to a file for later use. That is how all the images in this exercise were prepared. To copy any image, use the Snipping Tool in **All Programs/Accessories** on your Windows Desktop interface



Drag the cursor around the area that you want to capture and you'll see it copied into a new display, then use **Paste** to insert this snippet into a specific location in your document. If you only want to capture the active frame, press **Alt + Print Screen** and then Paste it to the new document.

This approach can also be used to add a map to a chart in Excel:



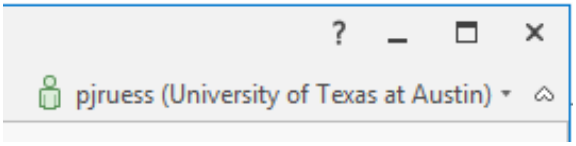
The manipulations just described transfer objects from one application to another.

To be turned in: An ArcMap map layout in it showing a map of Texas with gages, coupled with a graph showing monthly evaporation data plotted from the gages. In the presentation of information on maps and charts it is important to include sufficient labeling detail so that the information can be clearly and unambiguously interpreted. You should include a scale bar to indicate distance, a north arrow to indicate direction and labels or legends with units wherever they are needed to interpret map or quantitative values.

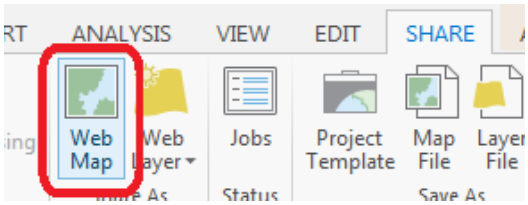
9. Sharing a Map Online

Now, let's suppose that you would like to share your map with your colleagues. This can be done with ArcGIS Online by using the ArcGIS Pro interface. Before creating an online map, you'll want to make

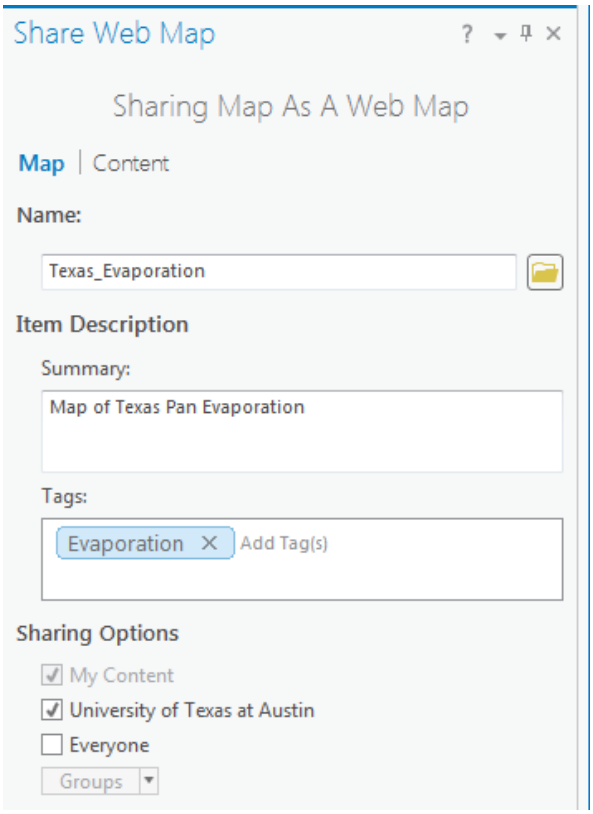
sure you're still logged in to ArcGIS Online in your ArcGIS Pro instance (check the upper right-hand corner of the screen).



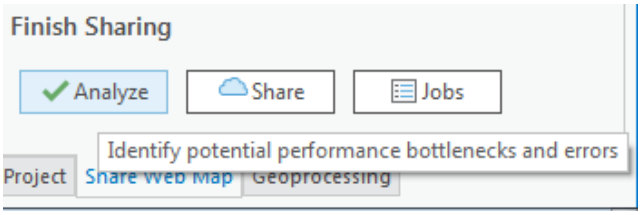
After you're sure you're logged in, go to the *Share* tab and select **Web Map**.



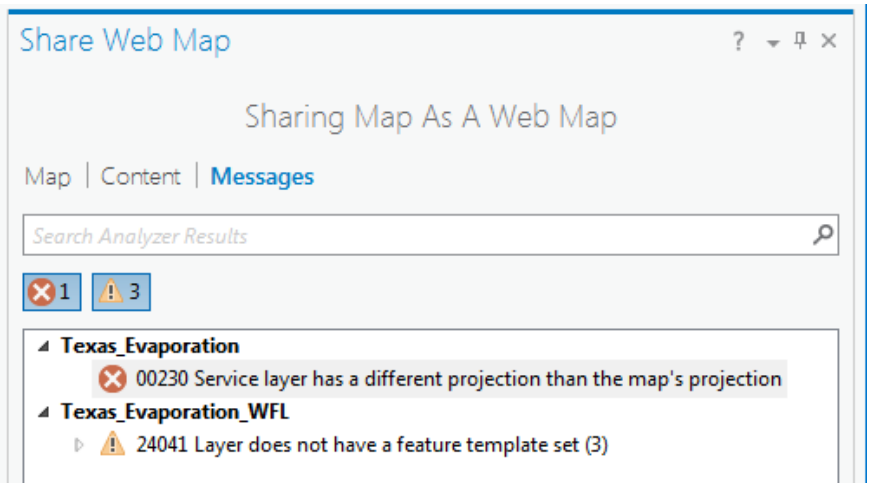
A sidebar will appear on the right where you will be able to give your map a **Name**, **Item Description**, and select **Sharing Options**. Fill out these sections, and select "University of Texas at Austin" under *Sharing Options.* This will enable all other group users to have access to your shared Web Map!



Before sharing your map, click **Analyze** to check that your map has all criterion required for publishing.



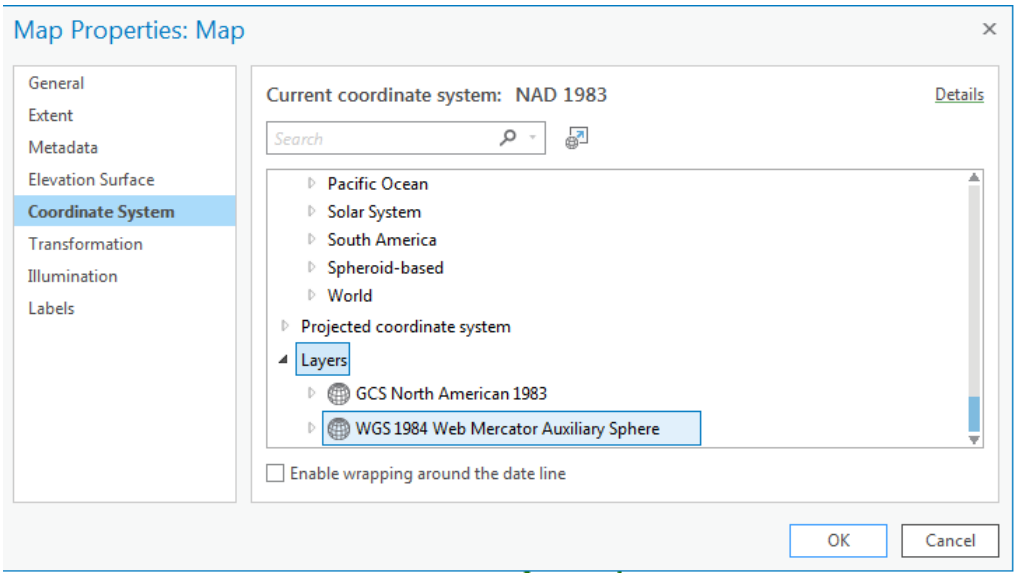
You should receive an error that looks like this:



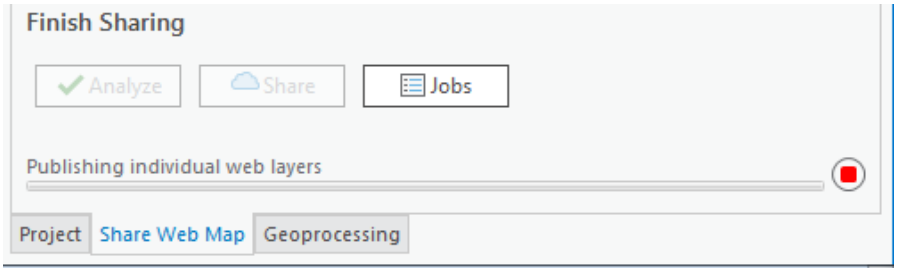
Remember when you previously changed the map's coordinate system to **NAD 1983 (2011) Texas Centric Mapping System Albers (Meters)**? Regrettably, this new coordinate system is different than the coordinate system for the basemap you are currently using (all basemaps use the **WGS 1984** global coordinate system). Hence the service layer (the basemap using **WGS 1984**) has a different projection than the map's projection (which you changed to **NAD 1983**).

A basemap is required for sharing a webmap, and the ArcGIS Pro basemaps cannot be changed from **WGS 1984**; therefore, all maps must be changed to this global projection before publishing online. To change the map projection, go to map properties, scroll to the bottom and expand "layers" (this shows all projections that currently exist in any of the map's layers), and select **WGS 1984 Web Mercator Auxiliary Sphere**. Now **Analyze** your map again for webmap sharing.

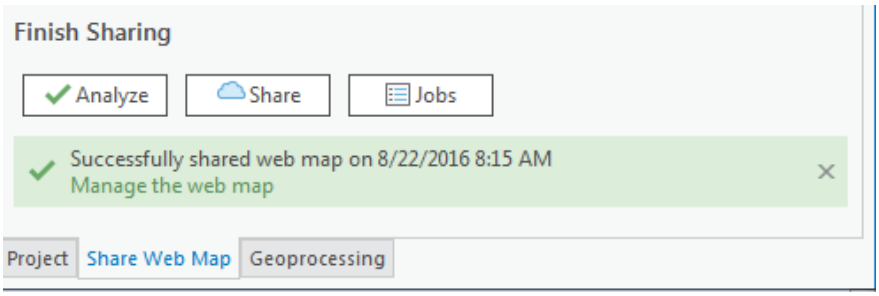
Note: The 24041 Layer feature template warning will be ignored for this particular exercise.



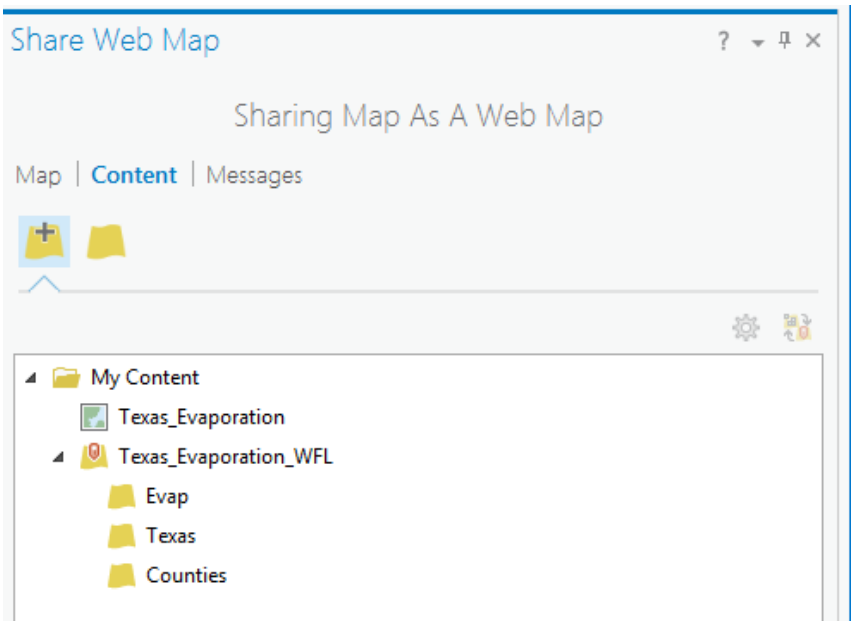
Now that your error is gone, click **Share** to create a web map from your ArcGIS Pro map. Note that you will want to have the basemap display box checked so that the basemap loads properly on your webmap. Once you have selected **Share**, a loading screen should appear that looks like this:



Once your web map has been successfully published you will receive a confirmation message.

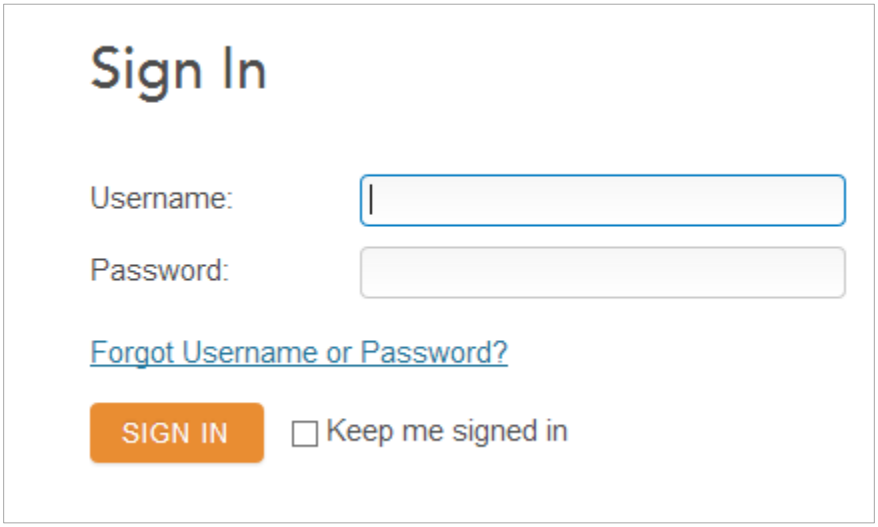


You can also view your webmap in the *Content* tab within the **Sharing Web Map** pane.

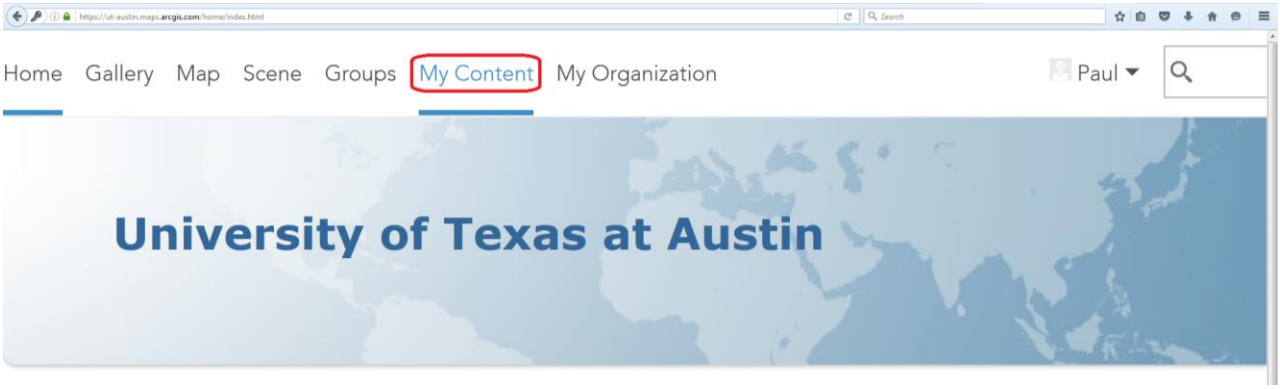


Following publishing, proceed to ArcGIS Online to view your webmap online.

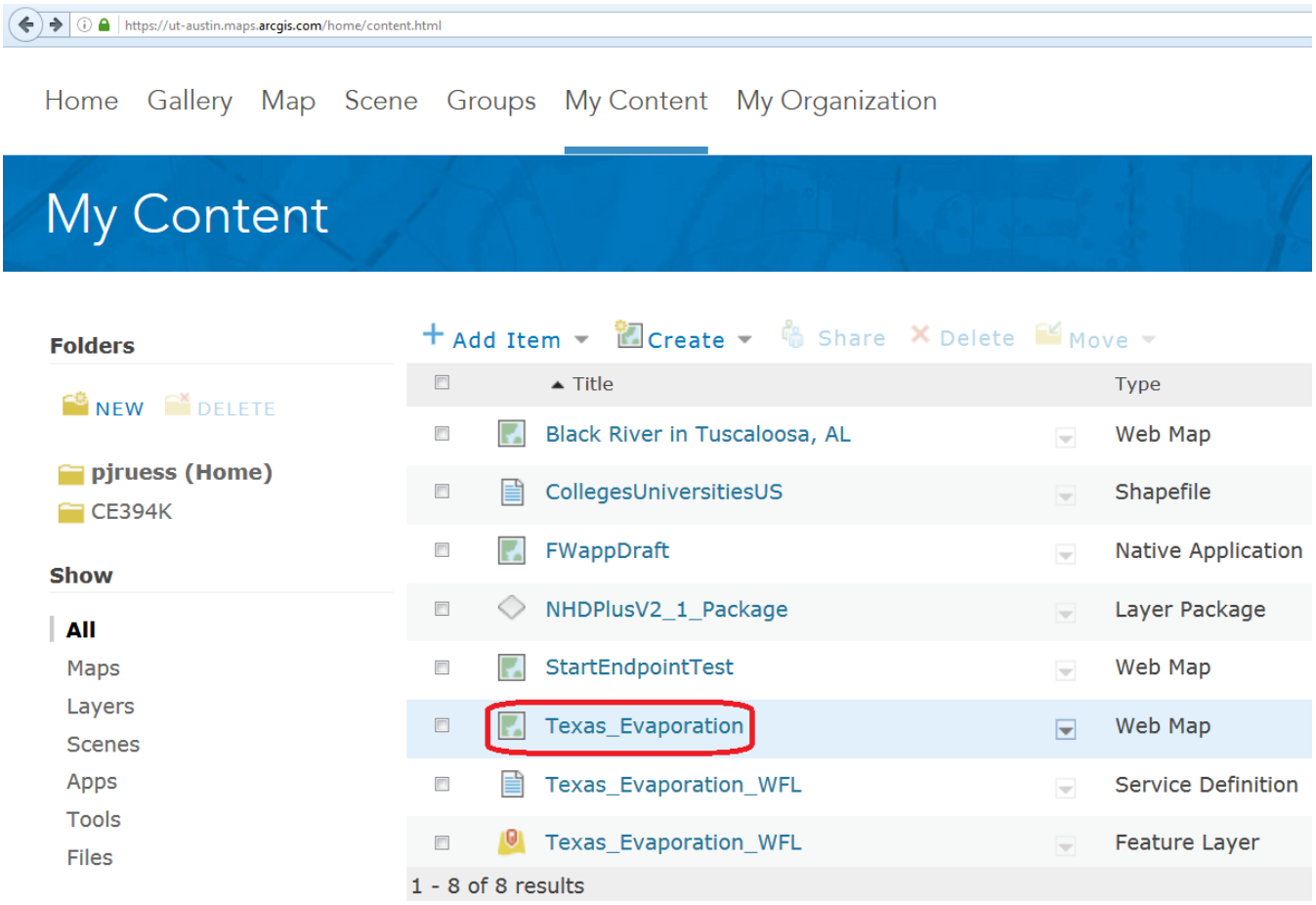
Go to http://www.arcgis.com and sign in with your ArcGIS Online Username and Password



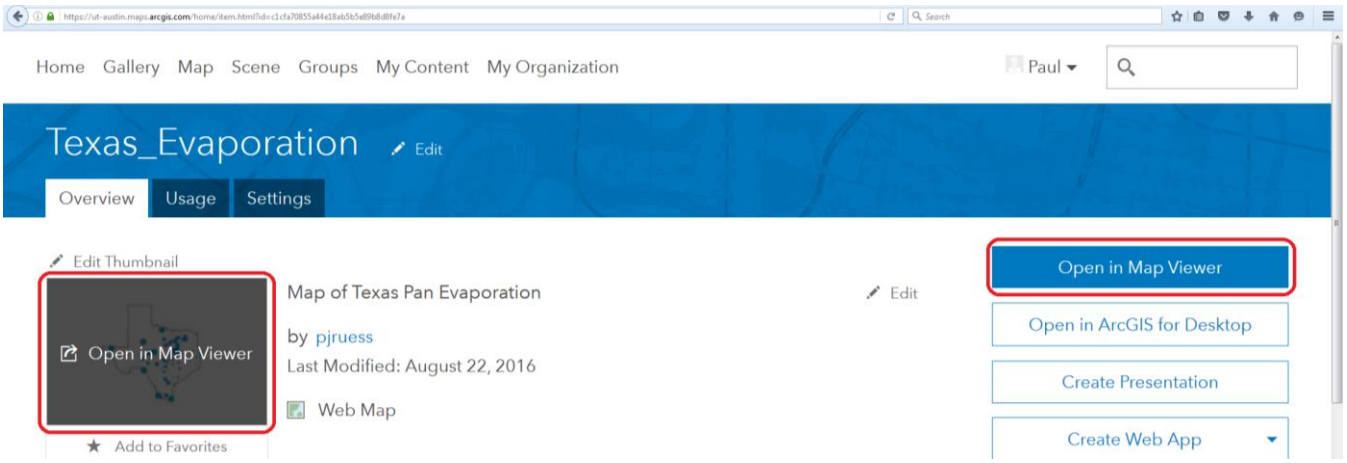
The landing page should look similar to the screen below. Click on "My Content"



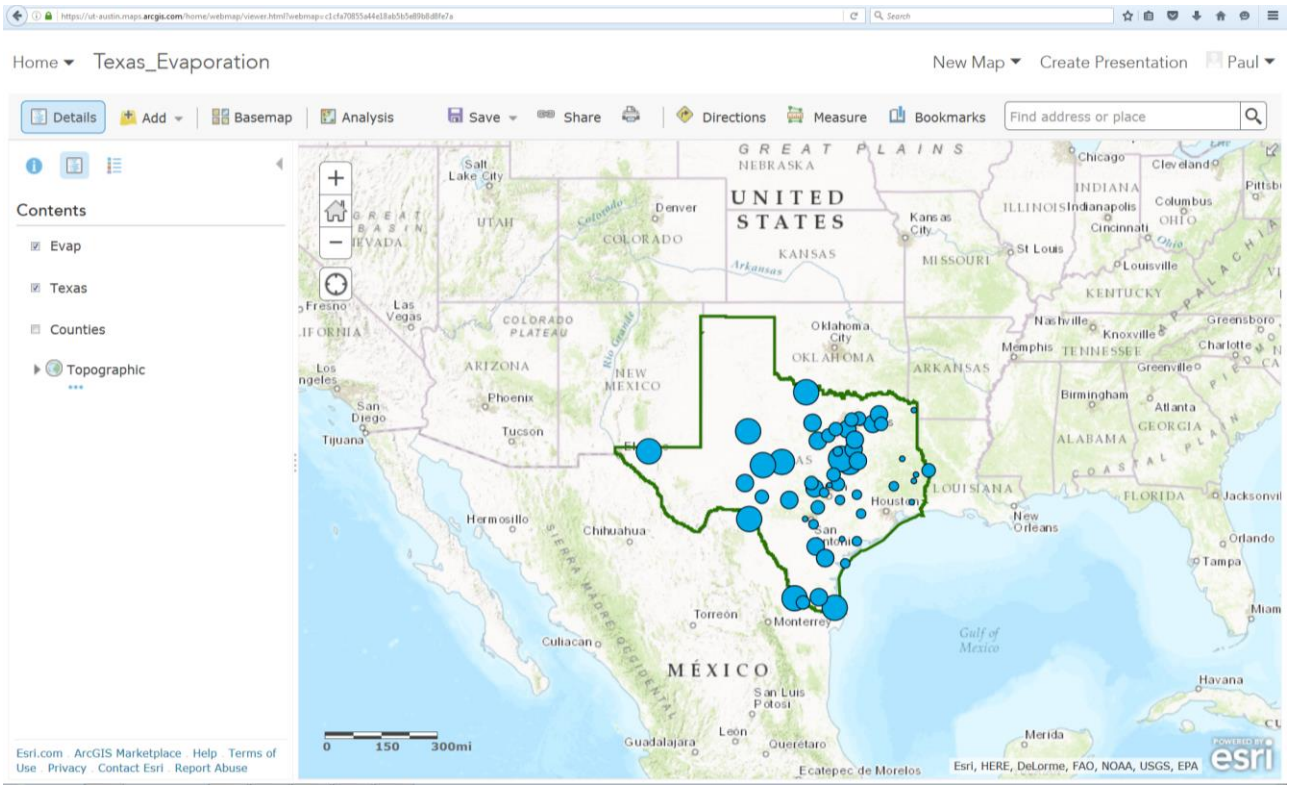
This opens a section where you can manage the content you have added to ArcGIS.com. Click on the **Web Map** file you just created.



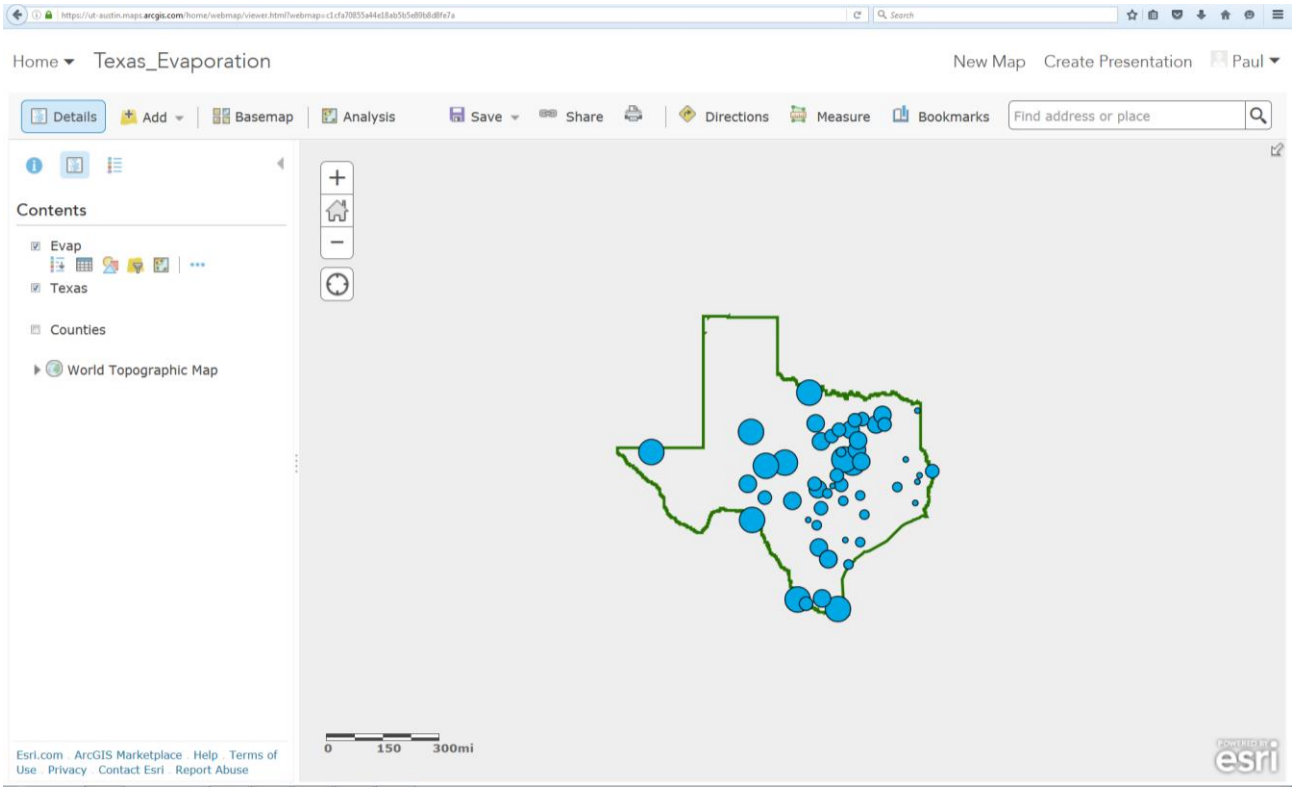
Now select **Open in Map Viewer** from the screen that loaded. Note that this can be done one of two ways: by hovering over the map thumbnail on the left side of the screen, or by selecting the blue **Open in Map Viewer** button from the right side of the screen.



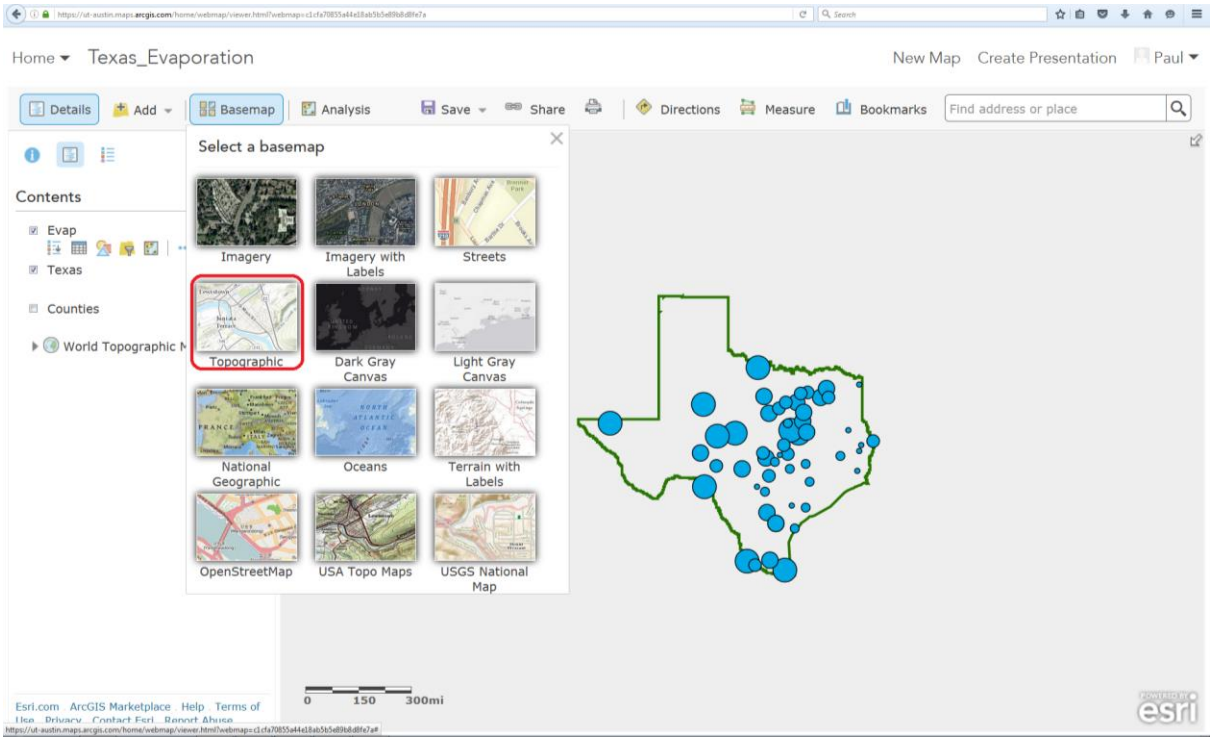
You should now see your ArcGIS Pro map displayed online on the World Wide Web for everybody to have access to. Very cool!



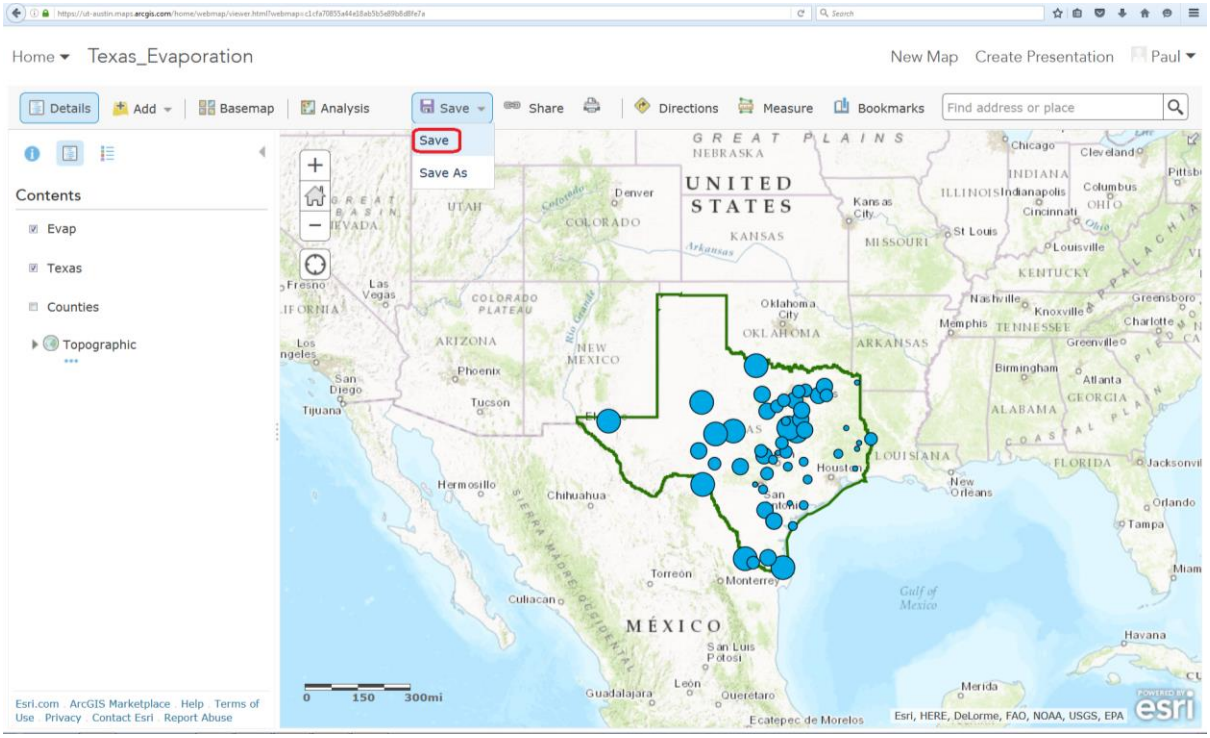
Note that if you did not check the basemap display box in ArcGIS Pro, your webmap may have come out looking like this:



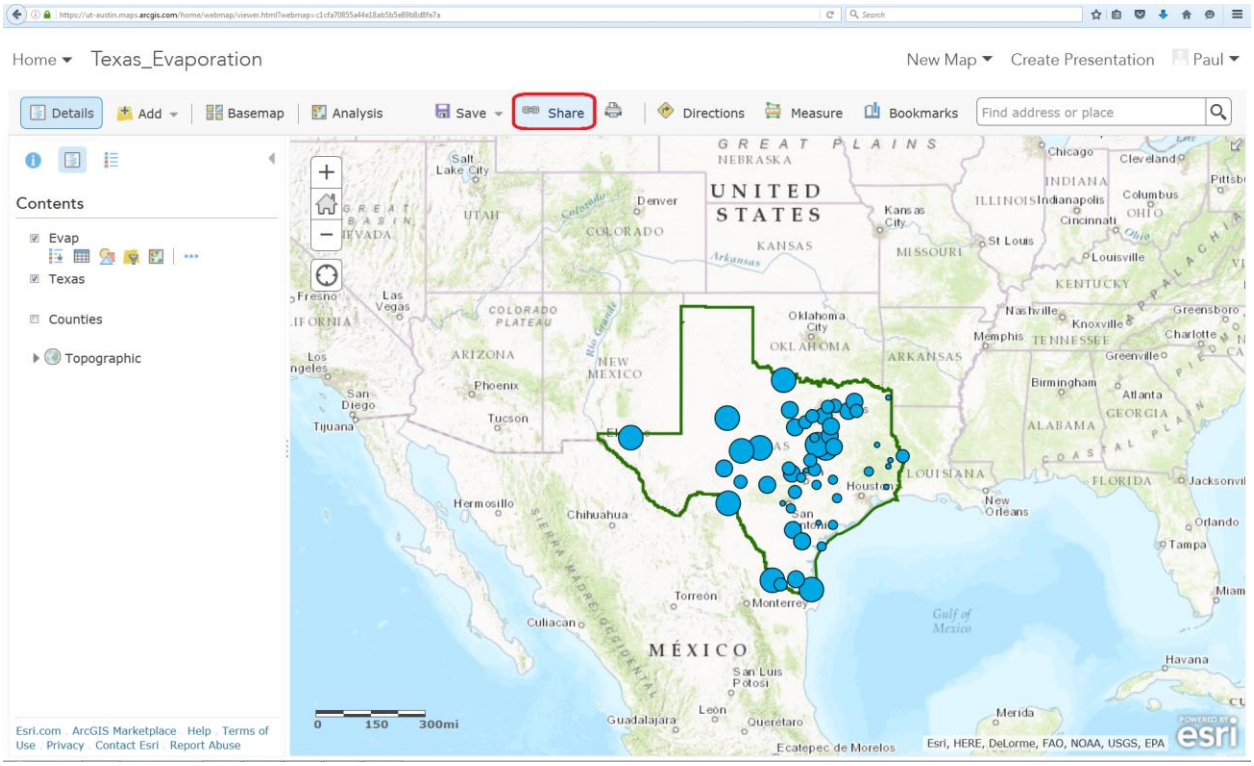
If this happened, click **Basemap** and select **Topographic** to reload the topographic map layer.



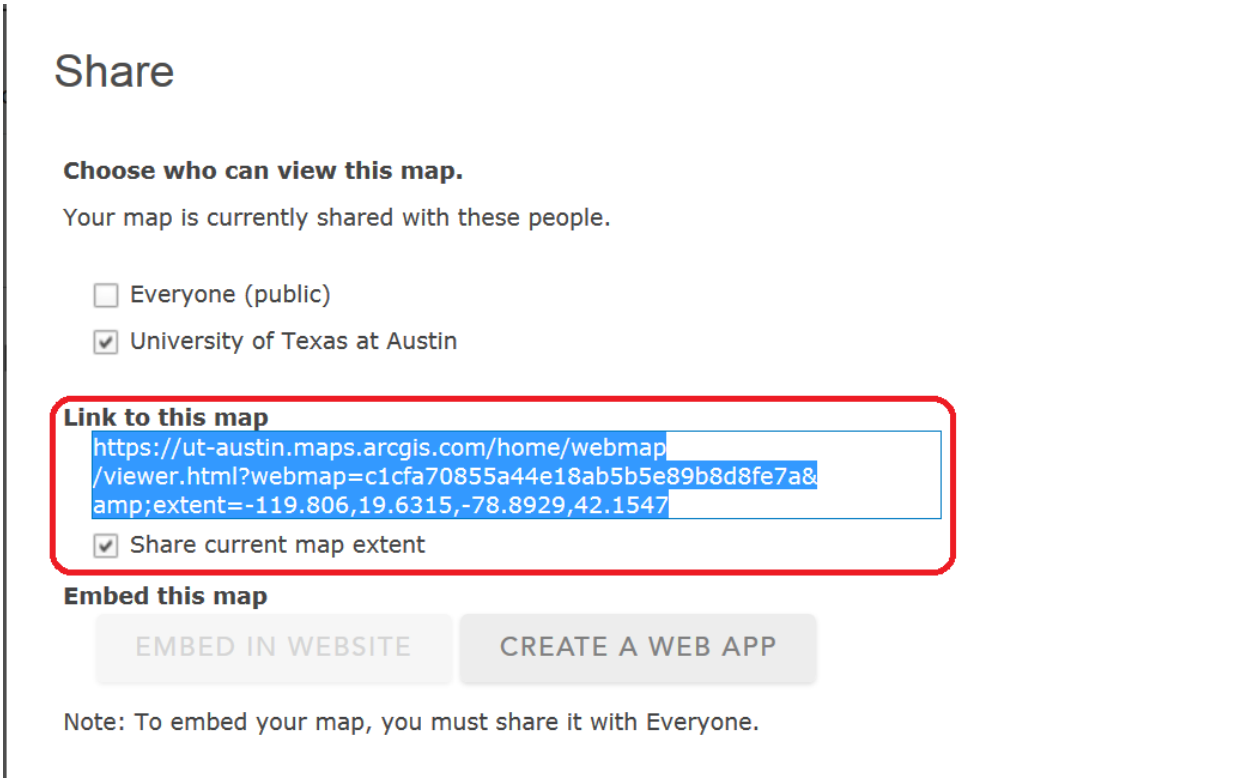
Once you are sure your basemap is working properly, click **Save** to save your webmap (otherwise you'll have to make these adjustments every time you open up your map).



Once you are finished, click on **Share** at the top of the screen.



In the pop-up screen that appears, copy the hyperlink and turn it in so that I have view it online.



To be turned in: The web link for your map so that I can view it online. Your URL should be similar to the following:

https://ut-austin.maps.arcgis.com/home/webmap/viewer.html?webmap=c1cfa70855a44e18ab5b5e89b8d8fe7a&extent=-119.806,19.6315,-78.8929,42.1547

Summary of Items to be Turned In:

(1) *An ArcMap map layout in it showing a map of Texas with evaporation gages, coupled with a graph showing evaporation data plotted from the gages. In the presentation of information on maps and charts it is important to include sufficient labeling detail so that the information can be clearly and unambiguously interpreted. You should include a scale bar to indicate distance, a north arrow to indicate direction and labels or legends with units wherever they are needed to interpret map or quantitative values. Let's see some nice cartography!!*
(2) *The web link for your map so that I can view it online. Please include this as part of the document that you prepare for (1) and submit the result as a single complete document.*

The assignment is due in a week from the date it was assigned in class.
UT Austin: Please submit your solution through Canvas to assignment "Exercise 1".
USU: Please submit your assignment as a single Microsoft word or PDF document in Canvas.