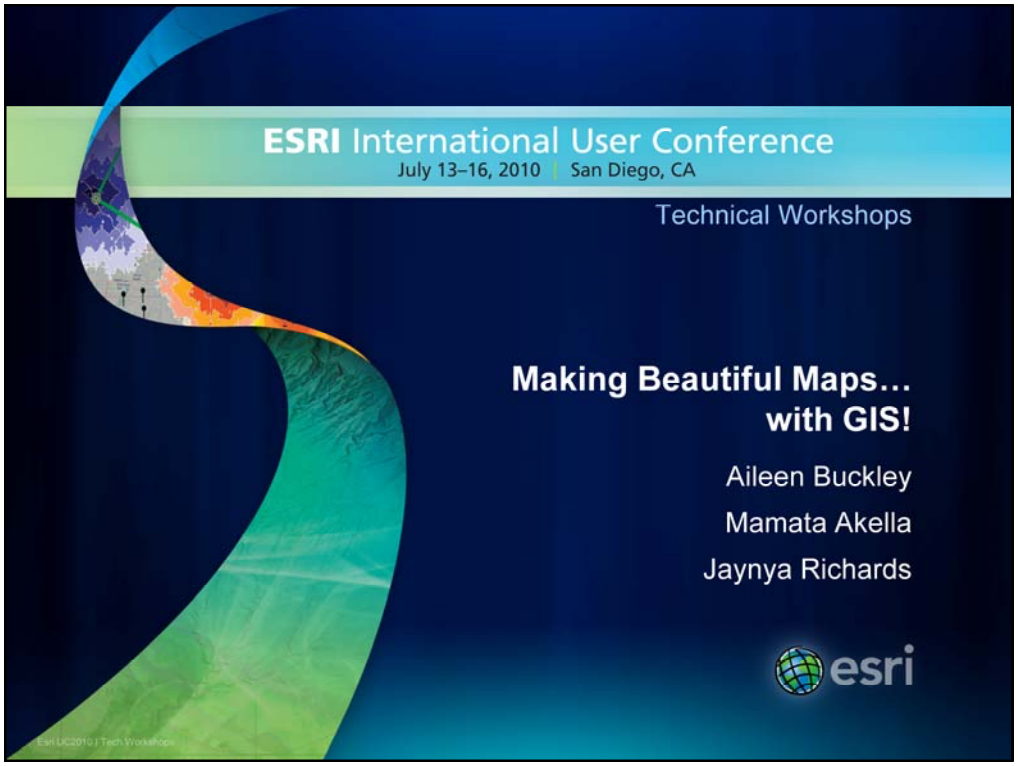
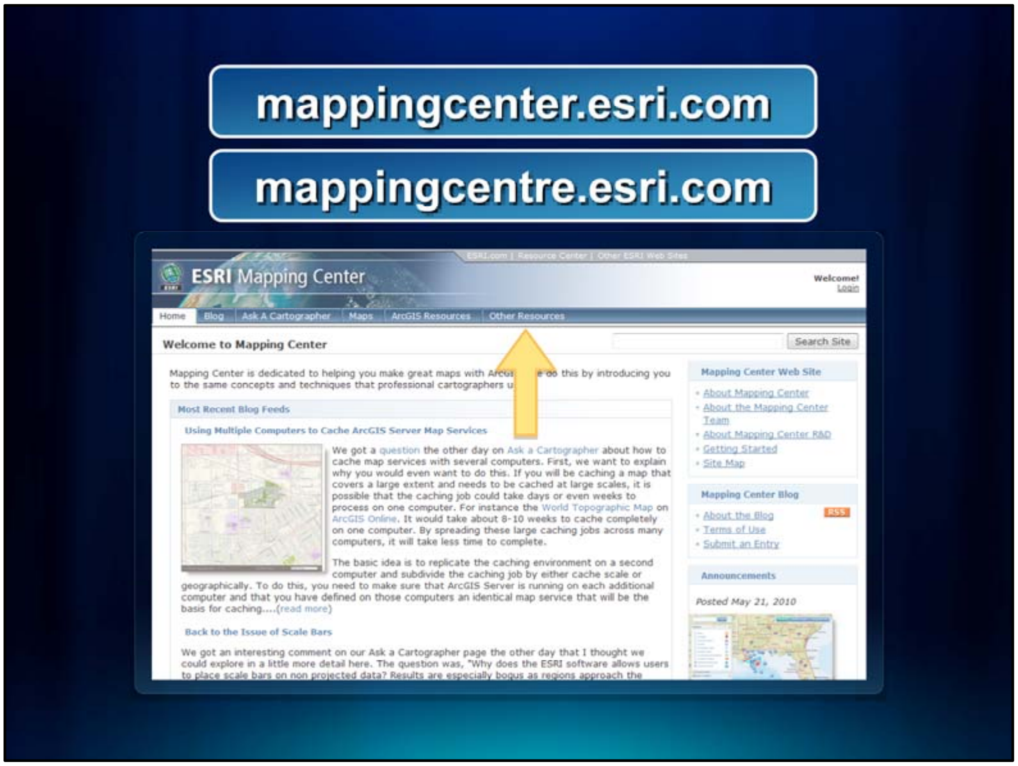


AILEEN – 30 MINUTES

Welcome to our session on making beautiful maps. My name is Aileen Buckley and these are my colleagues Mamata Akella and Jaynya Richards., We all work on the Mapping Center Team, and we have a few maps we want to share with you today as well as some of the methods we used to make them.

We had a little fun with the title for this session because we sometimes find that people are surprised to learn they <u>can</u> make beautiful maps using GIS! In this session, we want to demonstrate to you that this <u>is</u> possible.

ABSTRACT
Making Beautiful Maps – with GIS!
Presenters: Aileen Buckley, Jaynya Richards, and Mamata Akella
In this session, we introduce some special cartographic effects that will add a professional touch to your maps and really help you to get your message across! Stunning cartography coupled with your authoritative content can capture the interest of your map readers and give you the opportunity you need to tell your story. Think you can't make beautiful maps with GIS? Come to this session and learn how you can!



Before we get started, I want to point out that you don't need to take lots of notes because we'll be posting this presentation with the bottom notes on Mapping Center.

So, you can just sit back and relax - focus on the content, demos and techniques we show you, and think of any questions you might want to ask us at the end.

You'll be able to find this presentation on the Other Resources page of our Mapping Center web site. We'll post it there in the next two weeks – that will give us time to make any changes we think will help you after we give our talks.

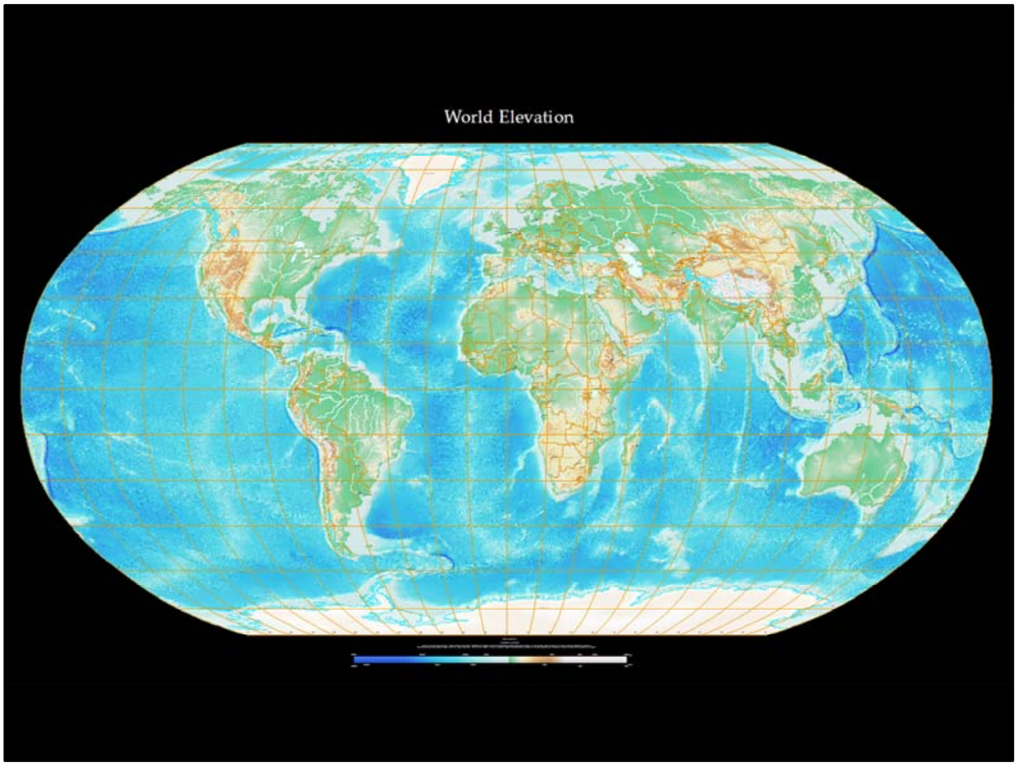
We'll show these URLs again at the end of this presentation.

For now – let's get started.

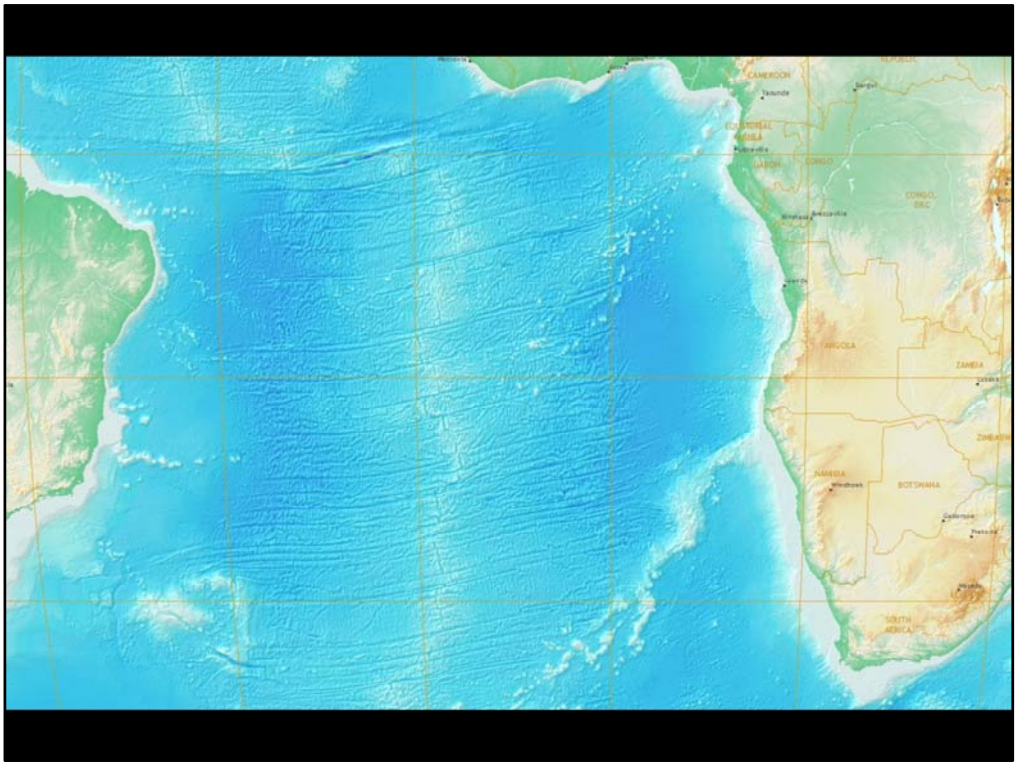
Our goal in this session is to demonstrate a variety of advanced cartographic techniques that you can use in your own map making. We'll do this by showing you through example using a number of maps that we created.

These maps were inspired by the work of others – we tried to replicate some of the cartographic effects to see how they could be done in ArcMap.

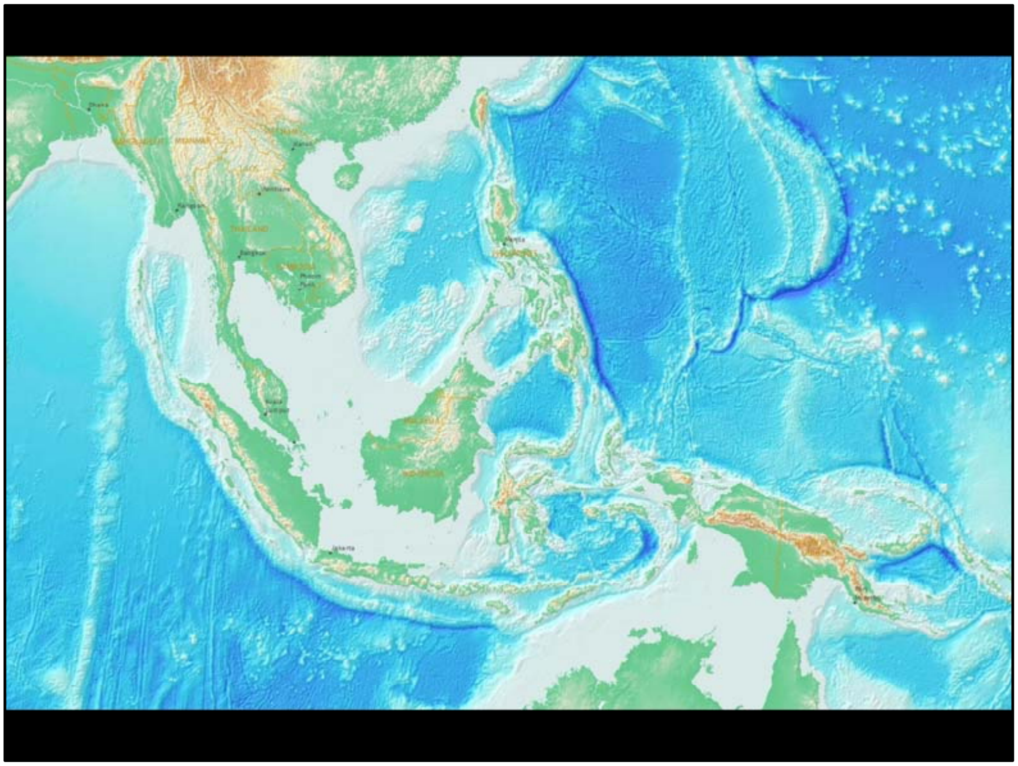
Just as a side note, all of the maps use data that you can find on our Esri Data and Maps DVD or that is publically available.



So let's get started with the first map. This is our World Elevation map. Let's take a quick tour of the map so you can see some detail.



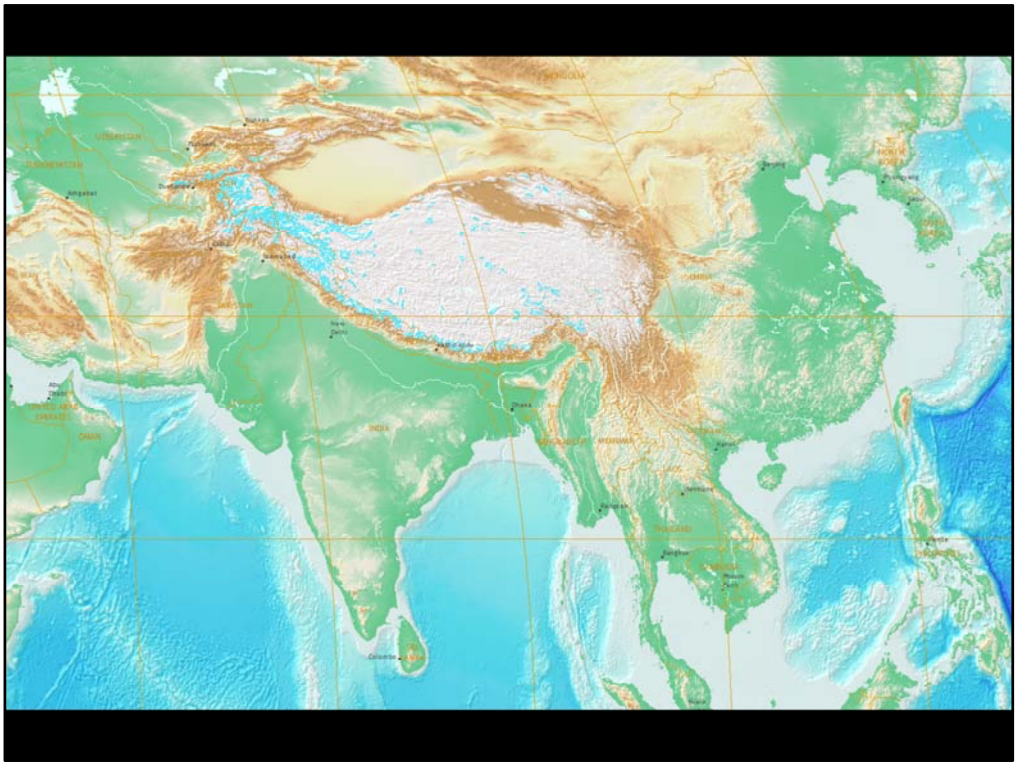
First, you can see that the colors are rich and vibrant.



The darker blues in the deepest areas of the ocean transition smoothly to lighter blue along the shorelines.

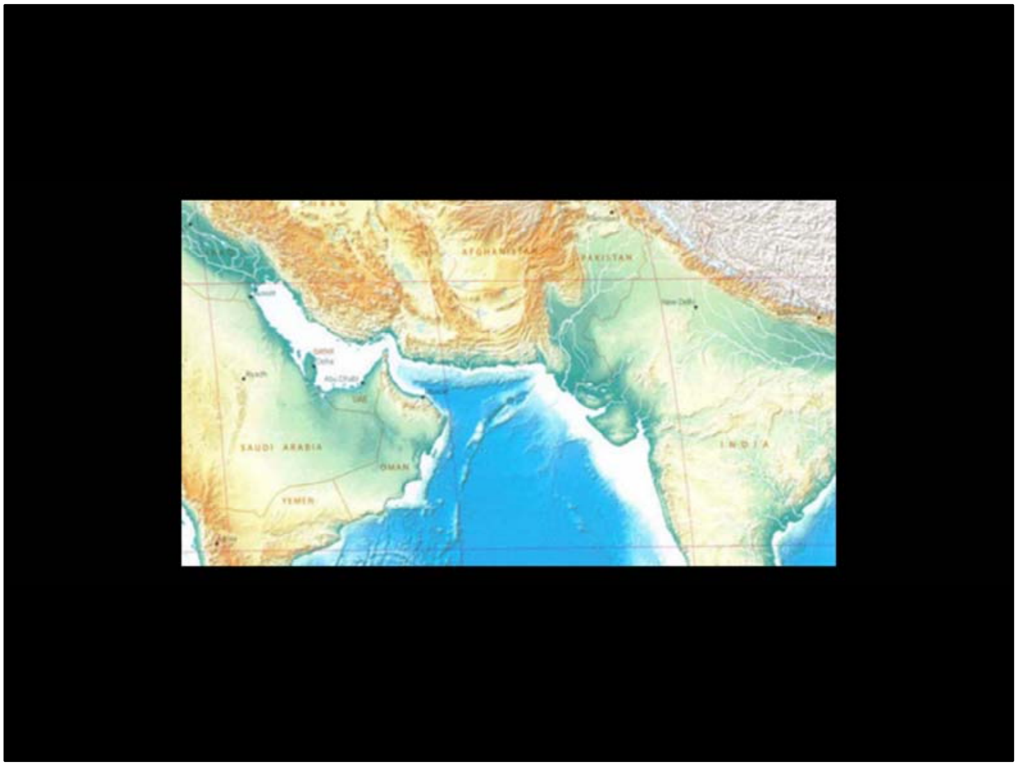
Sea level is apparent by the contrast between the light blue in the water and the highly saturated emerald green on land.

The greens in the low lying valleys also transition smoothly – first to light browns at the lower elevations, then to darker browns in the higher treeless areas, …

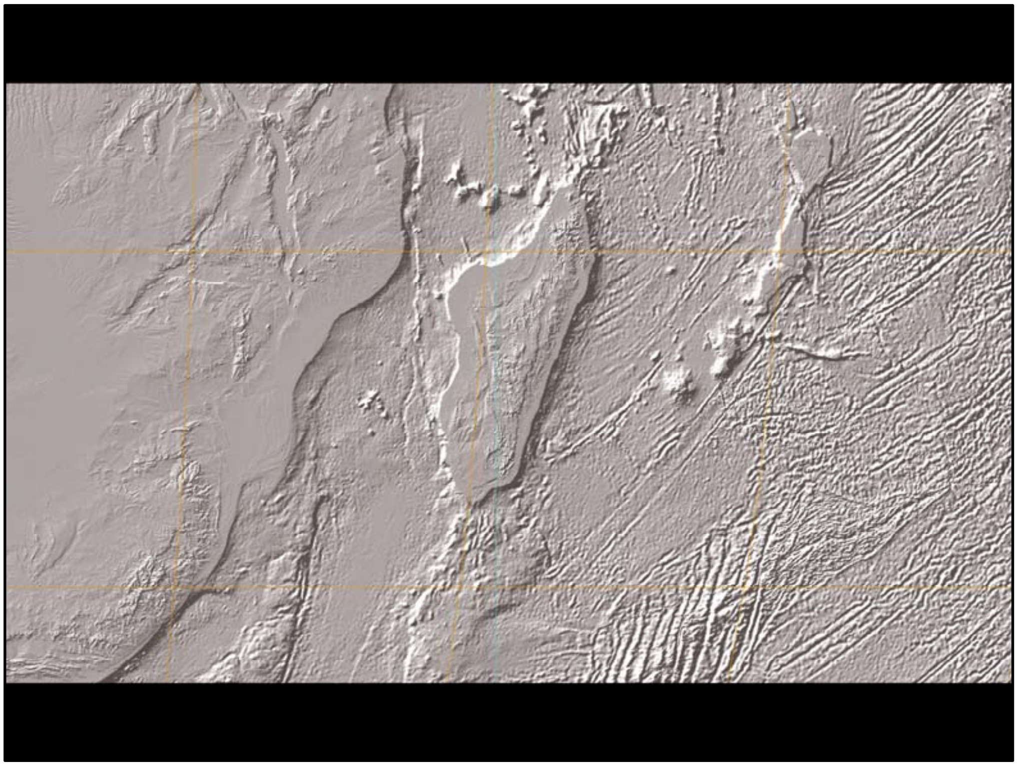


…and finally to white in the snow capped peaks.

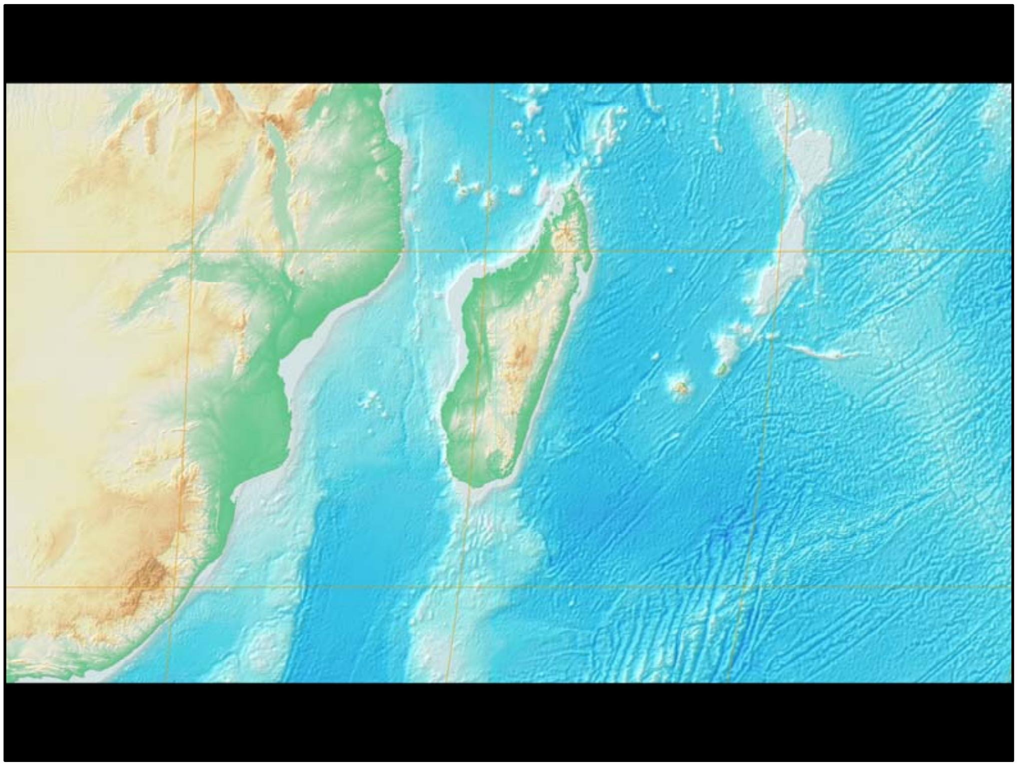
This map was inspired by the "Landforms of the World" by the wonderful cartographers at Raven Maps and Images.



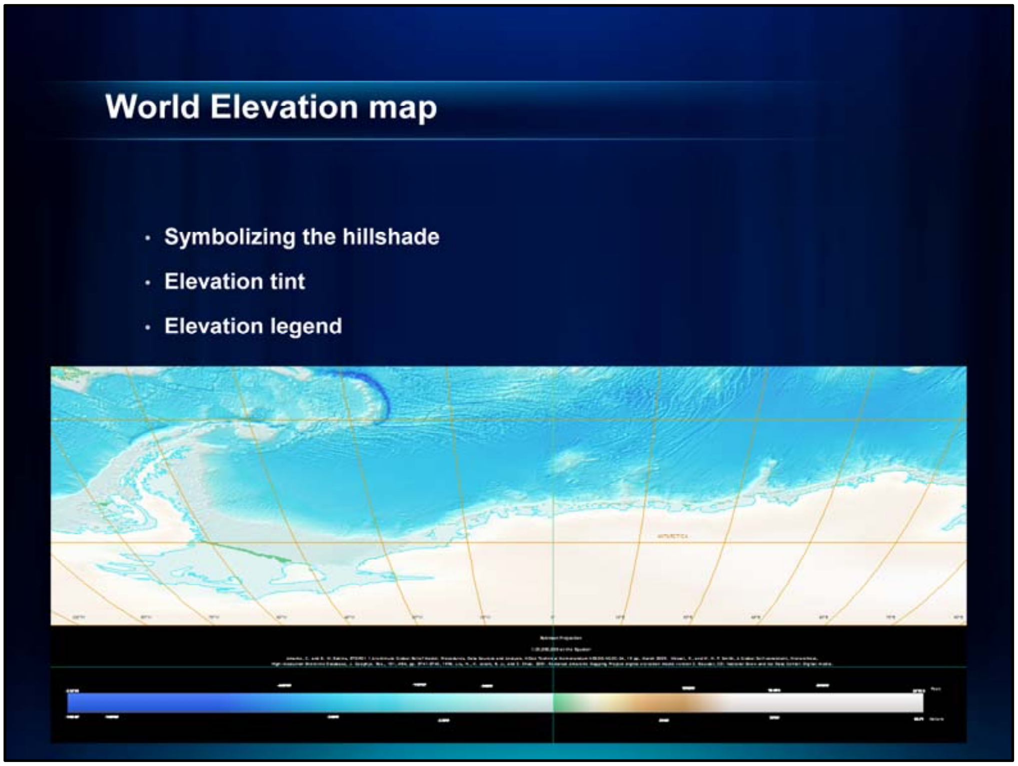
Raven maps are known for their stunning colors combined with their depiction of high levels of detail.



The cartographic effects that I want to talk about in relation to this map include…exaggerating the hillshade using a contrast stretch…



…symbolizing the elevation tint to show bands of elevation in various colors…

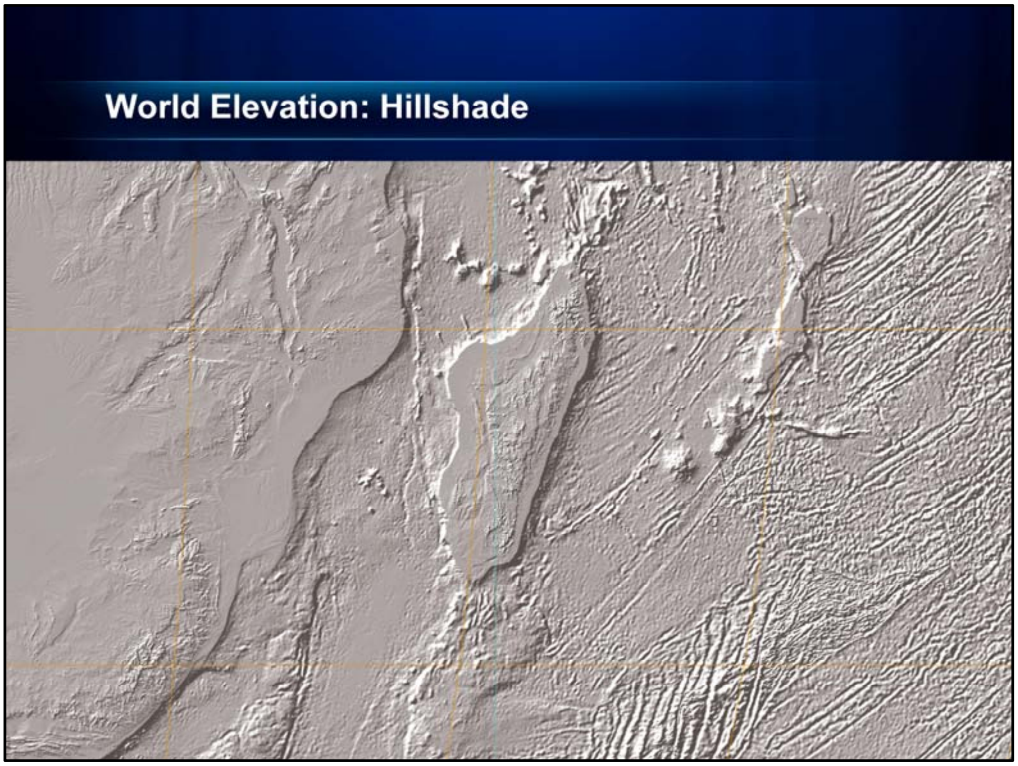


…and creating the elevation legend.

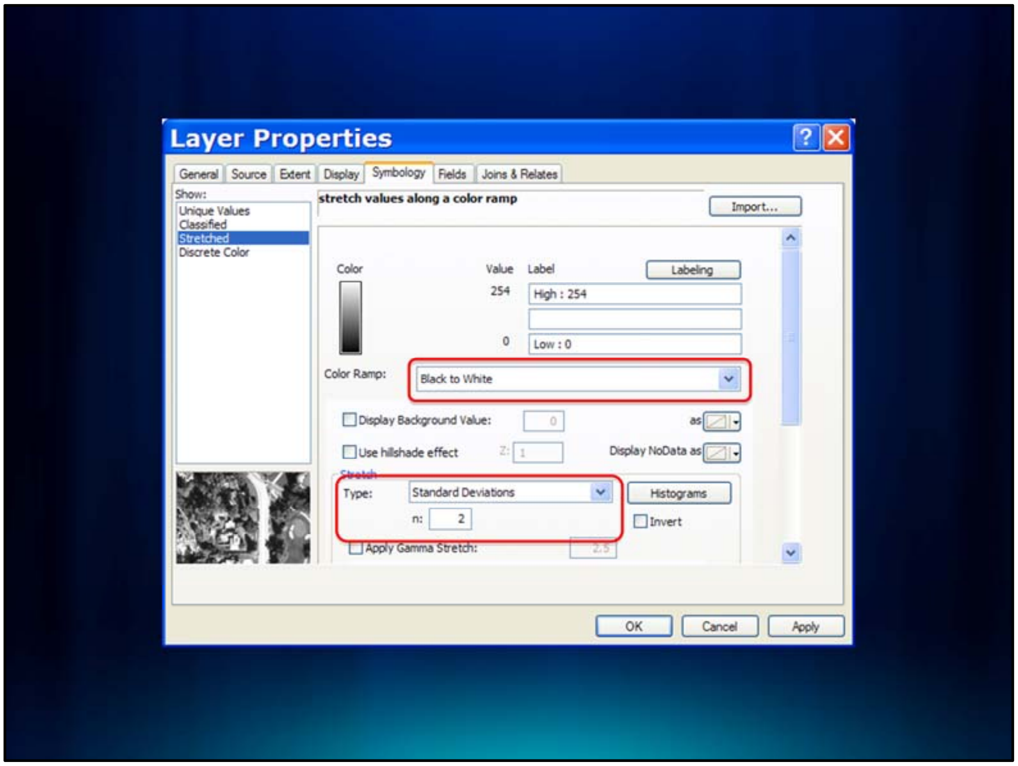
Part of the reason we were compelled to try and produce this map is because the ETOPO1 data became available in early 2009.

ETOPO1 is a 1 arc-minute data global relief model of the Earth's surface that includes both topographic and bathymetric data.

You can download it for free from the National Oceanic and Atmospheric Administration's Web site.

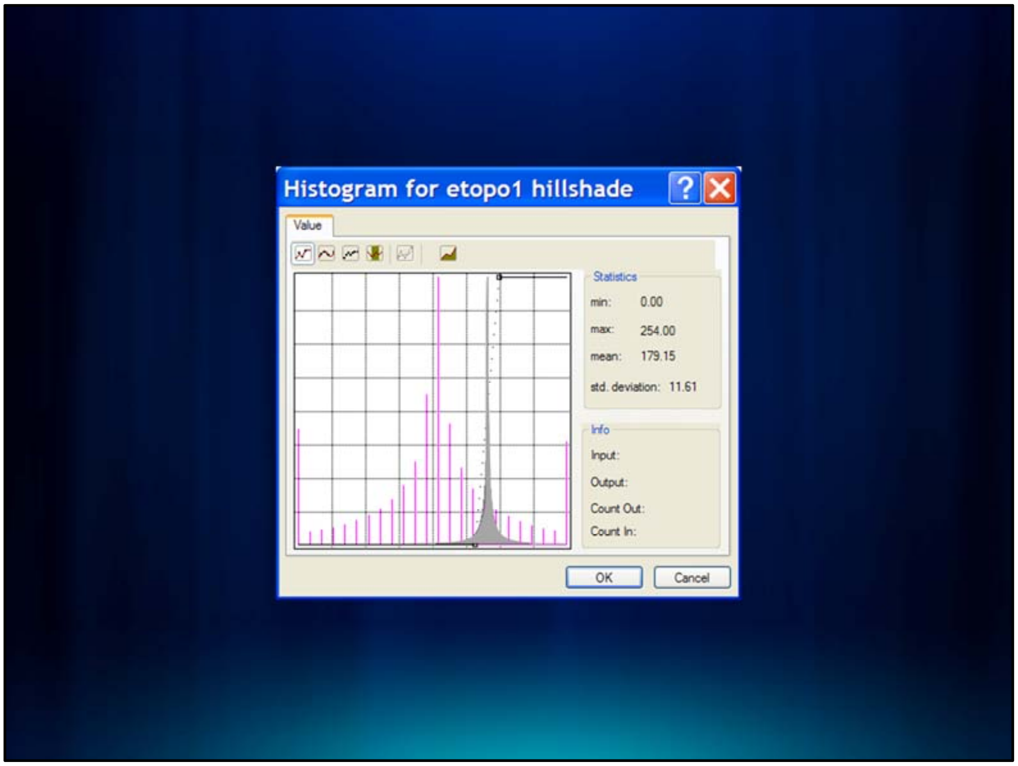


So let's get started with the hillshade. We have talked quite a bit about creating and symbolizing hillshades in past user conference presentations. Today, I want to share with you today something I recently learned about how you can exaggerate the surface without using the Z factor when you create the hillshade. The advantage of this approach is that you do not have to create a new hillshade with different Z factors to find the solution you are looking for.



Let's go into ArcMap so I can demonstrate this for you. Here you see the map document for the World Elevation map. I'll activate the Demo data frame and go into data view. Using the Demo Extent bookmark, you will be able to see more detail.

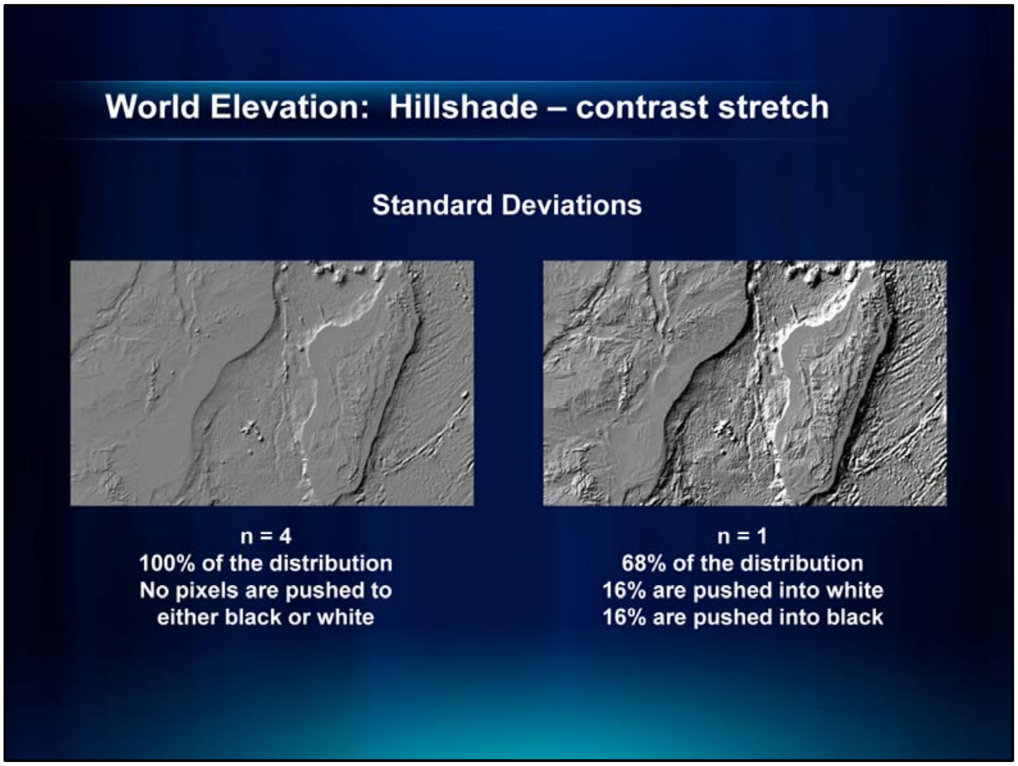
I'll right click the hillshade layer and click the Symbology tab. I'll move the dialog box to the side so you can see the changes I make. Here, we are using the default symbology. You can see now that we are using a black to white color ramp. And you can see that the default Stretch Type is Standard Deviations with n=2.



Let's look at the distribution of values in our data by clicking the Histograms button. First, you can see that the values in our hillshade range from a minimum of 0 to a maximum of 255. The values in our hillshade are represented by the gray area on the histogram. You can see that they are normally distributed about a mean, although that is skewed towards the higher values in the distribution. You can also see that the values are tightly clustered around the mean. This distribution is common for hillshaded surfaces.

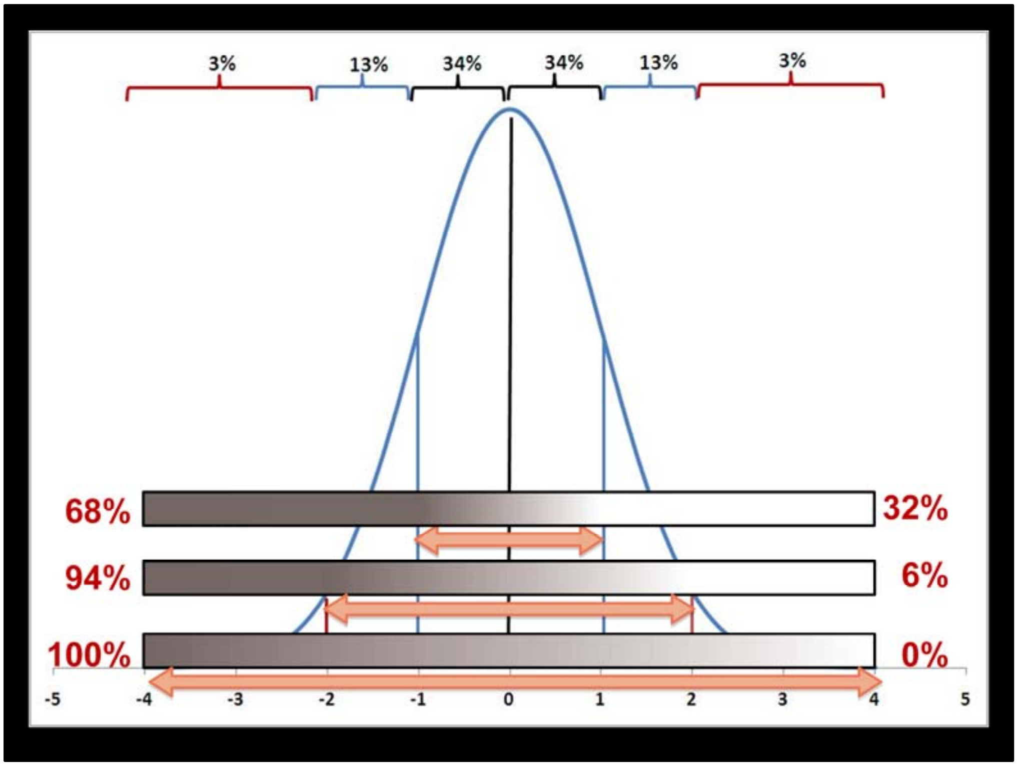
It also means that this majority of values are going to be in the middle range of our color ramp – that is, the medium grays. We need to stretch the values towards the tails so that more pixels are colored black and white.

We can do that by changing the standard deviations. Let's click Cancel to get back to the Symbology tab.



If I change n to 4 and click Apply, you will see that the landforms look less prominent. This is because n=4 also means that we are not applying ANY contrast stretch. Since this is a map of elevation, we might want to slightly exaggerate the hillshade, so instead I'll use 1 standard deviation. Now when I click OK, you can see that there is more contrast.

With one standard deviation the lowest 16% of the pixels become black (or 0), and the highest 16% becomes white (or 255); the rest are scaled linearly from 1 to 254.



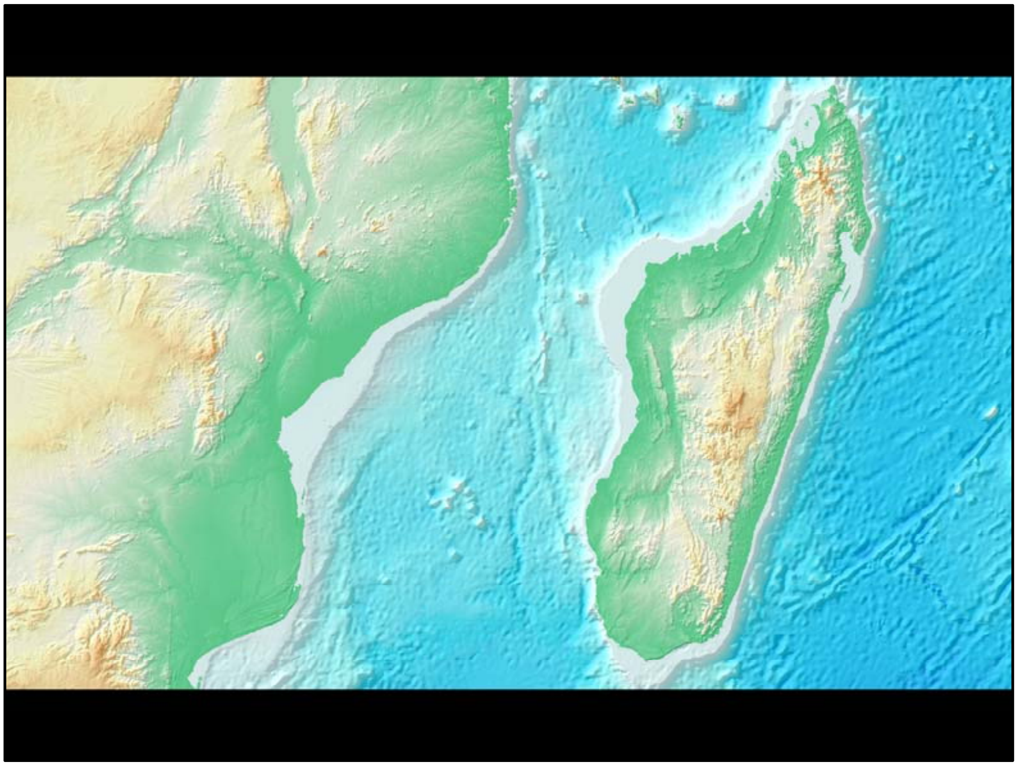
When we use standard deviations for the contrast stretch, we trim all pixels that have a value beyond the specified range, then linearly stretch the remaining pixels to use of the full range of values from 0-255.

So if we use 4 standard deviations, that is 100% of the distribution, so all the pixels are really just getting assigned the color that corresponds to their value in the color ramp.

If we use 3 standard deviations, that is 94% of the distribution so we can stretch 6% of the cells into the darkest and lightest colors – 3% on the dark end and 3% on the light end.

If we use 2 standard deviations, that is only 68% of the distribution so we can stretch 32% of the cells into the darkest and lightest colors – 16% on the dark end and 16% on the light end.

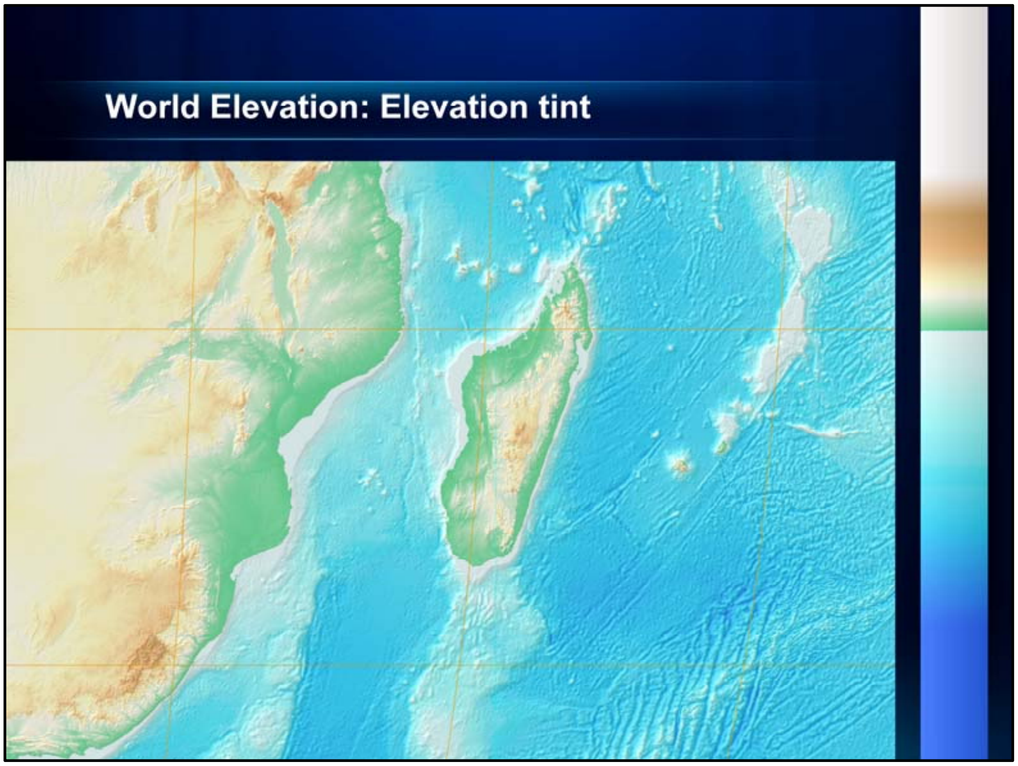
This is why the contrast is so exaggerated for 1 standard deviation. So let's use that for on our map.



There is another thing we could do with this hillshade – we could apply a Gamma stretch. Gamma refers to the degree of contrast between the mid-level gray values of a raster dataset. Gamma does not affect the black or white values in a raster dataset, only the middle values. By applying a gamma stretch, you can control the overall brightness of a raster dataset. We'll Apply a Gamma Stretch and change the value to 1.5 so you can see the effect.

This might be the type of hillshade we want to display under our elevation tint because our colors for the elevations are so bright and vivid. If we use a hillshade with a lot of gray in it, and then we display the transparent elevation tint over the hillshade, the colors of the elevation tint will become <u>less</u> saturated and vibrant.

Now if we close the layer properties dialog and turn on the elevation tint, you can see that we are exaggerating the elevation, but we are <u>not</u> de-saturating the colors with the gray in the underlying hillshade.

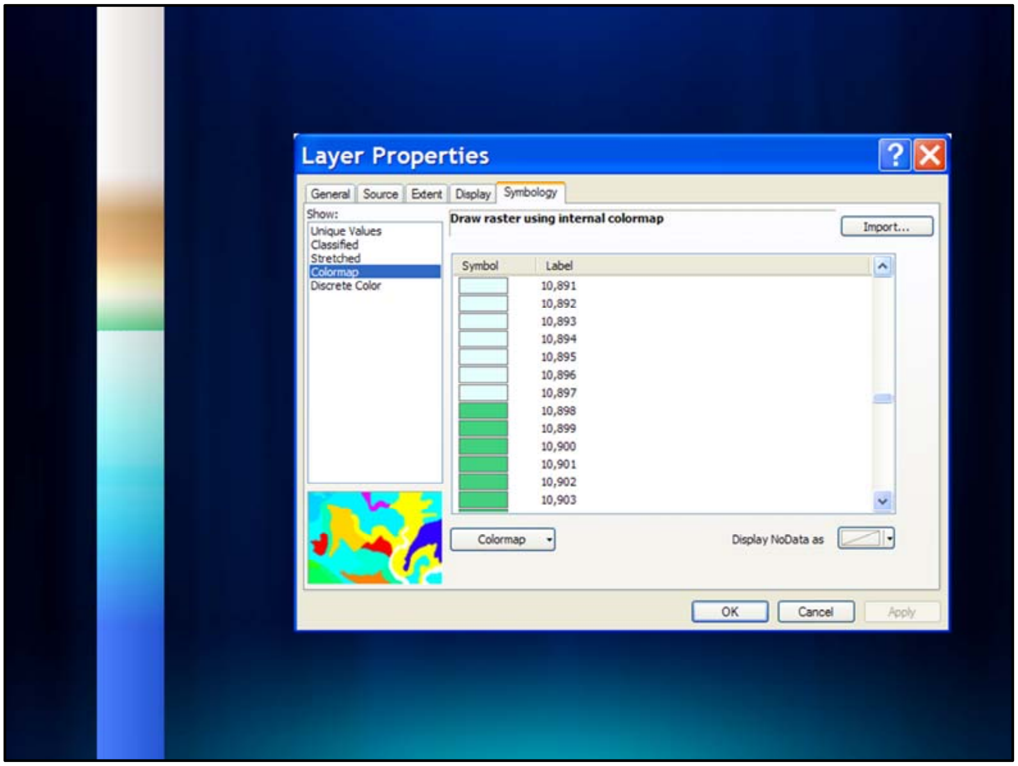


Let's move on now to the elevation tint.

First, let's open the layer properties for the etopo1 data which is the data that we originally downloaded from NOAA. If we click the Source tab, and scroll down to the bottom, you will see that the minimum value for the deepest part of the ocean is about -11,000 meters. The highest value is about 8200 meters.

What we want to do now is to assign colors across this range of values so that the blues are in the ocean and the greens, browns and whites are on land. We can assign colors to these elevation values using what cartographers call an elevation tint.

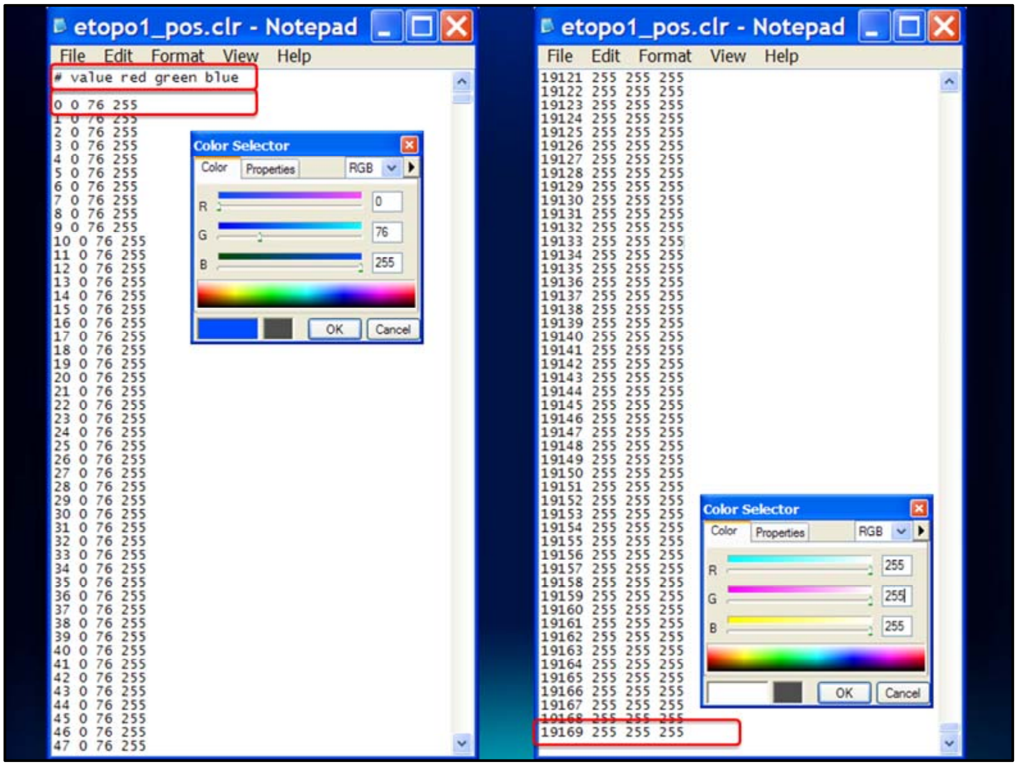
To explain this in more detail, I am going to go back to the PowerPoint slides.



Elevation tints are used by cartographers to assign specific colors to specific bands of elevation. On this map, the colors range from dark blues to light blues in the water and from greens to browns to white on land.

You may be familiar with using color ramps to achieve this effect, but because of the data we are using, which includes both surface elevation and bathymetry, we used a different method called a color map.

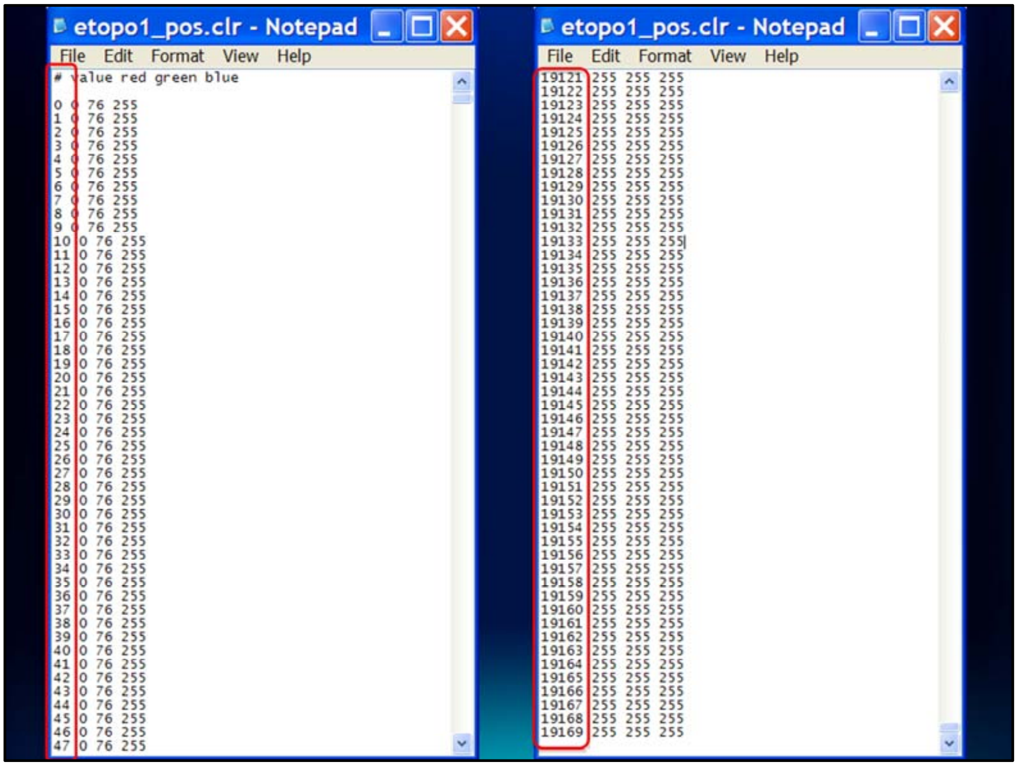
The primary reason we used a color map instead of a color ramp for this map was that we wanted greater control over the colors used and what elevations the colors represent on the map. This was especially important since we needed to depict the exact break between land and water.



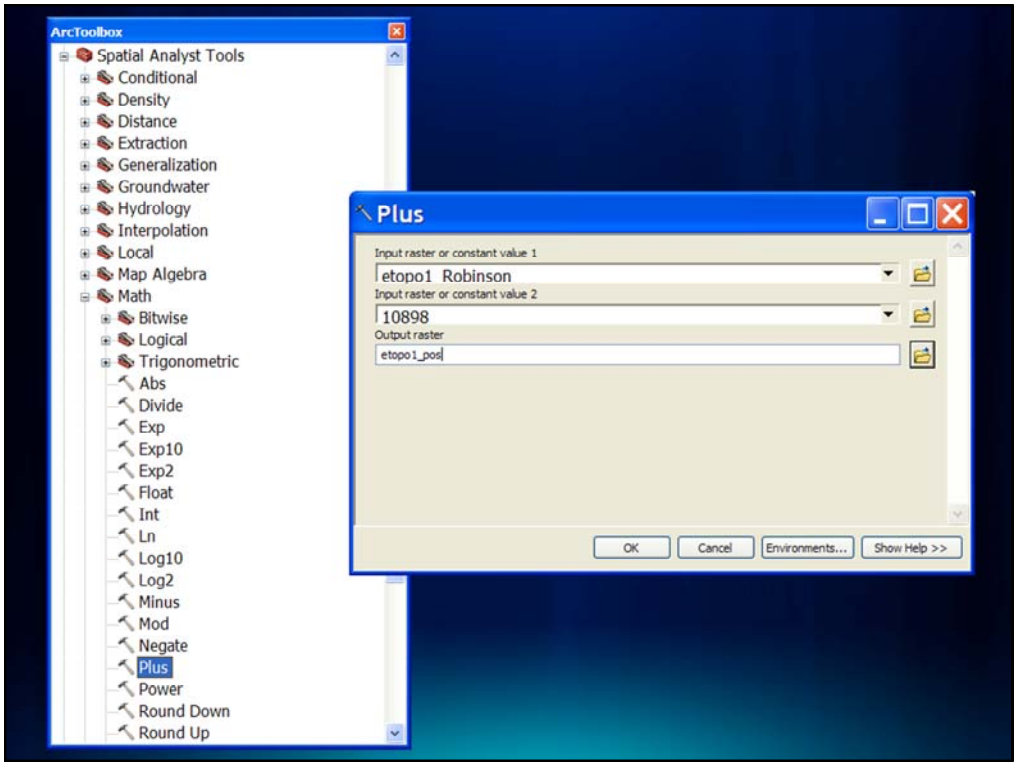
A color map gives you this control because each elevation value is assigned a specific color. If we look at the color map file itself, which is a text tile, you will see that there are four columns of numbers.

The first line, which is commented out using the pound (#) sign, tells you what those values represent. The first column is the elevation value. Then next three columns are the color definition using the Red, Green, Blue or RGB color model.

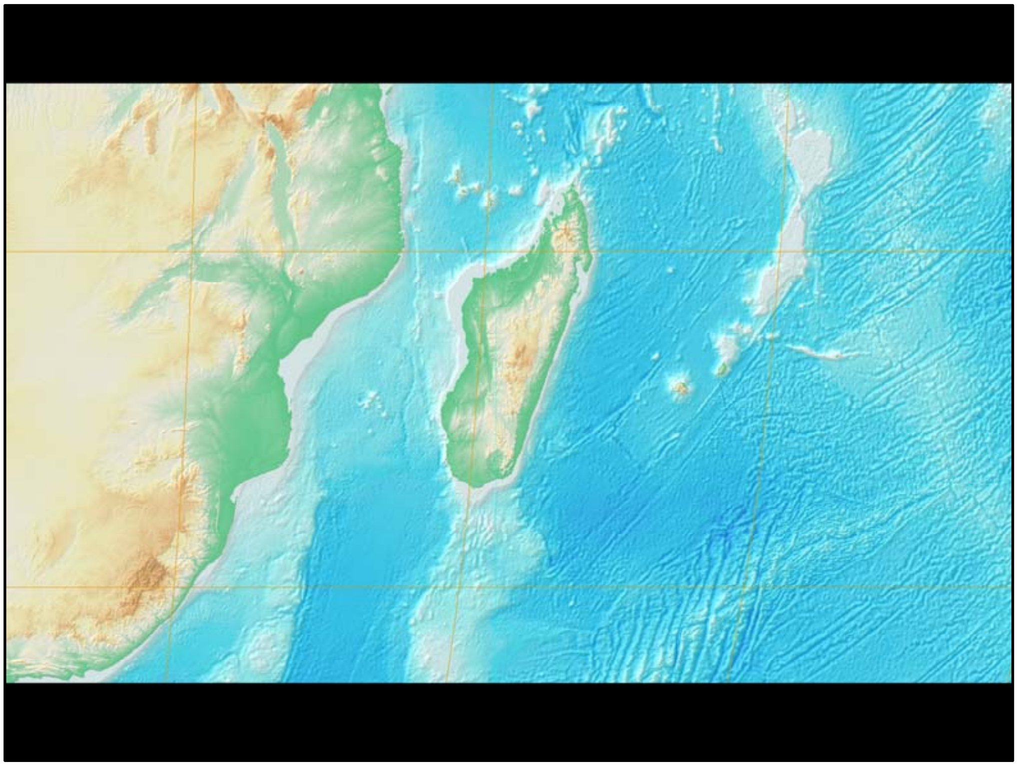
The values in this color model range from 1 to 255. So a value of 0, 76, 255 is the dark blue that we used for our deepest water, and a value of 255, 255, 255 is white which we used to show the snow at our highest elevations.



If you take a look at the elevation values in this file, you will notice that they are all positive – which is not of course how our original data recorded the elevations. We had to create a new raster with positive values because a limitation of color maps is that all of the values in them must be positive integers

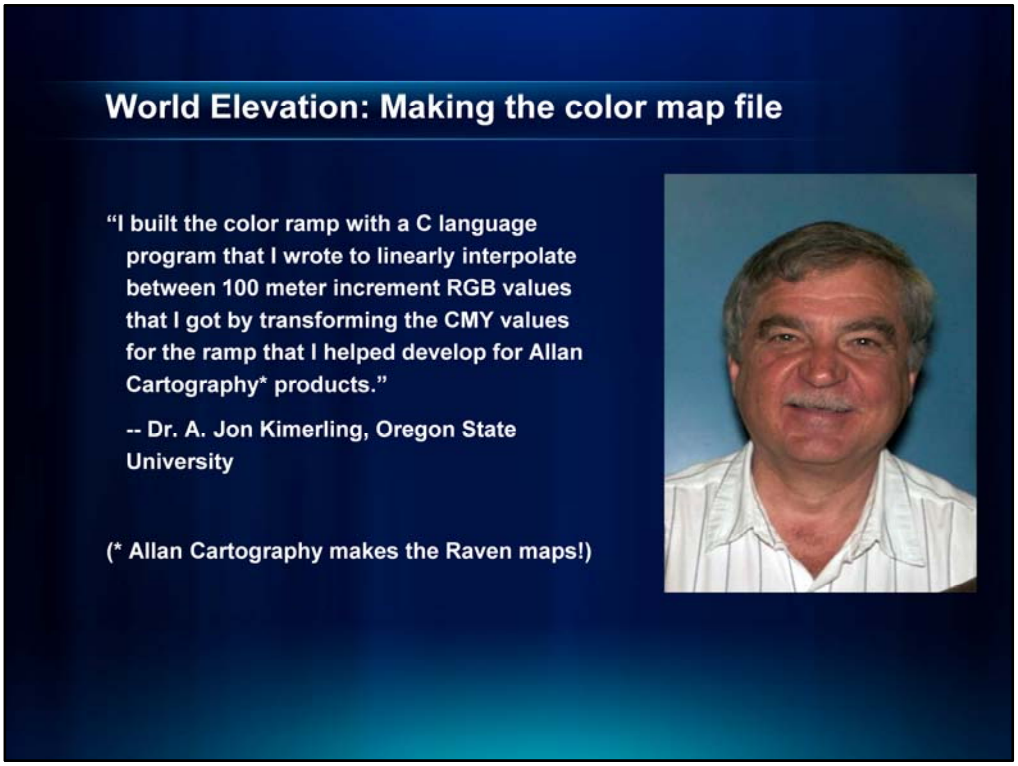


To make the new raster, we used the Plus tool in the Math toolset of the Spatial Analyst toolbox. We simply added the lowest elevation value, 10,898, to all the elevation values to force them to be positive. Now we could apply our color map to the new raster.



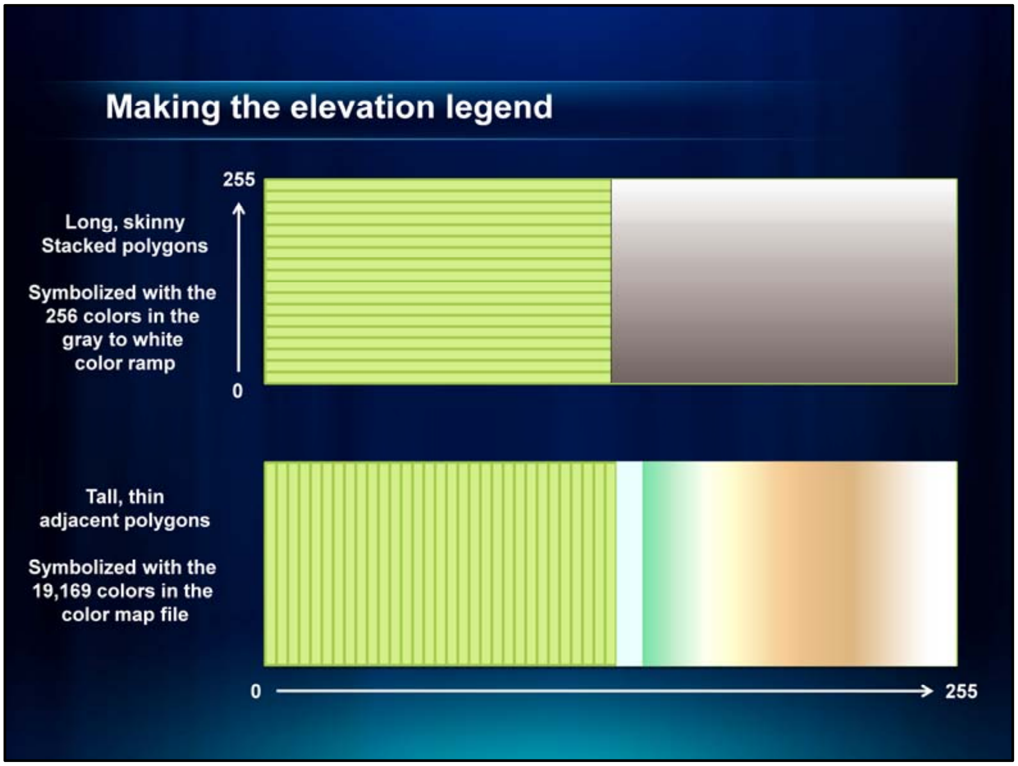
To do that, all you need to do is make sure that the color map file is in the same location as the DEM elevation data. When you add the elevation data to the map, the color map will automatically be applied.

The hardest part of using this method is determining which colors will relate to which elevations values. This is the real artistic part of achieving this cartographic effect.



At this point, I must acknowledge the wonderful work of Dr. Jon Kimerling, professor emeritus of Oregon State University. He created this color map and let me use it to show you how this map can be made. Note that he also developed the color maps for the other Allan Cartography products – Stuart Allan also owns Raven Maps and Images!

The last thing I'll talk about for this map is the elevation legend. This was created in two layers – the bottom layer is symbolized the same as the hillshade and the top one layer uses the color map file again. In order to use the transparency settings and apply the color ramp, I had to create the legend as two rasters in the size and shape of the legend I wanted on the map. Here's how I did it.



I essentially created two polygon feature classes – each with the same number of polygons as the number of values in the raster file.

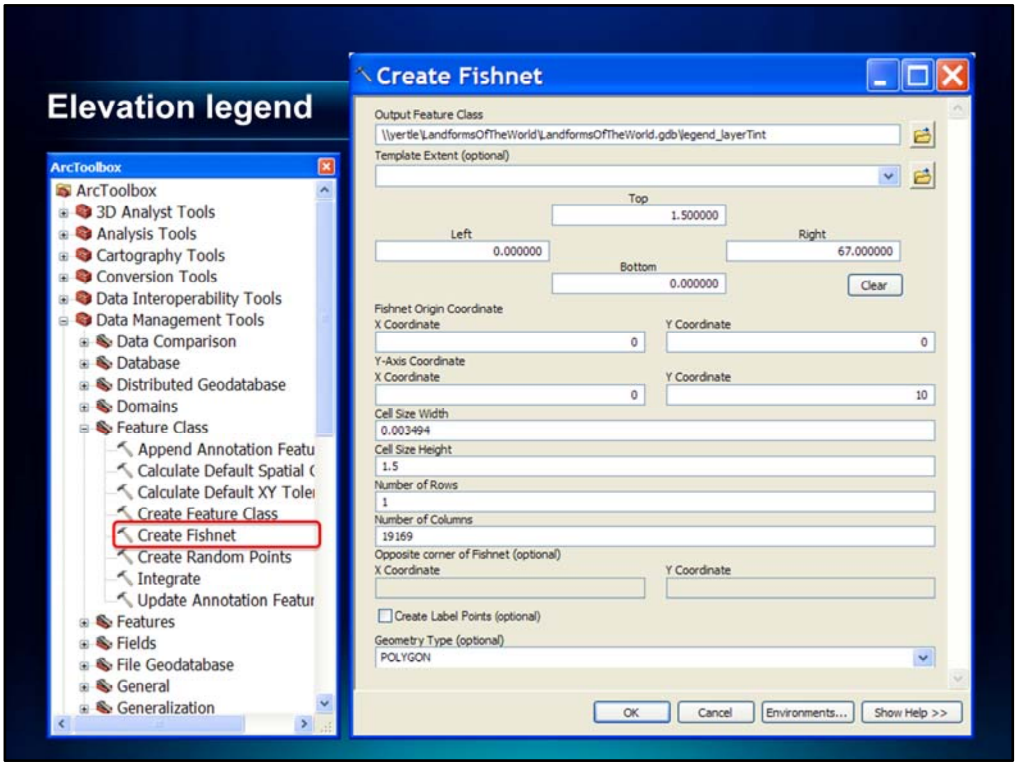
For the hillshade part of the legend, I needed 255 polygons that I could apply the modified black to white color ramp to. These were created as long skinny polygons stacked on top of each other.

For the elevation tint part of the legend, I needed 19,169 polygons that I could apply each of the colors in the color map file to. I created these as tall thin polygons adjacent to each other.

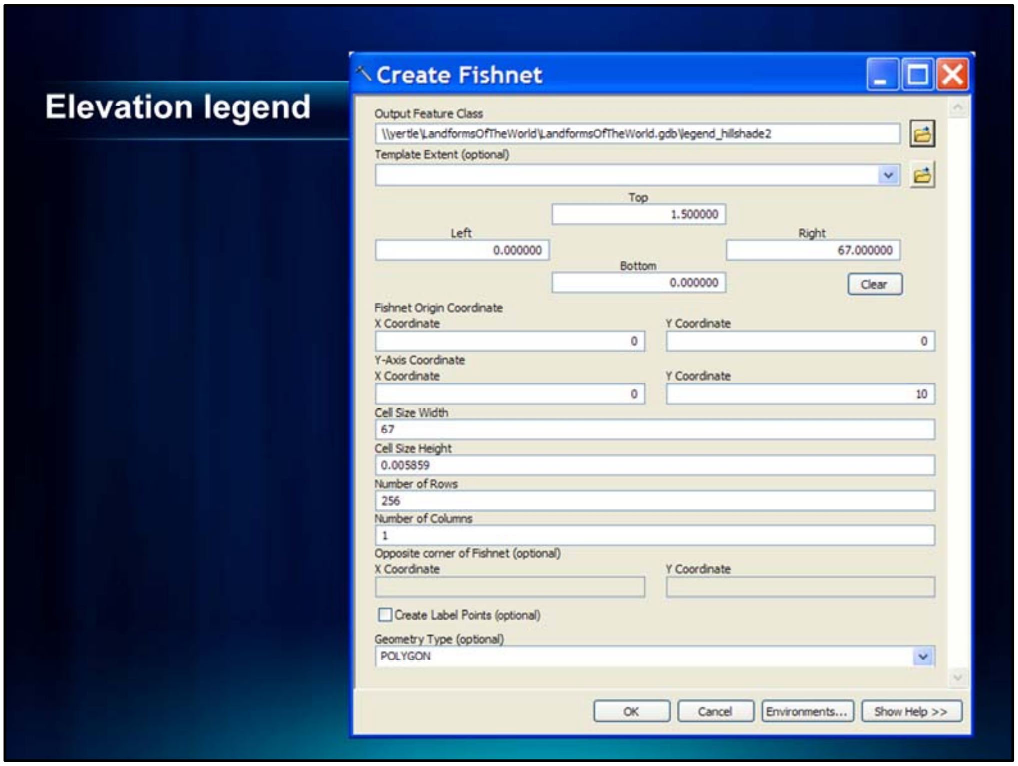
Then I converted these polygon feature classes to rasters so that the range of values in one was 0-255 and the range of values in the other was 0-19169.

Now I could apply the same symbology as I used for the hillshade and elevation tint on the map.

While I won't go into further detail here, I do include the instructions for making this legend in the bottom notes of the presentation which you can download from Mapping Center.

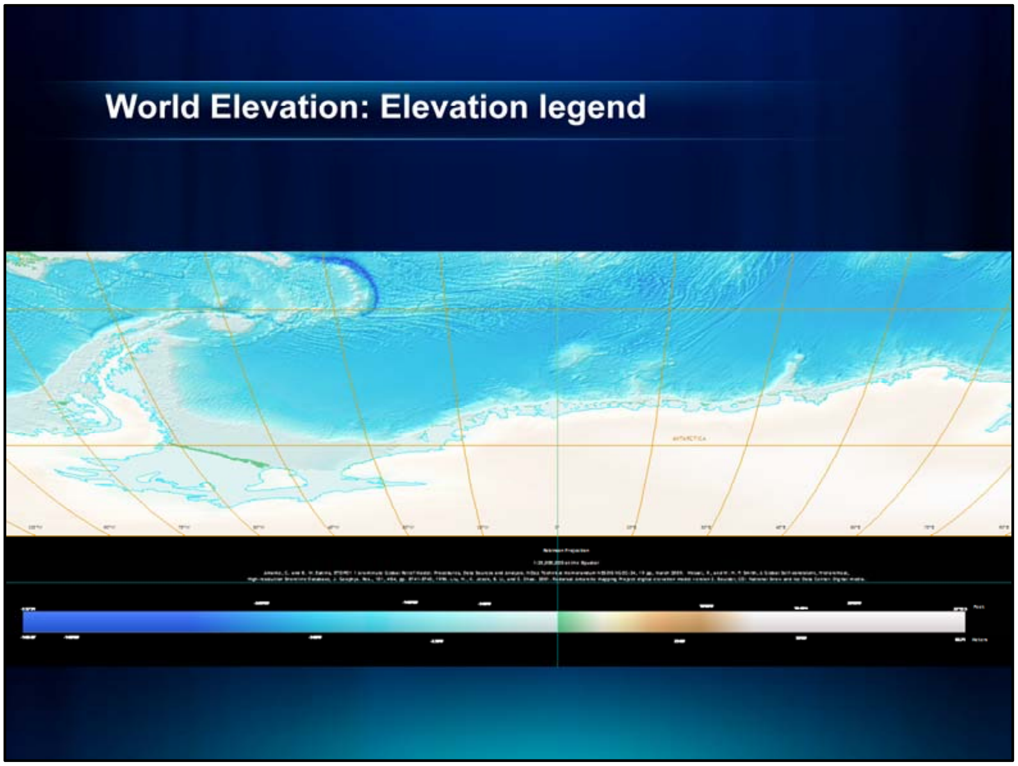


Using the Create Fishnet tool, which is in the Data Management toolbox in the Feature Class toolset, I created two polygon feature classes. I determined that rasters that were 1.5 degrees high and 67 degrees long (in WGS48 coordinates for a map at 1:25,000,000) would be exactly the size I wanted for the legend. The fishnet for the elevation tint was one row wide and 19,169 columns wide.



The fishnet for the elevation tint was one row high and 19,169 columns wide.

I defined the projection for each to be WGS84, then I converted each into rasters using the OID as the Value. That meant the raster for the elevation tint had columns of pixel values that ranged from 0 to 19,169, and raster for the hillshade had rows of pixel values that ranged from 0 to 256.



Once I had the rasters, all I had to do was assign the same symbology as I had for the hillshade and the elevation tint. For the hillshade part of the legend, I simply used the hillshade color ramp that I saved when I symbolized the hillshade on the map. For the elevation tint part of the legend, I copied the color map file and gave the copy the same name as the raster in the legend. When when I added the legend raster to the map, the color map was automatically applied. I set the transparency to 30% as on the map.

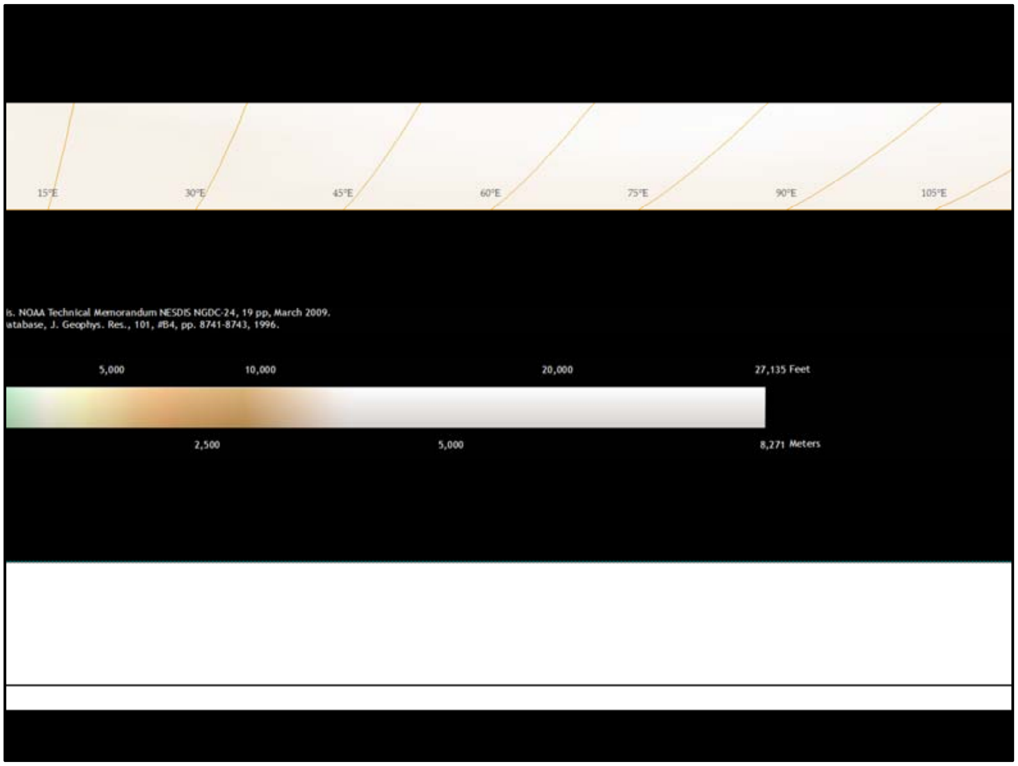
The values along the color ramp were easy to create. Recall that we have a fishnet with 19,169 tall thin polygons in it, each with a value that equals the elevation in meters plus 10,898. I added this feature class to my map. Then I opened the attribute table and added two new long integer fields to the attribute table and calculated the first to equal the OID – 10,898 – this field was called “meters”. The other field, called “feet”, was populated by multiplying the meters field by 3.2808 – the factor for converting from feet to meters.

I set the symbology to no color for the outline and the fill and on the Definition Query tab, I created a query to define which of the meter values I wanted to show in the legend. On the labels tab, I set the symbology for the label and then I set an offset so that the labels were positioned under the legend like I wanted them to be.

I copied this feature class in the table of Contents, opened up the Properties for the layer and on the Definition Query tab, changed the query to define the feet values I wanted to show in the legend. On the labels tab, I changed the offset to place the labels above the legend.

Then all I had to do was add two text boxes with “meters” and “feet” and place them after the last label on the legend.

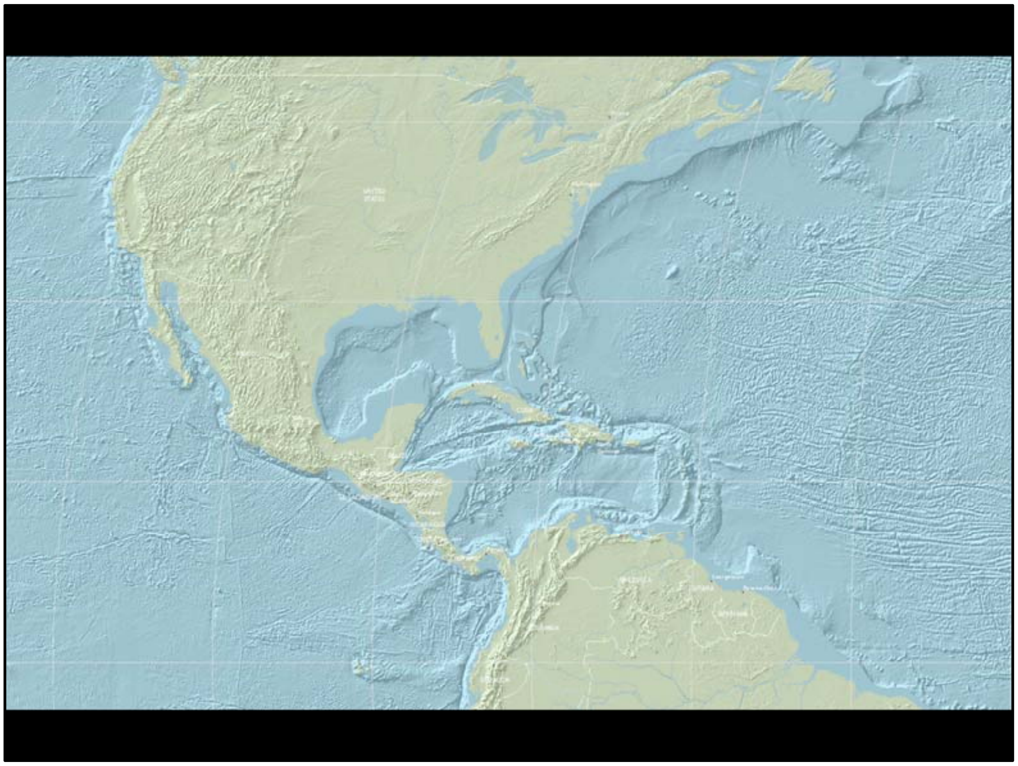
So that brings us to the end of our first map.



The final step in creating the legend was to add labels for the meters and feet, and then I was done!

Once I had the map for World Elevation, making a map of World Landforms was pretty easy. For this map, I replaced the layer tint with a polygon feature class that has the land and ocean areas. I used a light green tint for the land and a light blue tint for the ocean. I also added the glaciated areas and ice sheets.

The nice thing about this map is that the eye can see the landform detail a little better. To help keep the attention on the landforms, I used white text and a light gray graticule.



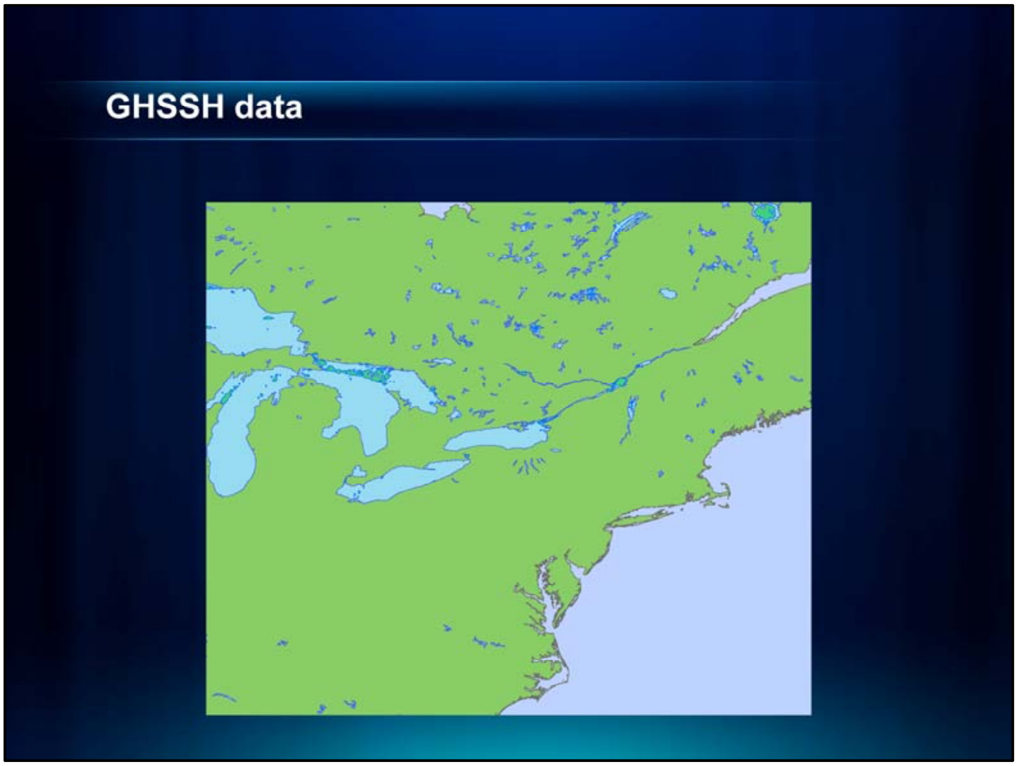
With these changes, the map reader can focus on the landforms in both the water and land areas.

The land/water polygon data that aligned with the etopo1 data that we used is a dataset that is available through a link on the etopo1 data download Web site. (DON'T SAY THIS -- On the ETOPO1 Web page, scroll down to the bottom and click the Data Sources & More Information link. On the ETOPO1 Data Sources page, scroll down to the bottom and click the GSHHS link.)

It is the Global Self-consistent, Hierarchical, High-resolution Shoreline or GHSSH Database. It is a set of coastline data sets at five different levels of generalization. In addition, the lakes on the land, the islands in the lakes on the land, and the ponds in the islands on the lakes on the land are also included! Again – all of these come in 5 levels of generalization.

Now, I want to show you these data so I'll switch to ArcMap now.

(To create the ocean polygons that we needed for symbolization, we performed a union with that polygon data set and one that we created for the extent of the world from 90 degrees north and south to 180 degrees east and west. The result was a feature class that had polygons for the areas of land and the rest were polygons for the area of ocean. We added this to our map and symbolized the oceans with a solid blue and a blue outline, and we did not fill the land area polygons.)



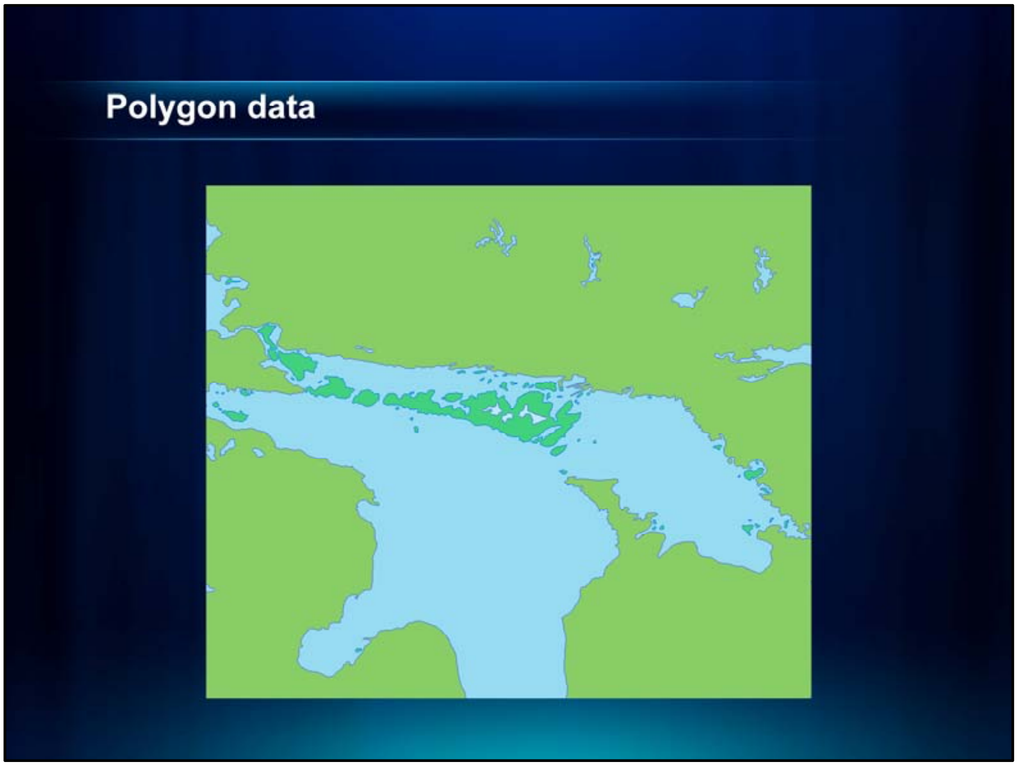
We'll open up our World Elevation map document and activate the GSHHS Demo Data frame and go to Data View.

Here, we'll use our Resolution bookmark and so you can see the data at its lowest resolution – if you look at the file name in the Table of Contents, you will see that the original fine names have letters in the middle – I use the words in the parentheses to keep them straight in my mind.

Now I will turn on increasingly detailed data. (And turn off the coarser ones so it draws faster.)

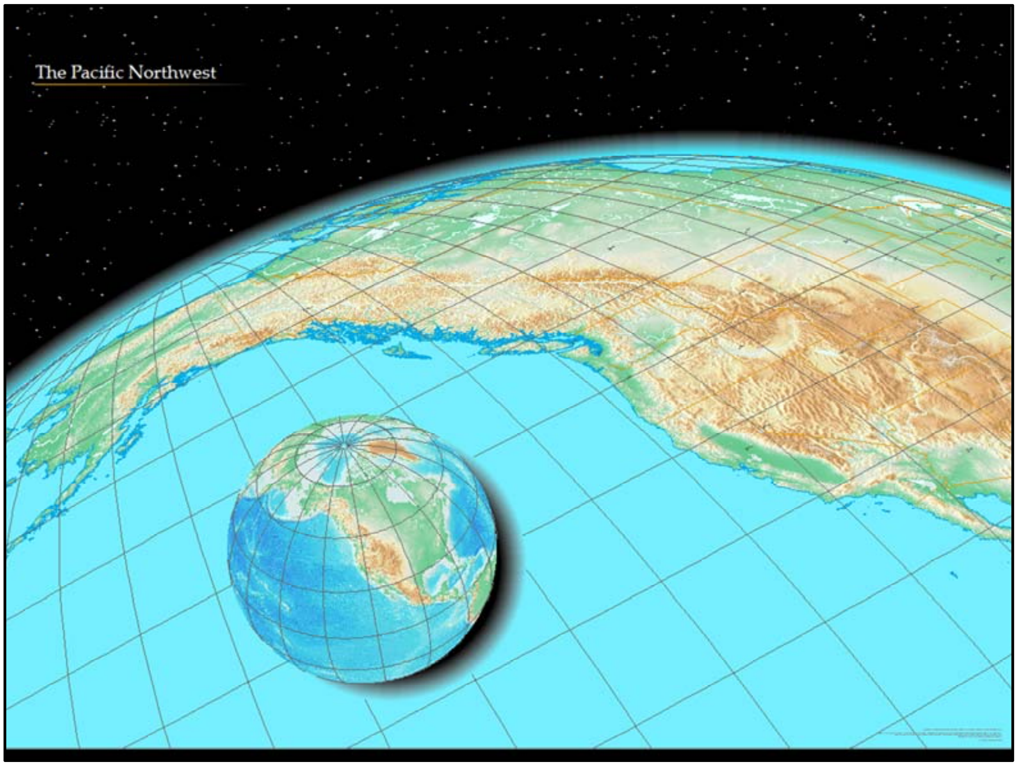
You can see that you have 5 levels to choose from.

I'll open the group layer for the data with the highest level of resolution, you'll see some additional layers. Now I'll use the Lakes and Ponds bookmarks so that you can see that there are also lakes, islands, and ponds on islands. All of these are available for all 5 levels of resolution.

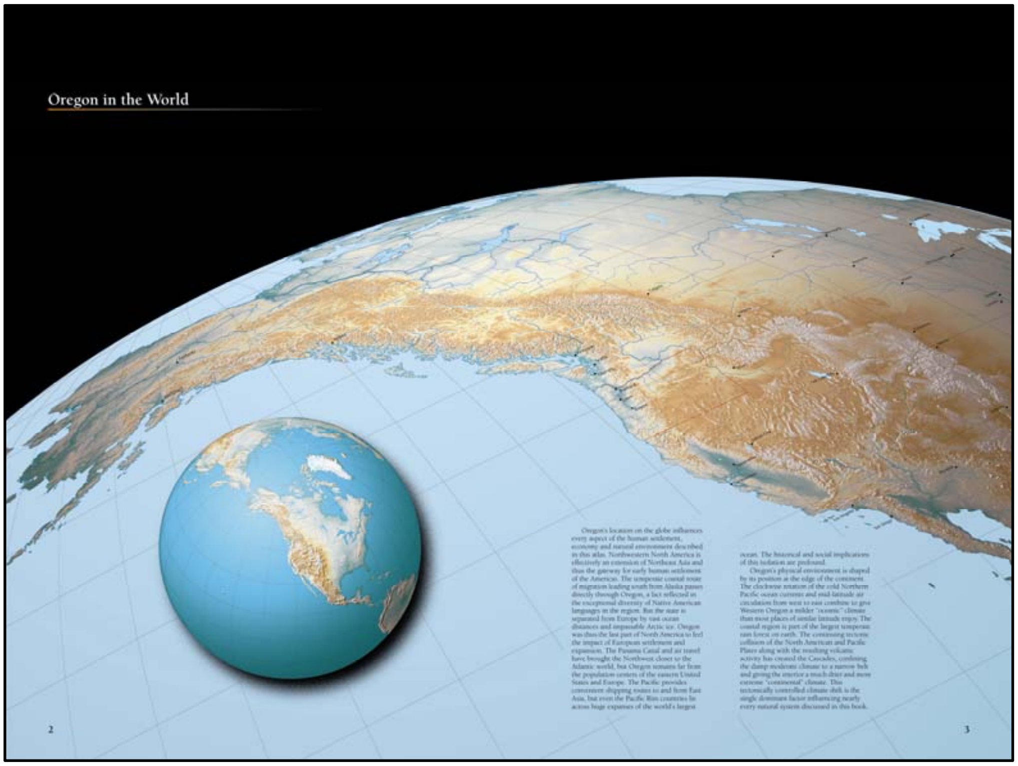


The data are lines when you download them. We went ahead and made them into polygons so that there is an attribute you can use to identify whether they are land or water polygons. We will soon put the on Mapping Center so you can download them.

And we are working on creating a set of coastal vignettes from these that you can also download, but I won't go into what that means right now as Mamata will talk about that in her demo.;



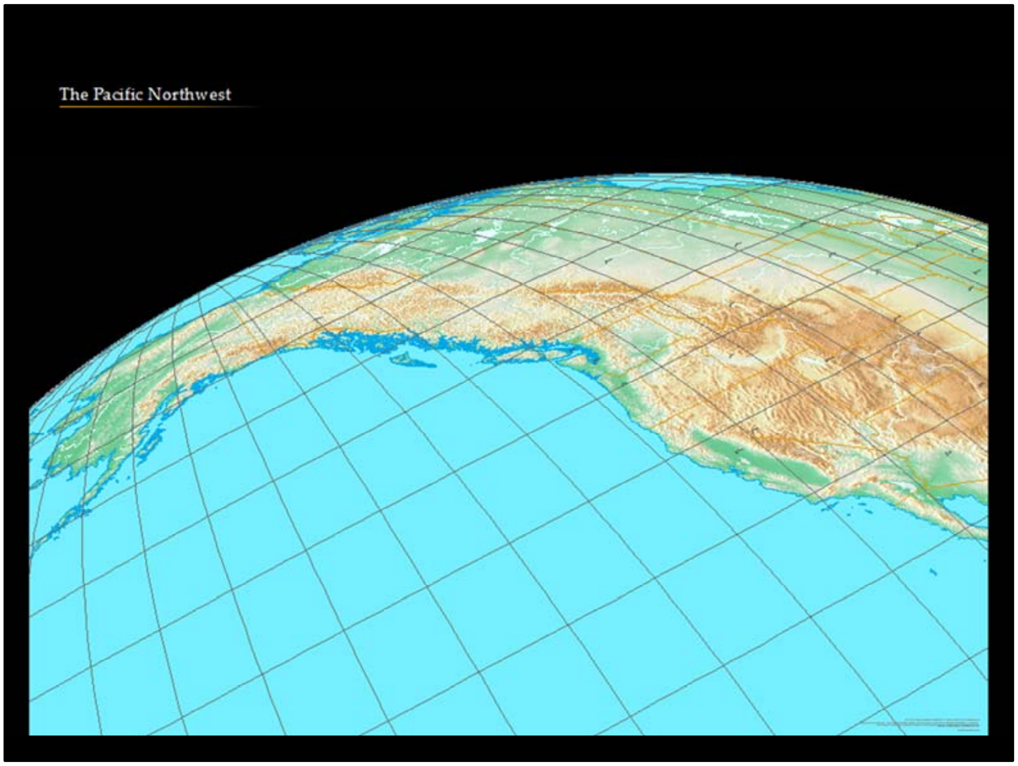
Now that we had the symbology worked out so well, we decided to re-purpose this map to make another. This was a map of the Pacific Northwest.



The map that inspired was the “Oregon in the World” map in the *Atlas of Oregon* that I worked in 2001 before I came to Esri.

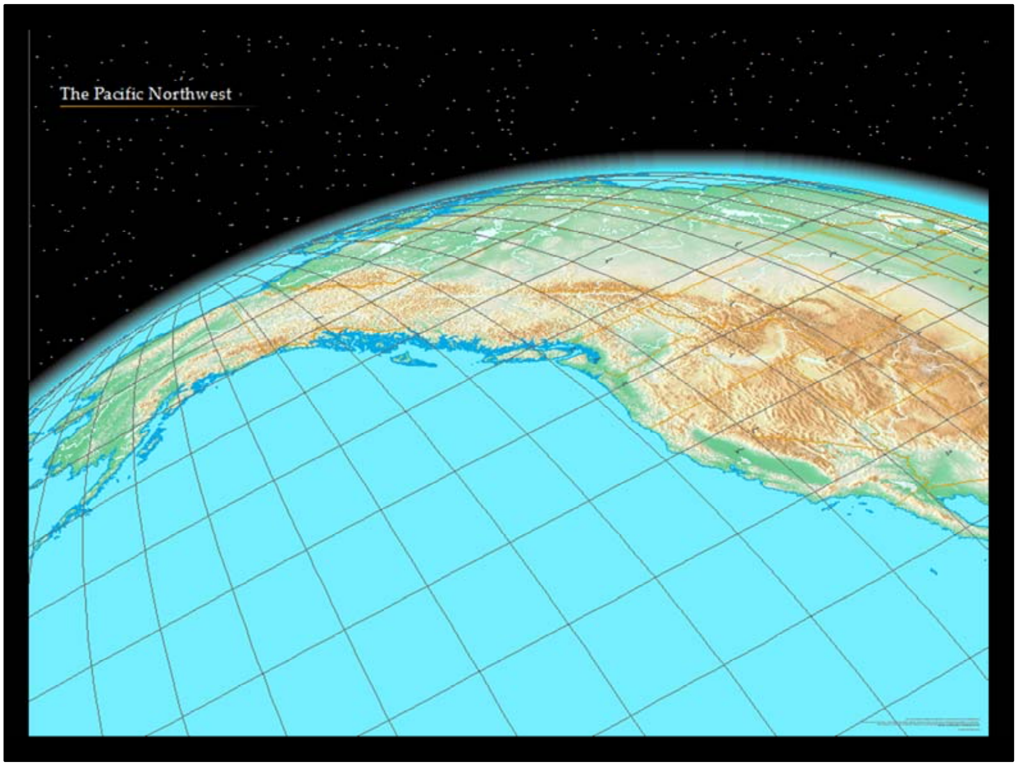
You can probably guess that the folks at Raven Maps also worked on this atlas. The beautiful teal and tan tones and the stunning landform detail give that away.

The edge of the world and the inset globe create a three-dimensional feeling that draws in the map reader. Here, the map projections provide much of the visual appeal.

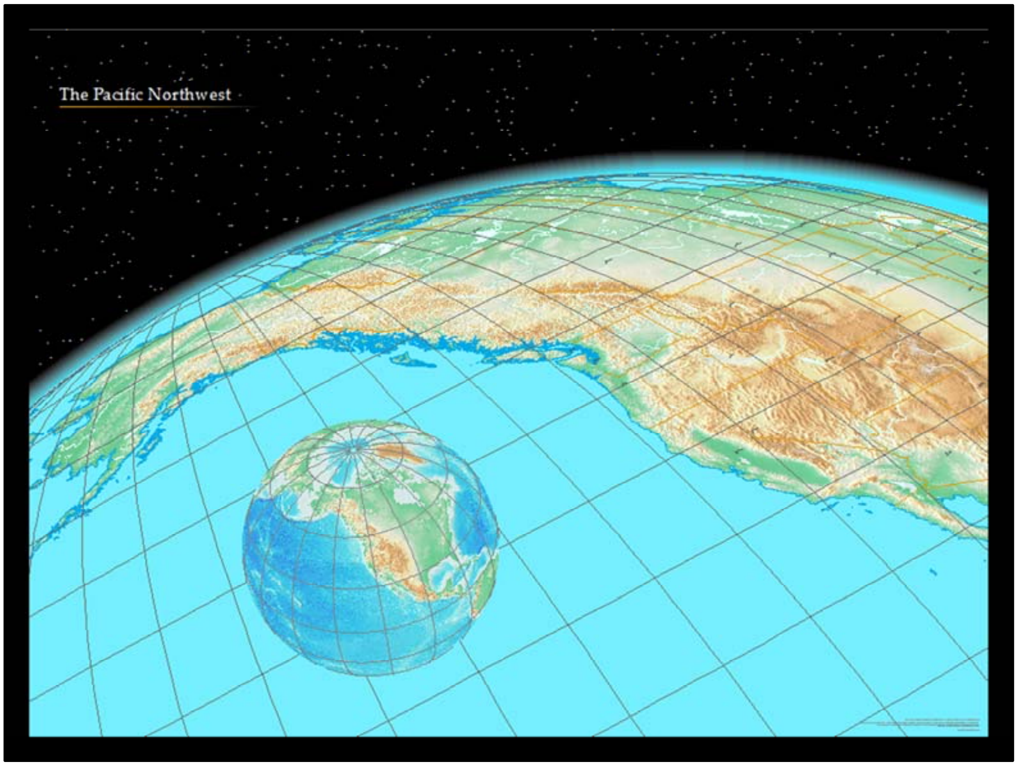


For this map, we started with the World Elevation map and made a few changes, including…

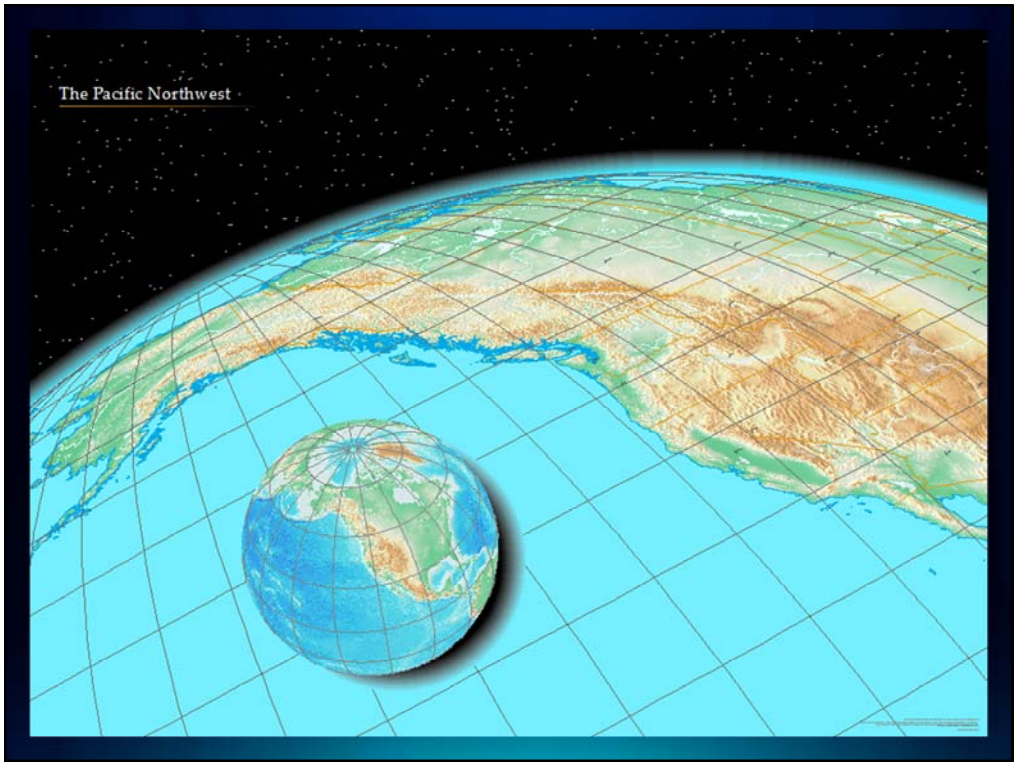
…using a different projection,…



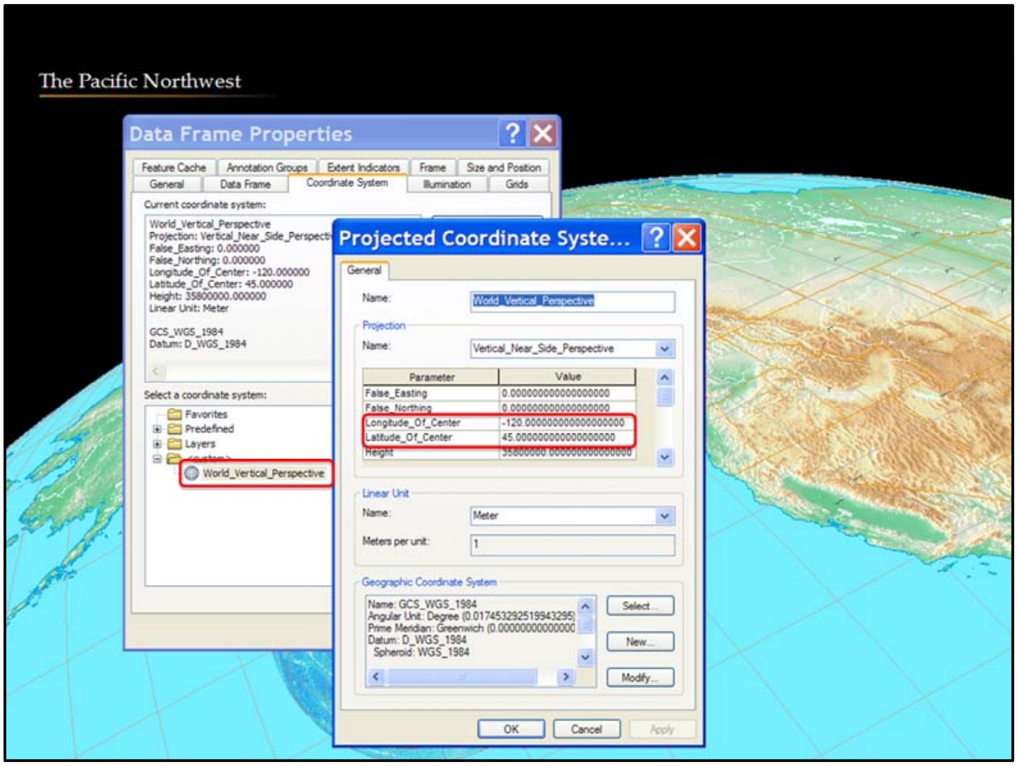
…adding stars to the background and a representation of the atmosphere to the main map.



Then we added the globe map…



…as well as a shadow for the globe. Our summer intern, Paulo Raposo, did a lot of this work – let's see what he did.



Let's go into ArcMap to start with the projection.

I'll activate the Demo data frame and go into Data View. Here you can see the etopo1 data we used on the last map.

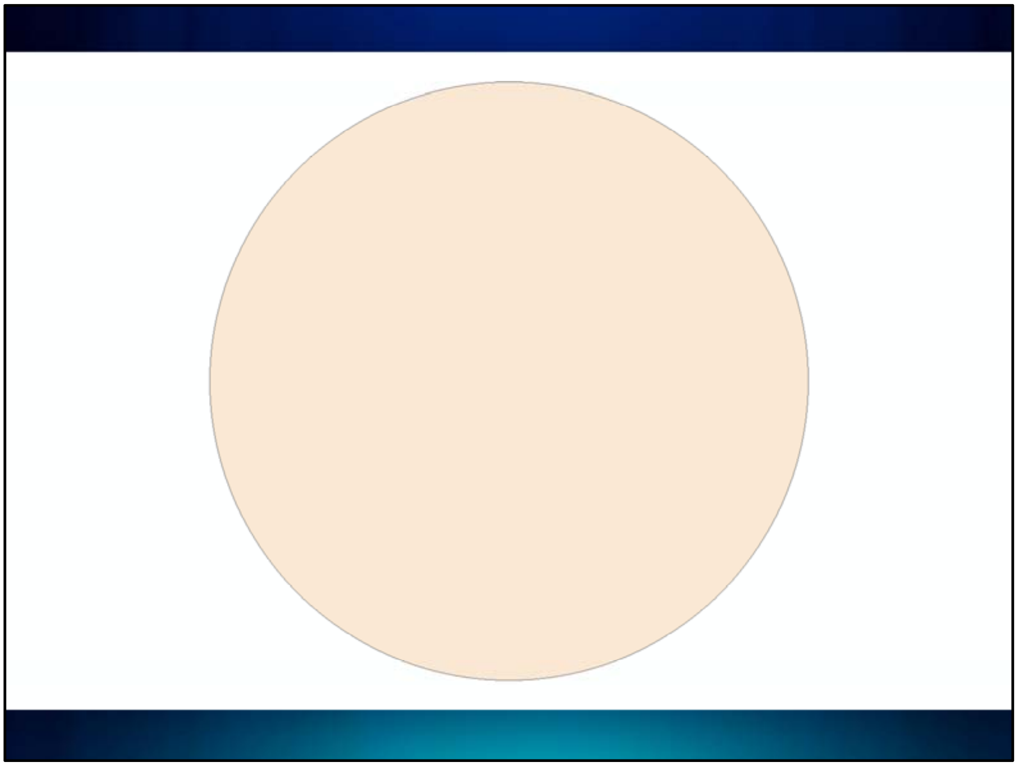
I'll open the data frame properties and click on the Coordinate Systems tab. You can see that the map is currently in the Robinson projection.

I'll change this to use a Predefined Projected Coordinate System for the World called Vertical Perspective. Then I'll click the Modify button the change the Longitude of Center to -120 and the Latitude of Center to 13.5.

I'll also click the General tab and rotate the data frame 10 degrees.

When I click OK you will see the changes this makes.

Now we can zoom to the extent that we want to show on our map.

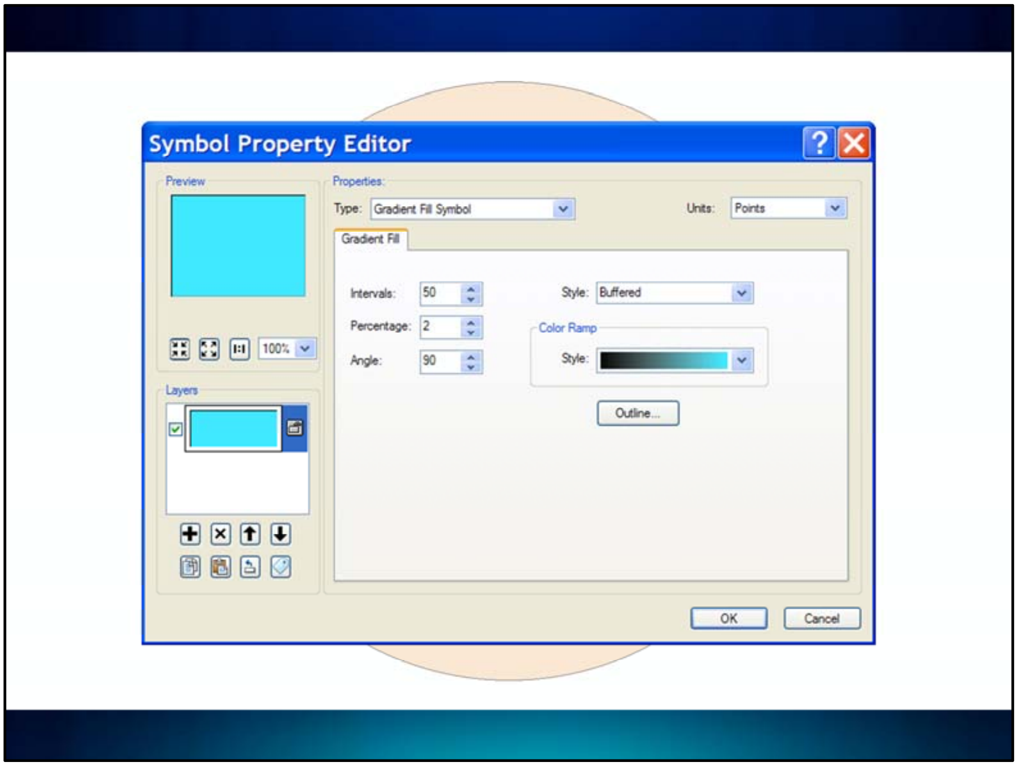


Next let's talk about how we added the atmosphere.

DEMO

First we created a new data frame. We made sure the drawing order of the data frames so that the data frame with what would be the atmosphere was under the data frame for the main map.

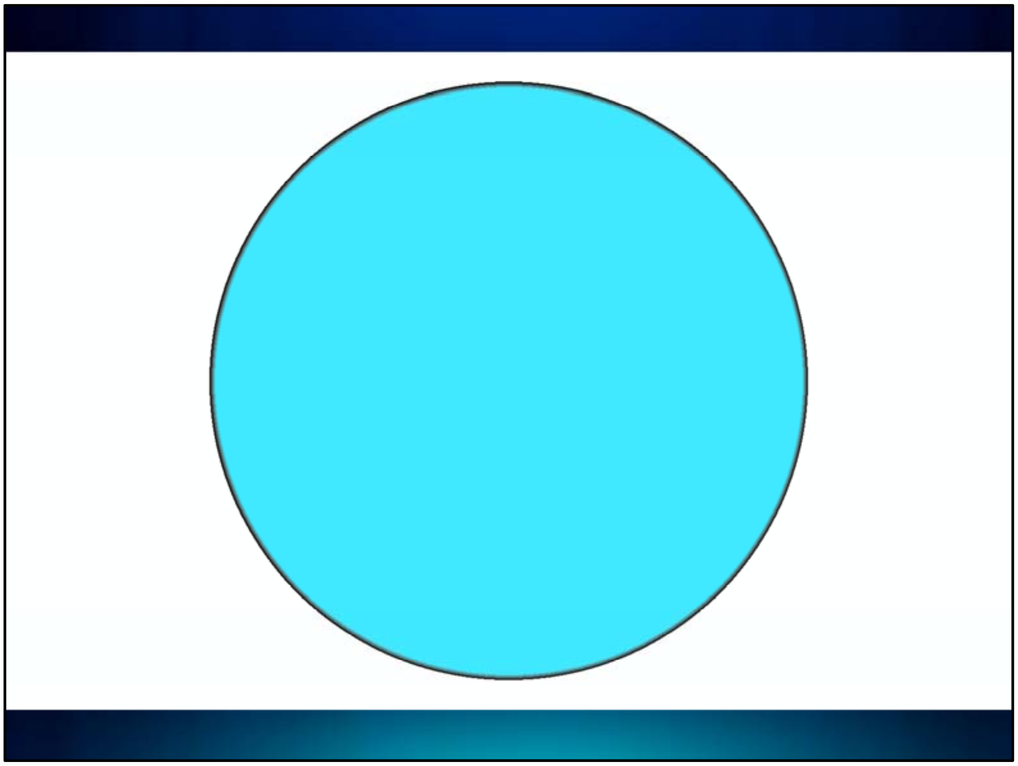
In Data View, we added a circle graphic to a data frame. Then we right clicked the data frame and selected Convert Graphics to Features. We checked the option to Automatically delete graphics after conversion. We added the exported data to the map as a layer. Then we symbolized it.



We used a buffered gradient fill and changed the Style to Buffered. We set the Intervals to 50 and the Percentage to 2.

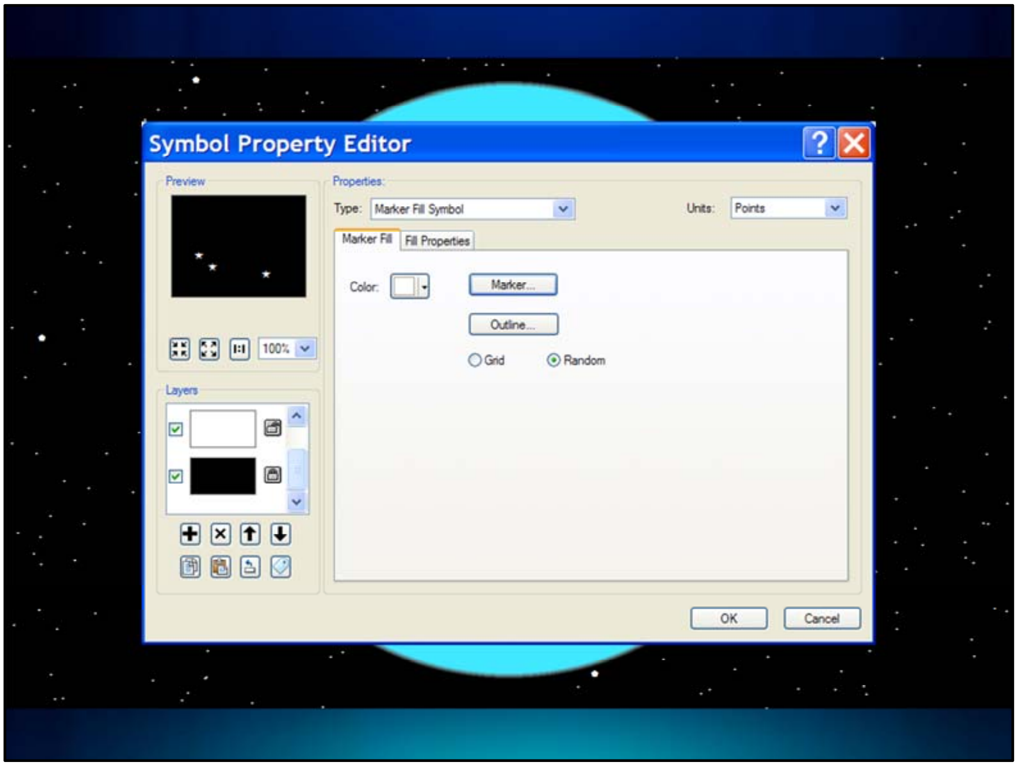
We changed the color ramp by right clicking it and selecting Properties, then clicked the color patch for Color 1 and changed it to black. We changed color 2 to an aqua blue (HSV values of 187, 75, 100).

After we clicked OK, we right clicked the ramp again to Save it to our personal style. We set the Outline to No Color



Then we clicked OK to save all our changes.

We switched back to Layout View to set the size and position of the data frame, then we panned and zoomed the data until it aligned with the extent of the earth in our main map.



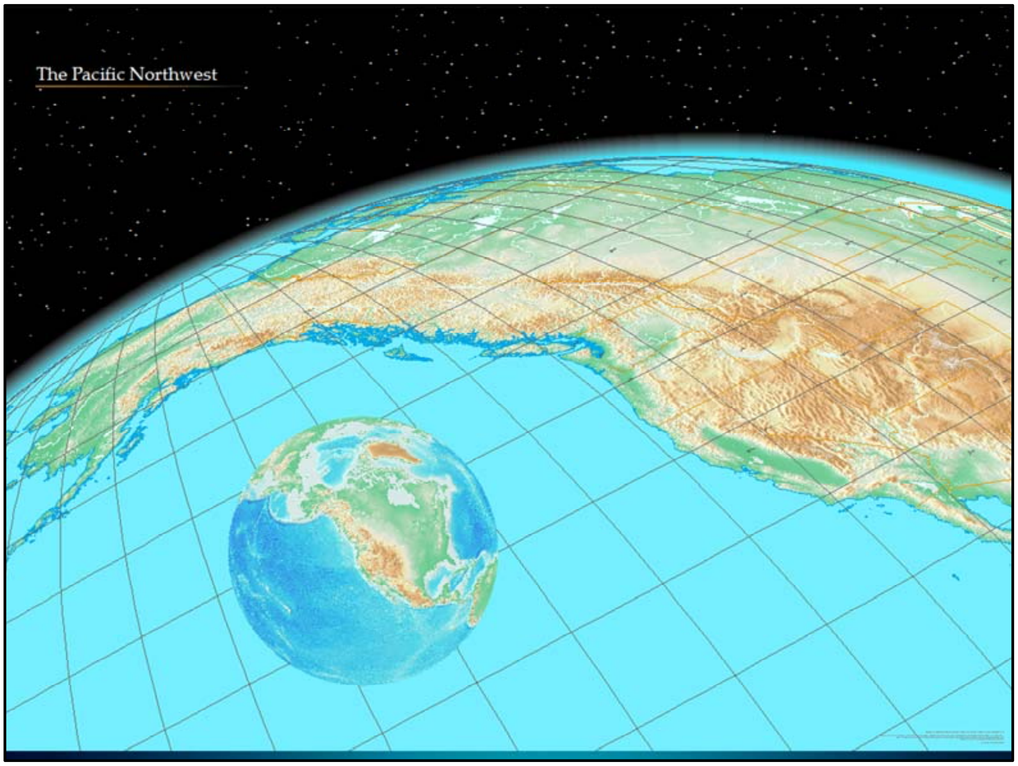
The stars were easy to add to this map. They are a multilayer symbol that we applied to the background of the data frame. Let's look how you can make it in ArcMap.

DEMO
On the top bar menu we'll click Customize then Style Manager. Here in my personal style, I will create a new Normal Background symbol. Then I'll click Change Symbol and Edit Symbol to edit it.

In the Symbol Property Editor, I'll add another layer to the symbol and make the top layer a Marker Fill Symbol. I'll click the Marker button and change the marker symbol to a star. I'll make it white and 12 points big. When I click OK, I'll set the fill to be random.

Then I'll click the Fill Properties tab and change the spacing for both the x and y to 50. I'll click OK to get back to the main Style Manger window, I'll call this symbol "stars". Then I'll close Style Manager.

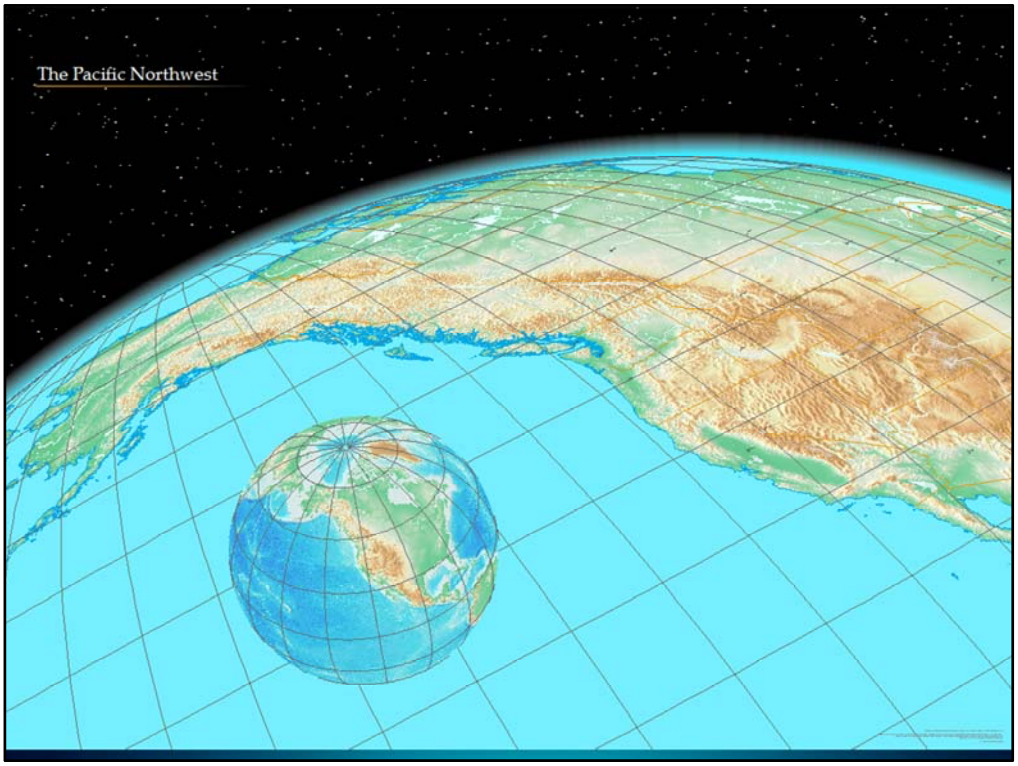
In the Table of Contents, I'll right click the Demo data frame and click Properties. Then on the Frame tab, I can set the fame background to be this symbol. When I click OK to apply these changes, you can now see the background how has this symbol.



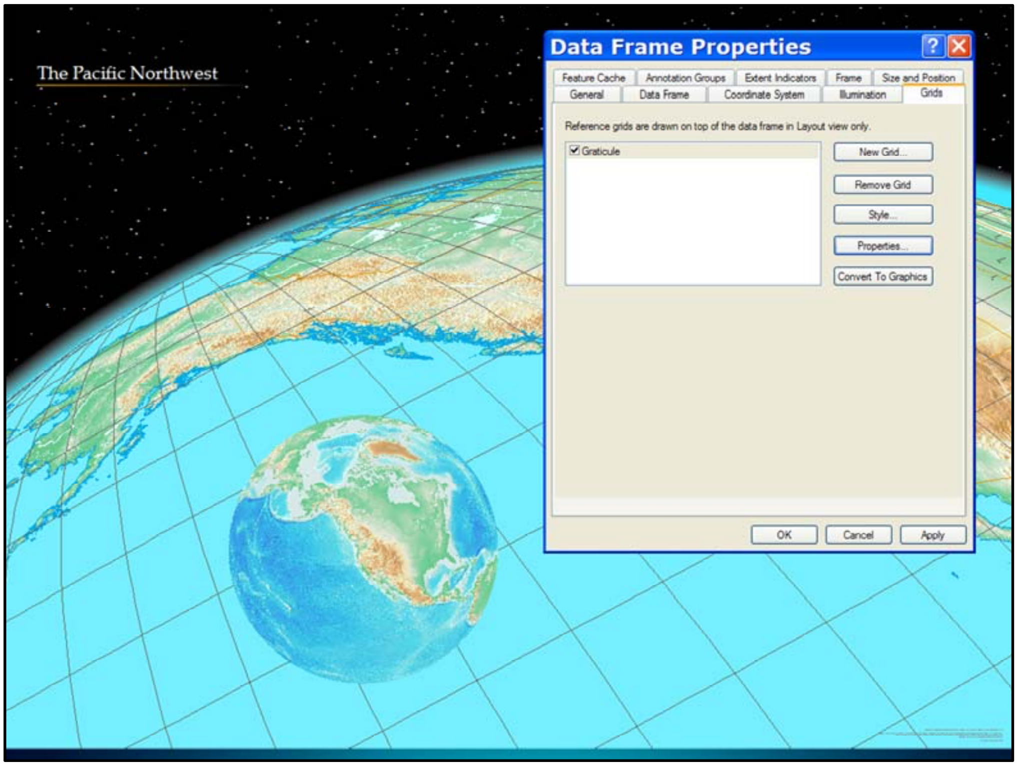
The last thing we did was to add the globe map with its drop shadow. This was pretty easy since we had already figured out how to make the main map. We just copied and pasted the Pacific Northwest data frame on the Table of Contents.

We changed a few of the projection parameters to shift the center of the globe in this view. We resized and repositioned the data frame.

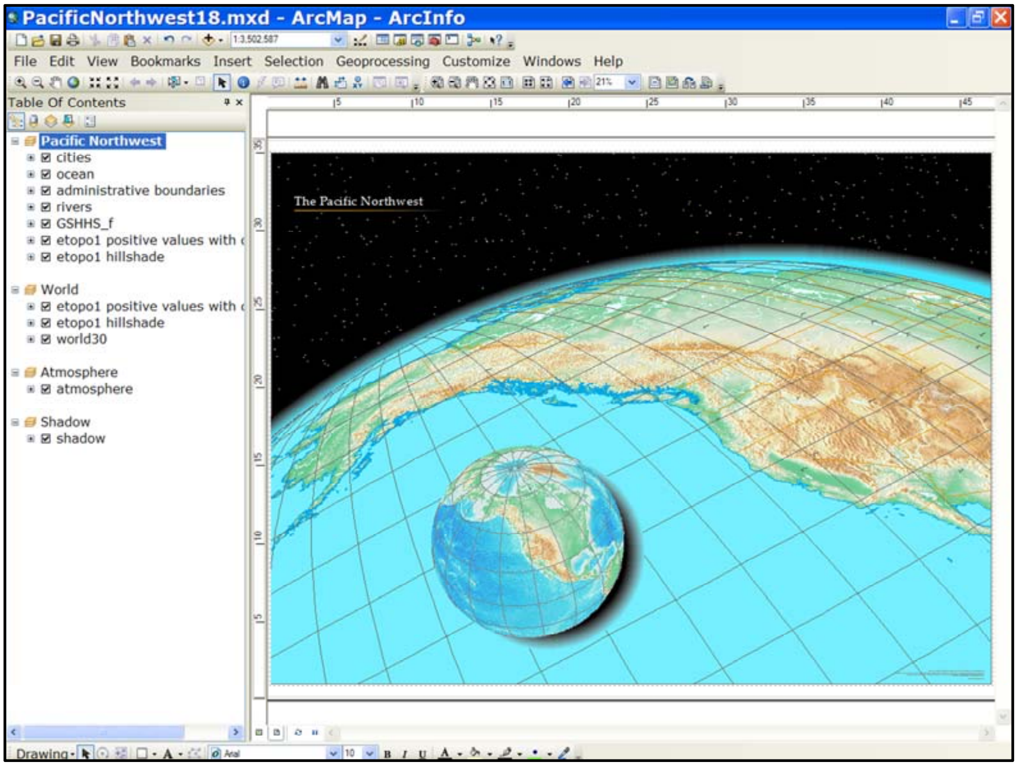
We turned off the ocean fill layer because wanted to show the bathymetry since it contrasted well with the solid ocean fill on the main map. We also turned off the drawing for all other feature classes so that on the final map only the graticule for the data frame showed.



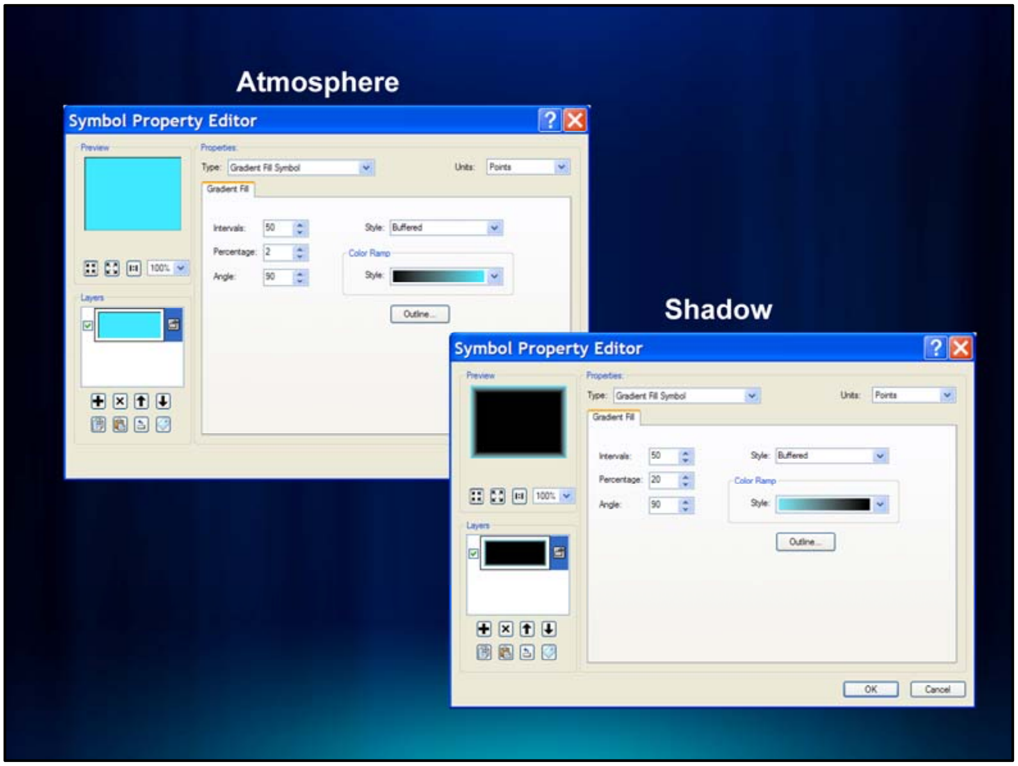
We also added a graticule. I want you to notice what effect adding the graticule has to the impression of dimensionality on the map. As I flip back and forth between the map with and without the graticule, this should be apparent.



Adding a graticule as a property of the data frame is easy and really a great addition to our map. It's simply a property of the data frame.

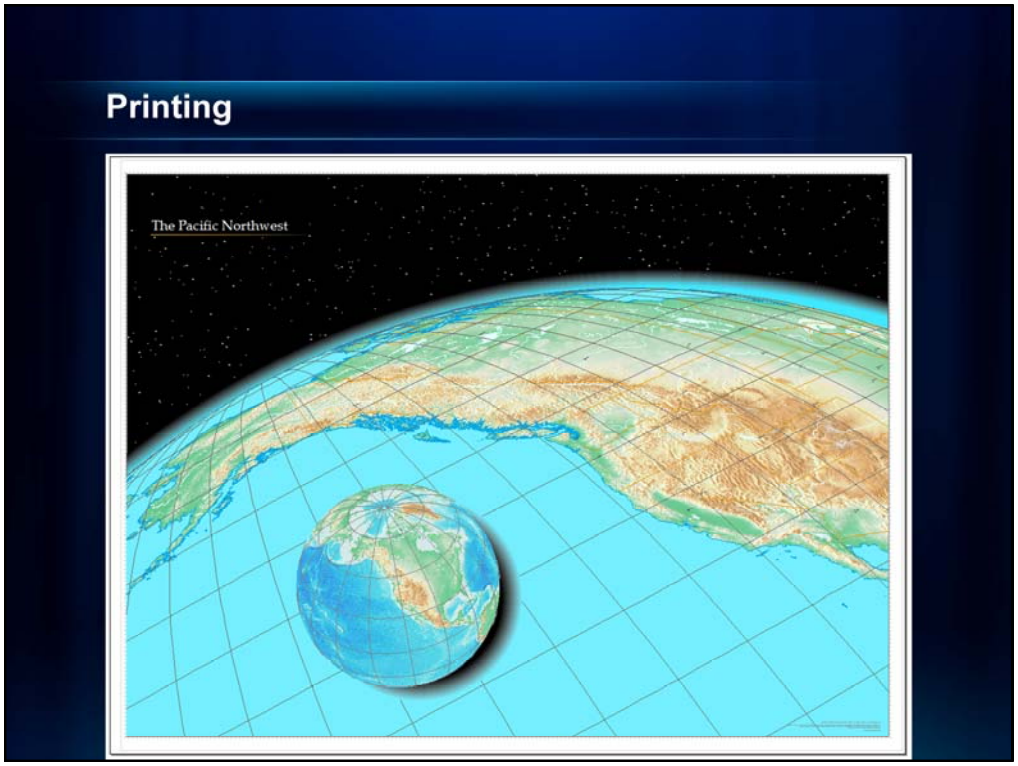


To create the drop shadow, we copied and pasted the Atmosphere data frame, resized and repositioned it so that it displayed to the lower left of the globe.



Then we changed the aqua to black , and changed the symbology so that we could show the drop shadow.

So that brings us to the end of our first two maps. Let take a look now at something completely different. We've seen a couple of examples of maps of the physical environment. Now Mamata Akella is going to share with us a political map she has been working on.



For those of you who have tried printing maps like these that have transparency in overlapping data frames, you will have encountered a problem. Any data frame that overlaps another and has any rasterization (due either to the use of rasters or due to the use of transparency and other effects that cause rasterization), will have a white edge around the frame. We cannot do anything about this since this is really a limitation of the Windows Graphic Driver Interface. However, we have written some documentation about how to overcome this using third party software. I have noted the related documents in the bottom notes of this PowerPoint for when you download it form Mapping Center after the UC.

For now, let's move on. At this point, I'm going to turn things over to my colleague Mamata Akella to introduce you to a new map and some additional advanced cartographic effects.

NOTE
For more info on the overlapping data frame "white corners" problem, see this article:
http://resources.arcgis.com/content/kbase?fa=articleShow&d=17336.
The bug number is NIM006938.

MAMATA – 25 MINUTES

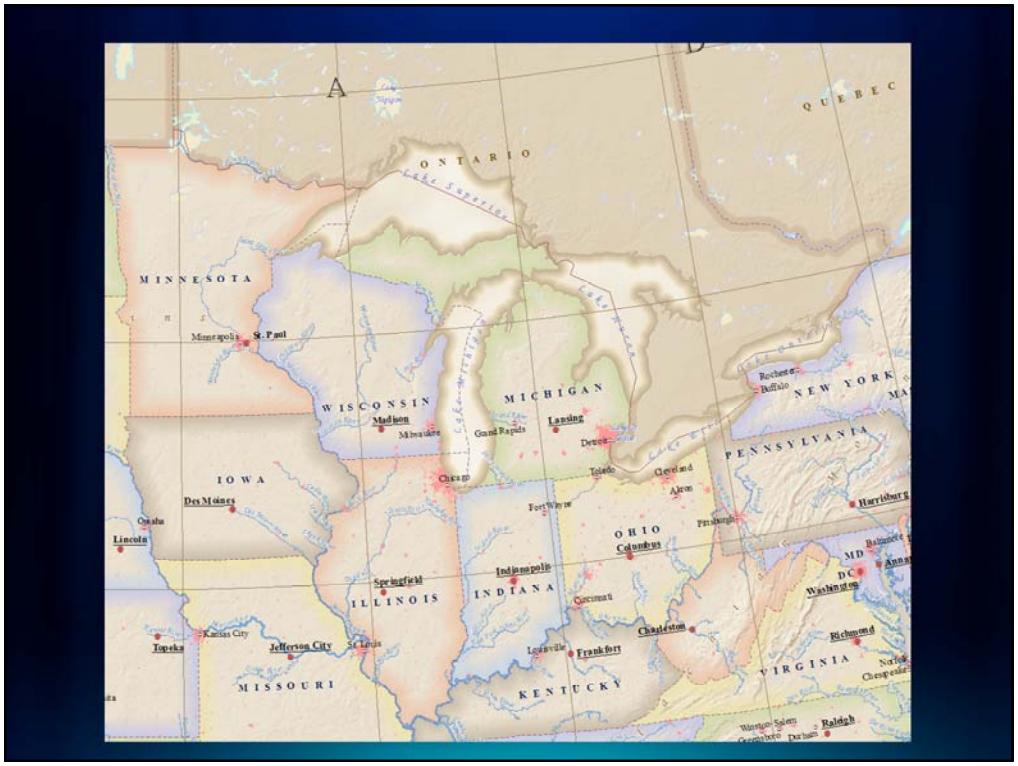
Thanks, Aileen!

Next, we are going to talk about this U.S. Political map of the contiguous U.S. that we made.

Similar to the other maps shown in this presentation, let's take a quick tour of the map.

This map uses six different colors for tint bands: <u>purple</u>, <u>green</u>, <u>blue</u>, <u>brown</u>, <u>orange</u>, and <u>yellow</u>.

You'll notice how the curvature of the text follows the graticule as opposed to being placed vertically.



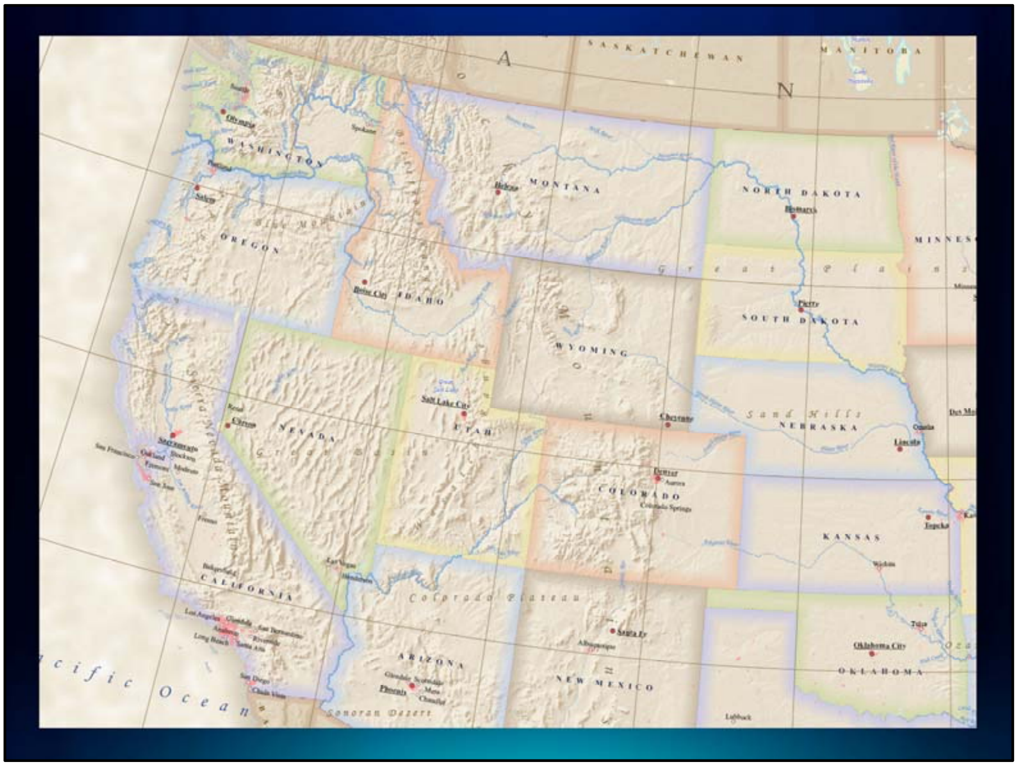
The map has sepia tones and historic looking effects and fonts.

It uses a parchment fill on the background and subtle ocean vignettes.

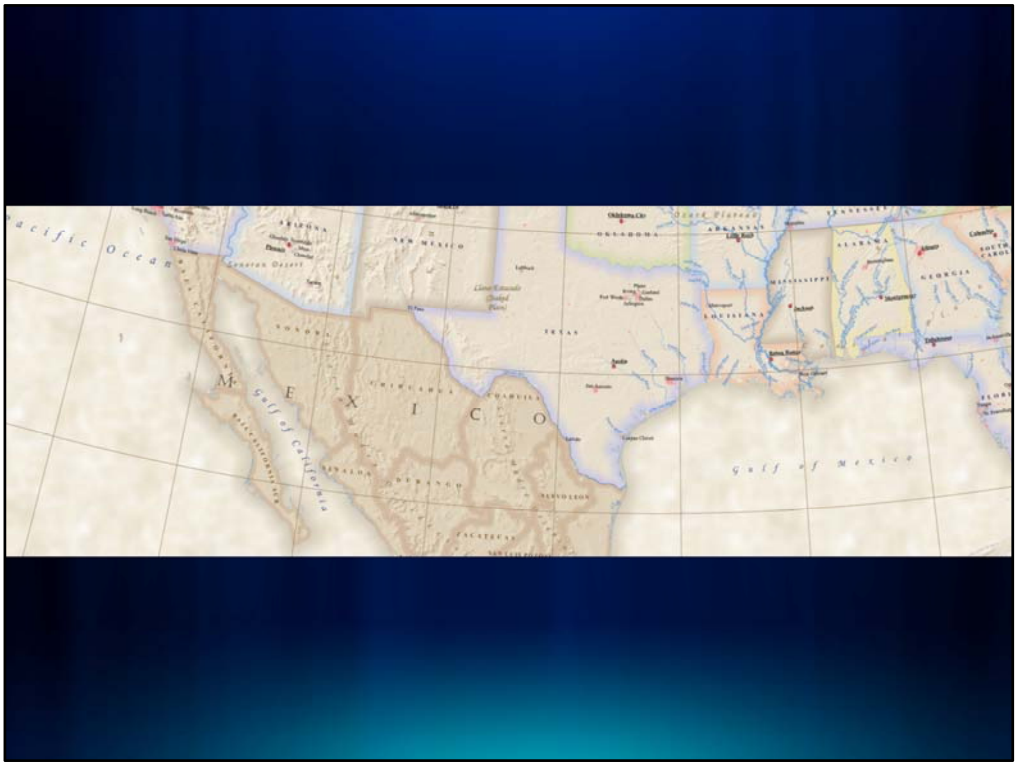
The map that we used as inspiration is the, “Atlas of True Names”.

It inspired us because of its historic flare, tint bands, sepia colors, and beautiful text.

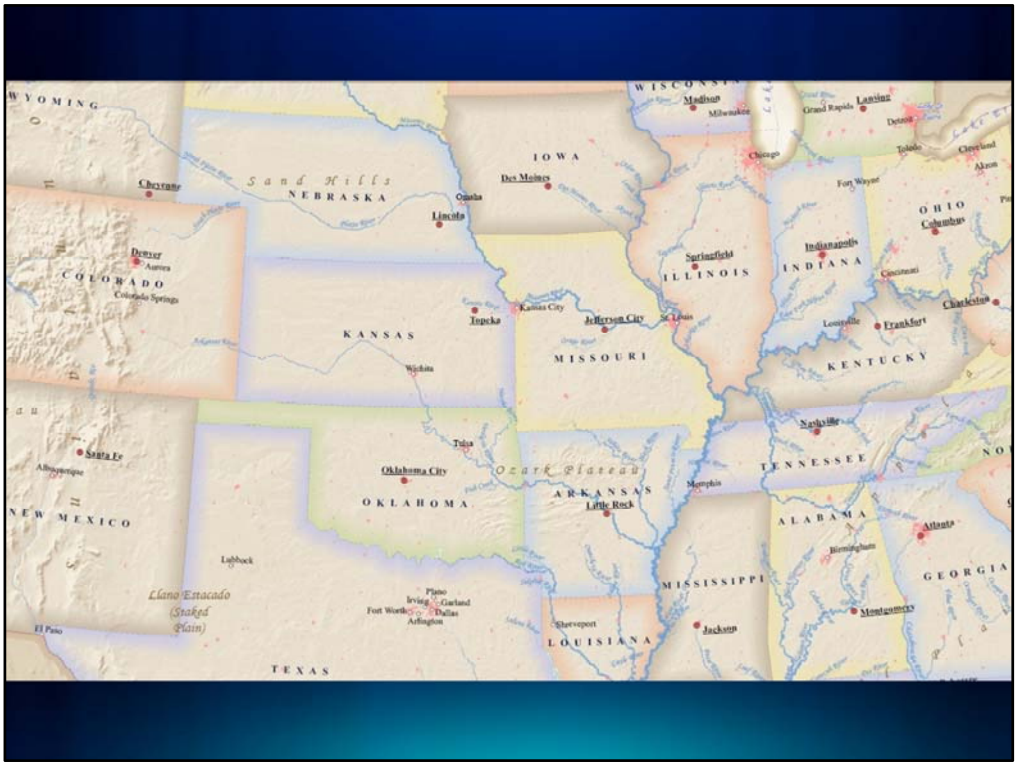
The effects I want to show you on our version of this map are…



…the hillshade…



…the parchment background…



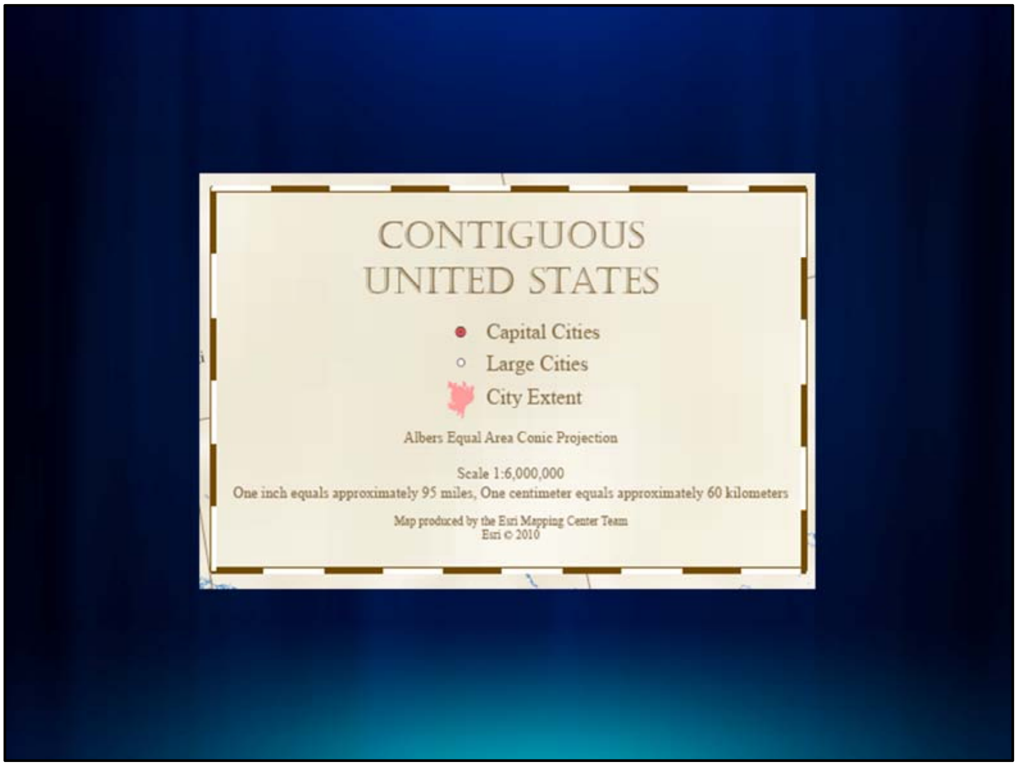
…the tint bands…

…the ocean vignette…

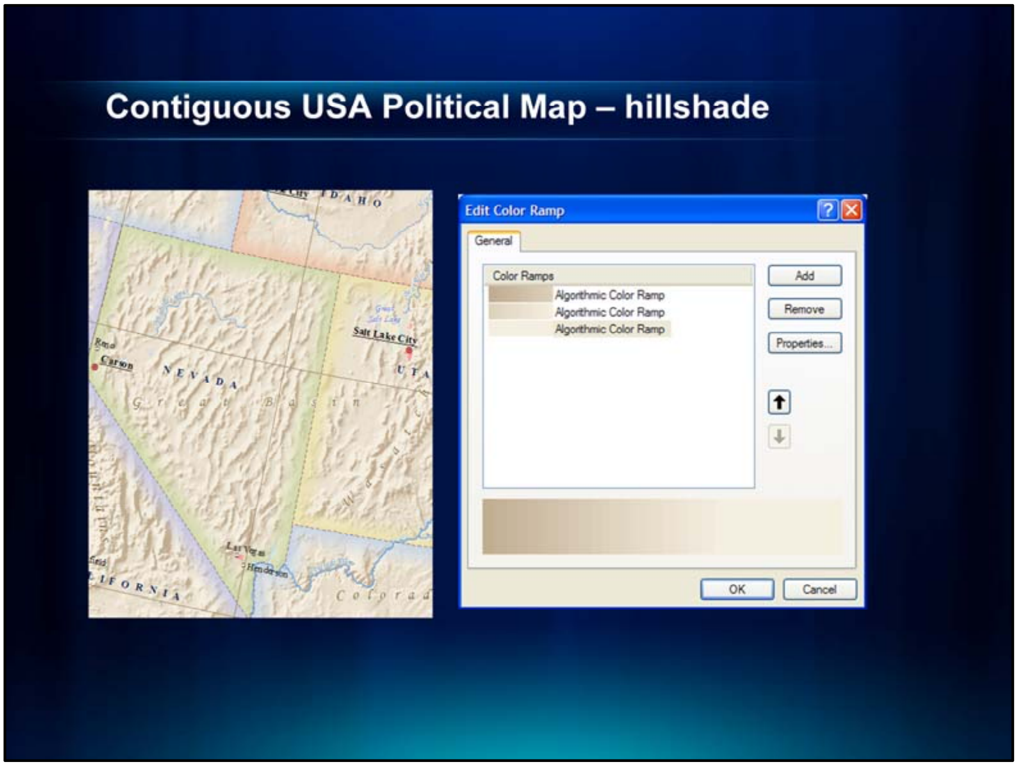
…symbolizing the Great Lakes…

…symbology and labeling for the cities…

…the graticule and decorative neat line…



…as well as creating a Legend Patch Shape for the City Extent in our legend.



Hillshade

Alright, first, let's talk about the hillshade and the way the terrain is represented on this map. The hillshade on this map was also made using etopo1 data. There are two differences from how the hillshade on this map is symbolized compared to how Aileen symbolized her hillshade:

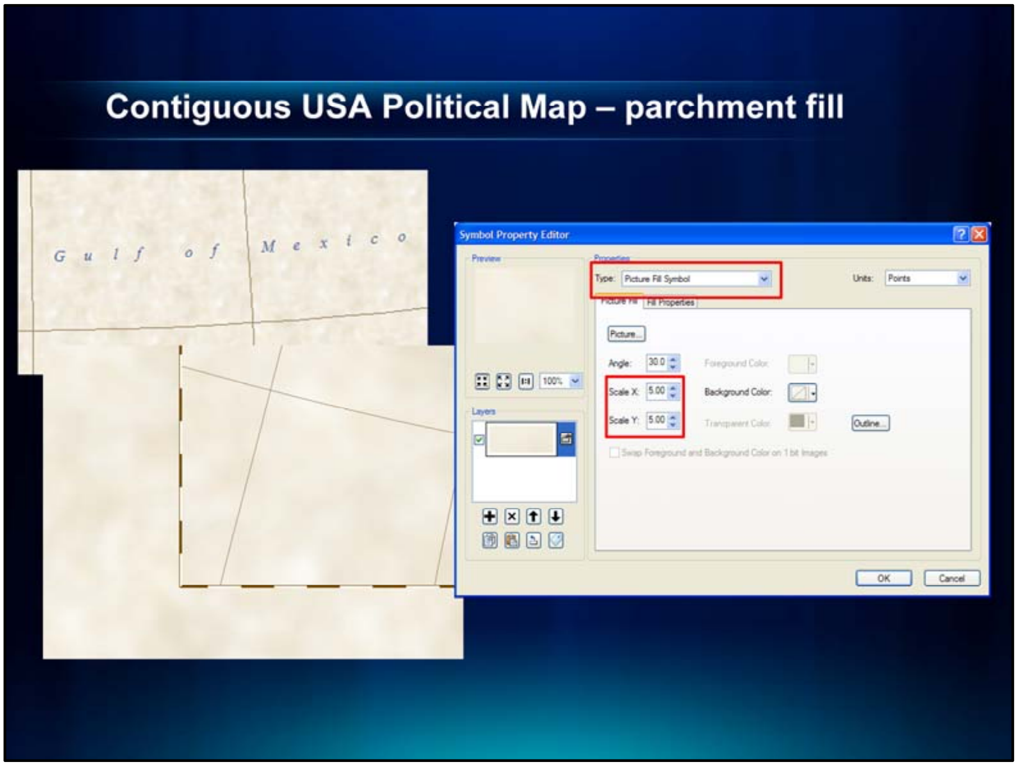
- first, this map does not use an elevation tint and
- second, this hillshade uses a more sepia tone, color ramp.

Using this color ramp gives the map an antique feeling.

Open the symbology for the hillshade color ramp and show the three parts

As you can see, this color ramp has three parts. The shadows are being symbolized using a darker brown color which then gradually progresses to a light tan color.

This helps emphasize the varying terrain on the map.

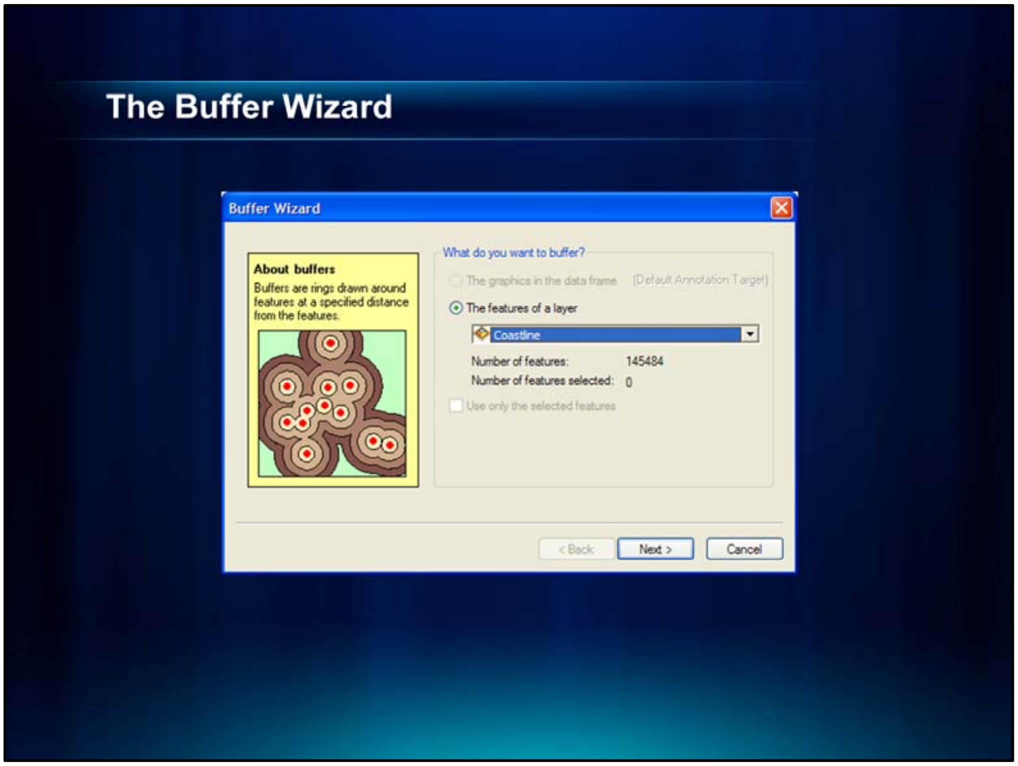


Parchment background

The next effect that I would like to go over is the parchment fill used on the background of the map. To create this effect, I first downloaded the Historical style from Mapping Center on the ArcGIS Resources tab. In order to create this effect, I am using a Parchment picture fill symbol on my ocean polygon.

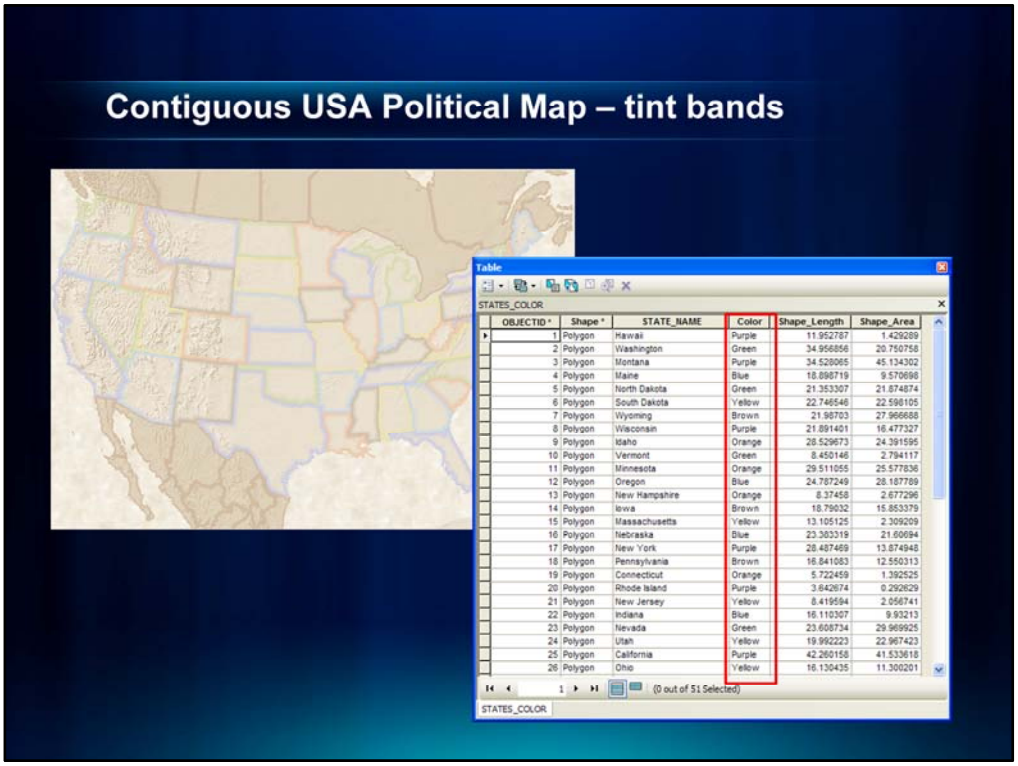
Let's open the symbology tab for the ocean layer and look at the properties of the parchment fill symbol. You might notice that the parchment fill is scaled by both the X and Y. Let's go back to the map to see why I had to do this.

The parchment within the data frame was applied using the symbol we just looked at. The parchment fill on the outside of the data frame is a graphic box that is filled using the same parchment fill. In order to get the pattern on the parchment in the data frame and the graphic box on the outside to be more uniform, we scaled the fill inside the data frame.



The next three effects I am going to show you all use the Buffer Wizard. Before I go over the effects, let me first show you how to add this tool to one of your ArcMap toolbars.

- Click on Customize in the top bar menu
- Click on Customize…
- In the Customize window, click on the Commands tab
- In the "Show Commands Containing" search, type in Buffer Wizard
- Drag the Buffer Wizard tool onto any of your toolbars in ArcMap by dragging and dropping the icon



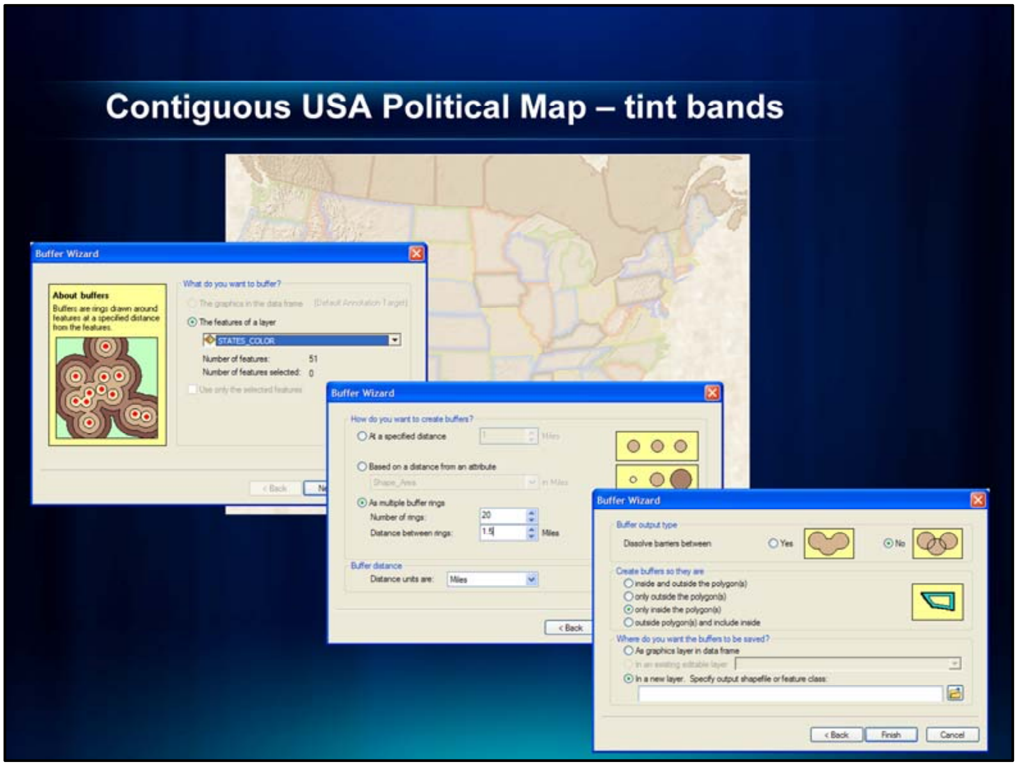
As we showed before, one of the effects we really liked on the Atlas of True Names map are the tint bands. So let's take a look at how we created them.

For this map, we have 6 different tint band colors that are being used:

- purple,
- green,
- yellow,
- orange,
- brown, and
- blue

The first step was to assign each state a color. To do this, we used a states feature class from Esri's Data and Maps DVD. Then, we looked at our printed "inspiration" map and manually populated this Color attribute for each state.

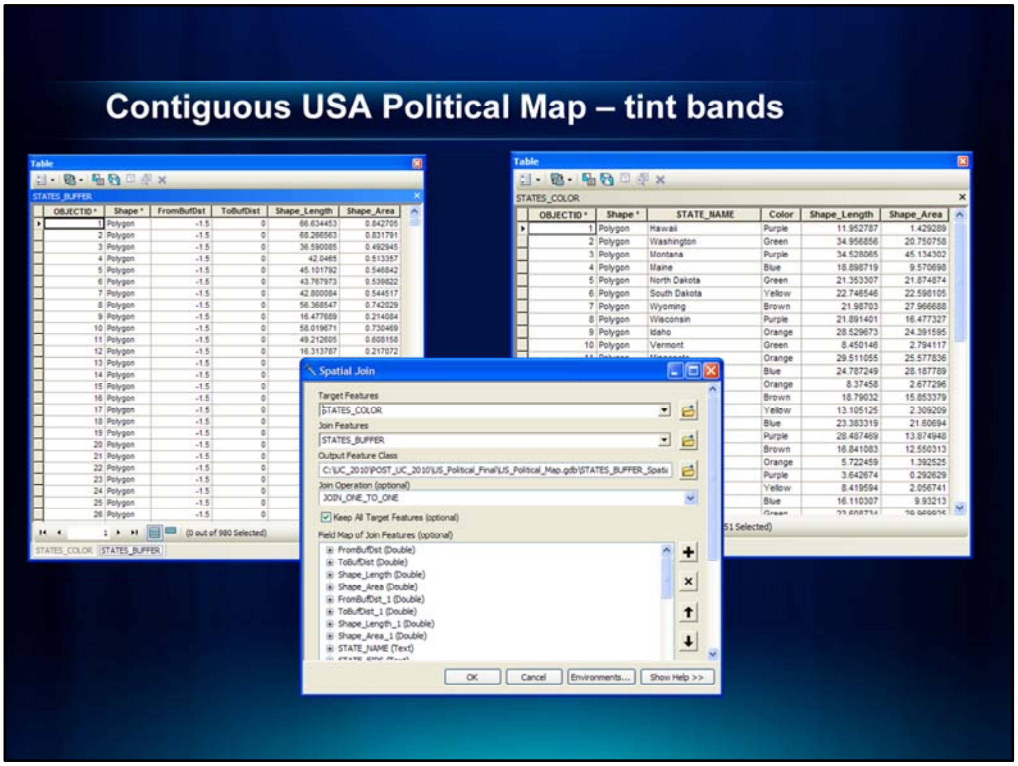
Open attribute table and show the color field



The next step was to use the Buffer Wizard to create the tint bands.

The input for the tool was the states feature class that we just looked at that had a color assigned to each state.

We created 20 multi-ring buffers at a distance of 1.5 miles, opted to not dissolve barriers between the buffers, and created the buffers only inside the polygon.



As you can see, the result from the Buffer Wizard did not retain all of the attributes that we had in our original states feature class where we assigned our colors.

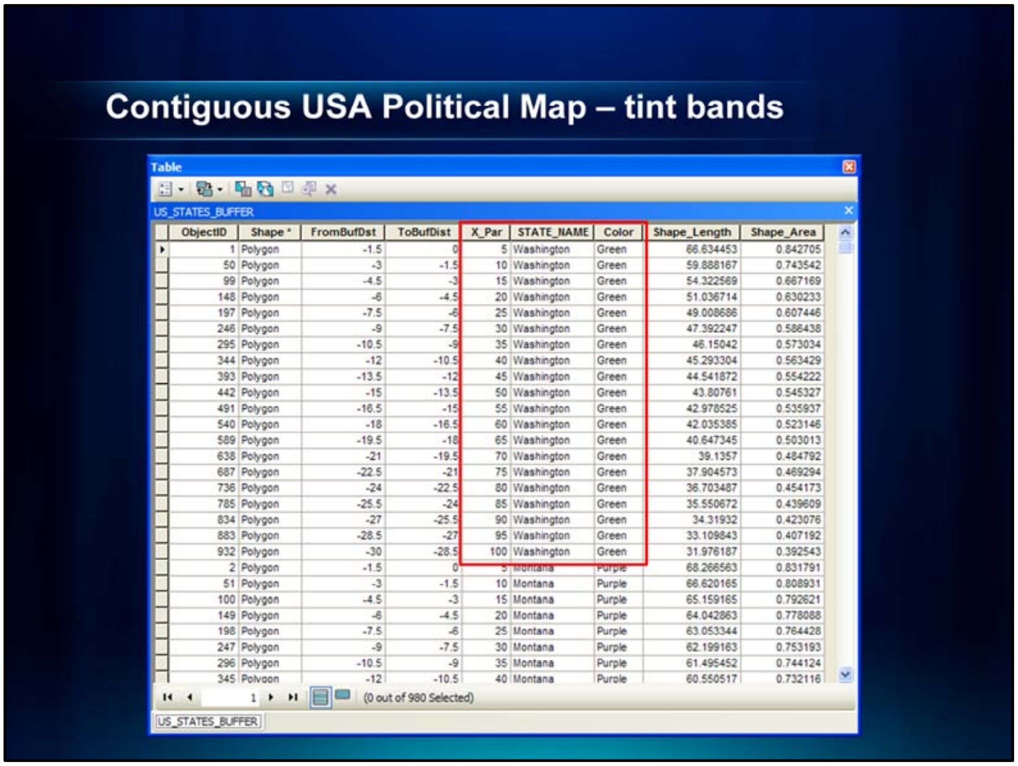
In order to combine the attributes from both datasets, we had to spatially joined the attributes of the original states feature class with the result of the buffer wizard.

To do this, we used the Spatial Join tool.

The result of the Spatial Join was this…

Open the attribute table for US_STATES_BUFFER

Now, we have the buffer distances, state name, and color all in one feature class.



ObjectID	Shape *	FromBufDst	ToBufDist	X_Par	STATE_NAME	Color	Shape_Length	Shape_Area
1	Polygon	-1.5	0	5	Washington	Green	66.634453	0.842705
50	Polygon	-3	-1.5	10	Washington	Green	59.888167	0.743542
99	Polygon	-4.5	-3	15	Washington	Green	54.322569	0.667169
148	Polygon	-6	-4.5	20	Washington	Green	51.036714	0.630233
197	Polygon	-7.5	-6	25	Washington	Green	49.008686	0.607446
246	Polygon	-9	-7.5	30	Washington	Green	47.392247	0.586438
295	Polygon	-10.5	-9	35	Washington	Green	46.15042	0.573034
344	Polygon	-12	-10.5	40	Washington	Green	45.293304	0.563429
393	Polygon	-13.5	-12	45	Washington	Green	44.541872	0.554222
442	Polygon	-15	-13.5	50	Washington	Green	43.80761	0.545327
491	Polygon	-16.5	-15	55	Washington	Green	42.978525	0.535937
540	Polygon	-18	-16.5	60	Washington	Green	42.035385	0.523146
589	Polygon	-19.5	-18	65	Washington	Green	40.647345	0.503013
638	Polygon	-21	-19.5	70	Washington	Green	39.1357	0.484792
687	Polygon	-22.5	-21	75	Washington	Green	37.904573	0.469294
736	Polygon	-24	-22.5	80	Washington	Green	36.703487	0.454173
785	Polygon	-25.5	-24	85	Washington	Green	35.550672	0.439609
834	Polygon	-27	-25.5	90	Washington	Green	34.31932	0.423076
883	Polygon	-28.5	-27	95	Washington	Green	33.109843	0.407192
932	Polygon	-30	-28.5	100	Washington	Green	31.976187	0.392543
2	Polygon	-1.5	0	5	Montana	Purple	68.266563	0.831791
51	Polygon	-3	-1.5	10	Montana	Purple	66.620165	0.808931
100	Polygon	-4.5	-3	15	Montana	Purple	65.159165	0.792621
149	Polygon	-6	-4.5	20	Montana	Purple	64.042863	0.778088
198	Polygon	-7.5	-6	25	Montana	Purple	63.053344	0.764428
247	Polygon	-9	-7.5	30	Montana	Purple	62.199163	0.753193
296	Polygon	-10.5	-9	35	Montana	Purple	61.495452	0.744124
345	Polygon	-12	-10.5	40	Montana	Purple	60.550517	0.732116

We then added a field called X_Par which refers to "transparency".

We calculated the values in this field using a calc statement that you can download off of Mapping Center's ArcGIS Resources tab.

Let's talk a little about what the X_Par field is, and then I can show you how we are using it in the Symbology tab.

As you can see, Washington has 20 buffers. For each of the buffers, the transparency value ranges from 5-100. The first buffer with an X_Par value of 5 has very little transparency which means it will be similar to the original color. On the other hand, the 20th buffer here has a X_Par value of 100 while the last buffer is fully transparent so it blends into the hillshade.

Ok, now let's take a look at how we are symbolizing the tint bands.

Open the Symbology tab and show that we are symbolizing on Categories > Unique Values, Many Fields

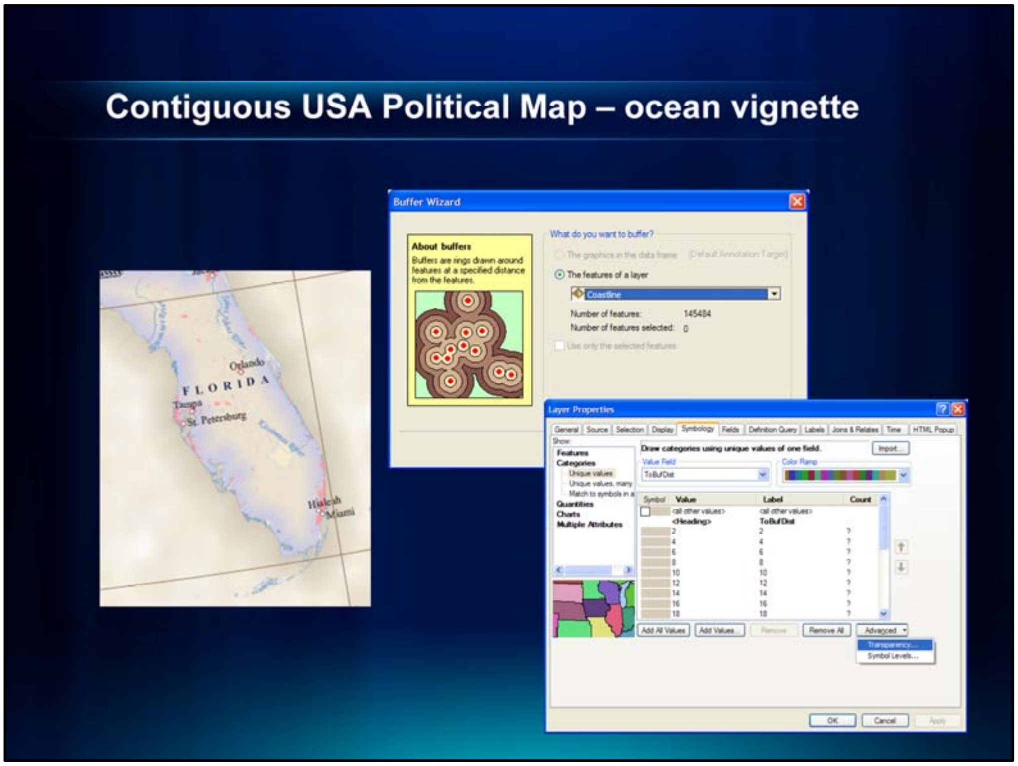
As you can see, we have our symbology sorted by color and buffer distance. To get the right colors, I inserted an image of the original map and used the Eyedropper tool to select the color.

The X_Par field is used here in the Advanced option.

When you click on Transparency…, the Transparency window opens. Here, we'll opt to use the X_Par field to assign varying levels of transparency to our buffers.

Click on the Advanced button and show where to set the transparency field

Ok, now let's go on to the next effect where we also used the Buffer Wizard – the ocean vignette.



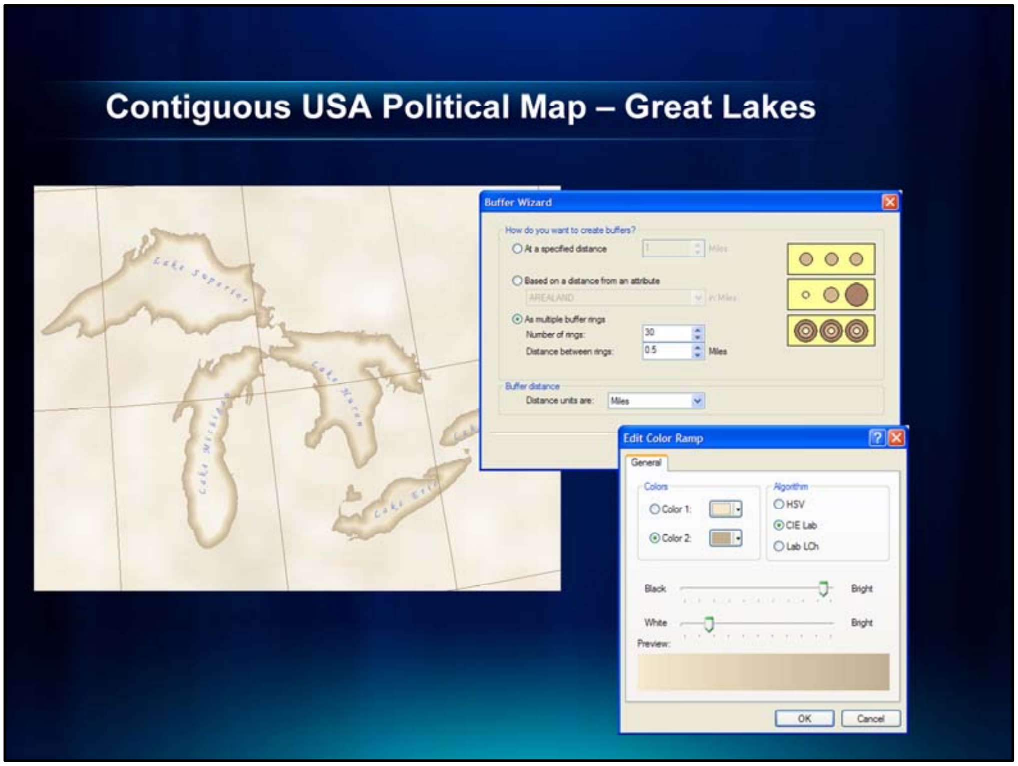
Ocean Vignette

Ocean vignettes provide better figure-ground by visually separating the land areas which are the "figure" or area of focus on our map, from the ocean areas which are the background.

For this map, we used the land area polygon as the input for the Buffer Wizard. We built 25 buffers at a distance of 2 miles.

Unlike the tint bands, the buffers were created were only outside of the polygon.

Similar to the tint bands on each state, we used the X_Par field so the vignette fades transparently into the background.

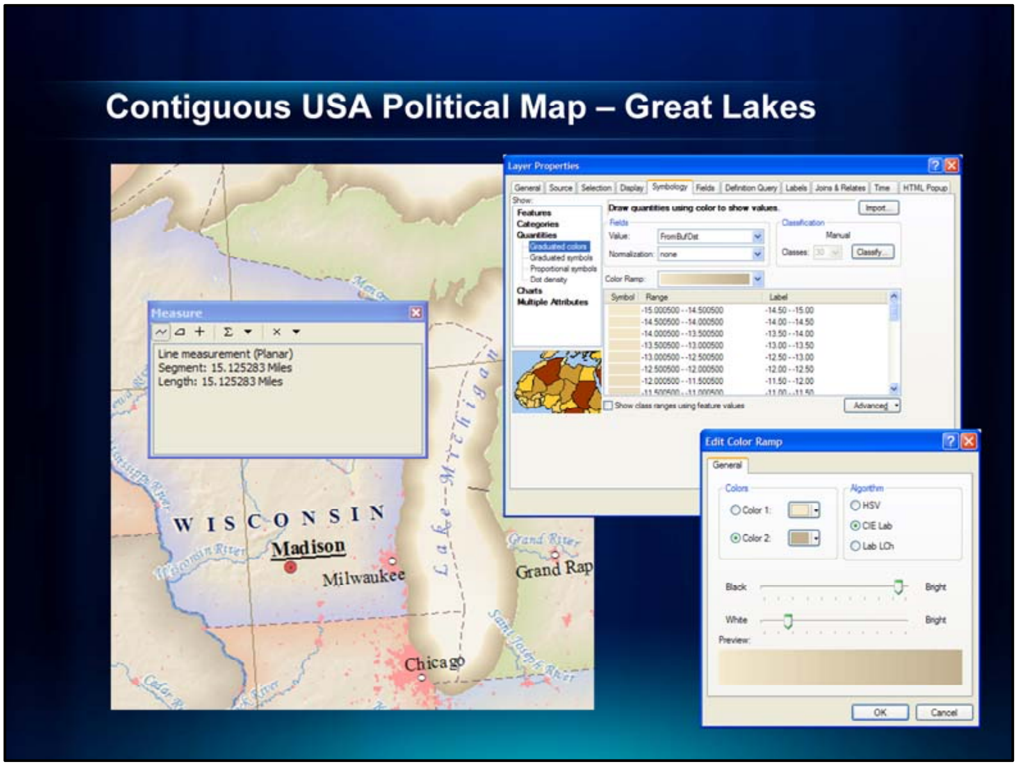


Symbolizing the Great Lakes

Let's take a look at how we are symbolizing the Great Lakes.

The Great Lakes are symbolized using two layers:

- First, we symbolized the lakes underneath with the same parchment fill that was used on the oceans to mask out the hillshade underneath.
- The second layer on the top uses buffers similar to the tint bands for the states and the ocean vignettes.



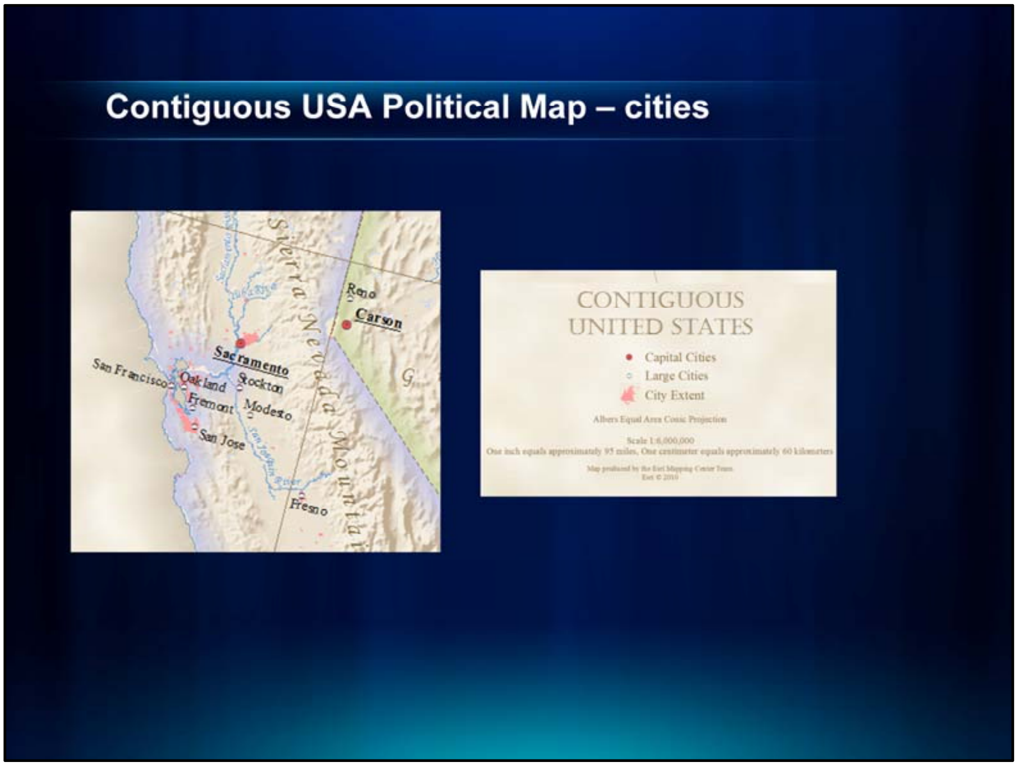
Let's take a look at how we decide how many buffers we needed and at what distance they should be. For the gradient effect, we first measured the distance using the Measure tool that we wanted the buffers to be.

We determined that we wanted the buffer to be 15 miles inside of each lake. With that information, we then created multi-ring buffers using the Buffer Wizard. We created 30 buffers inside of the polygon at a distance of 0.5 miles from each other equaling 15 miles.

The reason there are 30 buffers at 0.5 mile intervals as opposed to 15 buffers at 1 mile intervals is because we wanted to give more of the gradient effect from the outside to the inside of the polygon.

Then, we symbolized the buffers using Graduated Colors and applied a light to dark brown color ramp that blends to the background parchment color. As you can see, color 1 is a dark tan and color 2 is a color very close to the parchment color so it blends very nicely into the background.

Ok, now let's move on to how we are symbolizing and labeling cities on this U.S. Political map.

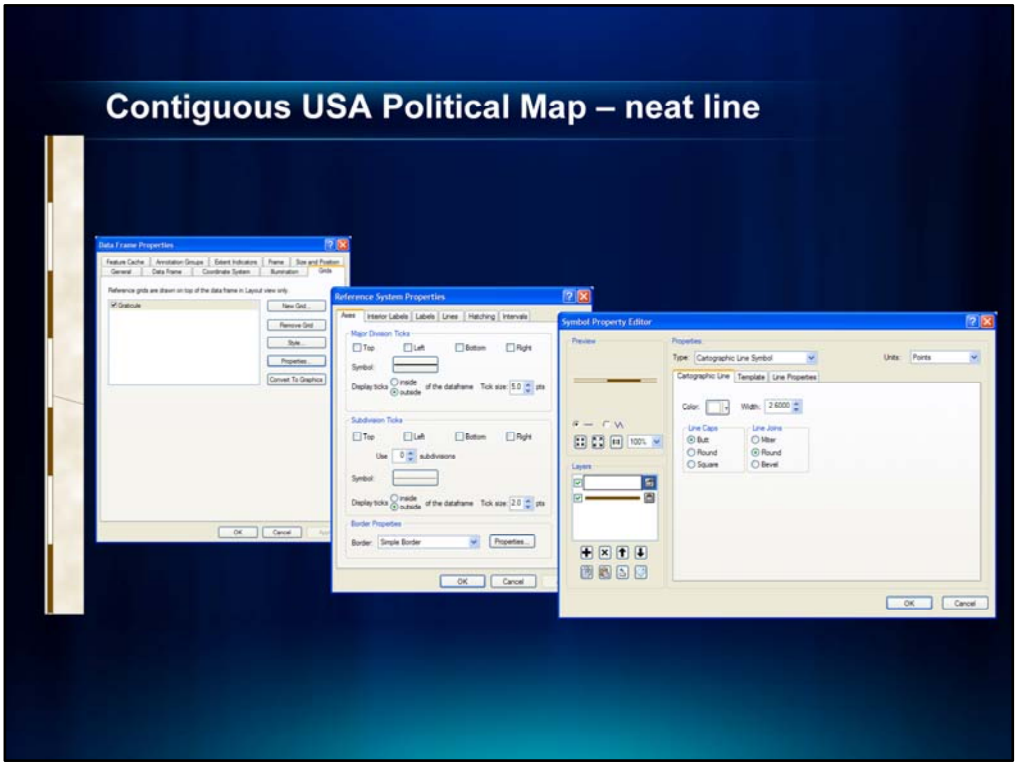


Symbology and labeling for cities

There are three ways the cities are being symbolized and two ways that the cities are being labeled.

- Symbology-wise, first, urban areas in the US are being symbolized with polygons. We are using a salmon color fill to symbolize them.
- To highlight more information about the urban areas being symbolized, we are using two point feature classes to label and symbolize cities.
- The reddish point symbol is used to define which features are capital cities while the white point symbol is used to define cities that are not capitals and that have a population greater than 200,000.

Capital cities are labeled in bold with an underline. The majority of the labels are also aligned to the Graticule. This is a property you can easily set in Label Manager and it gives an extra effect to your map!



Decorative neat line

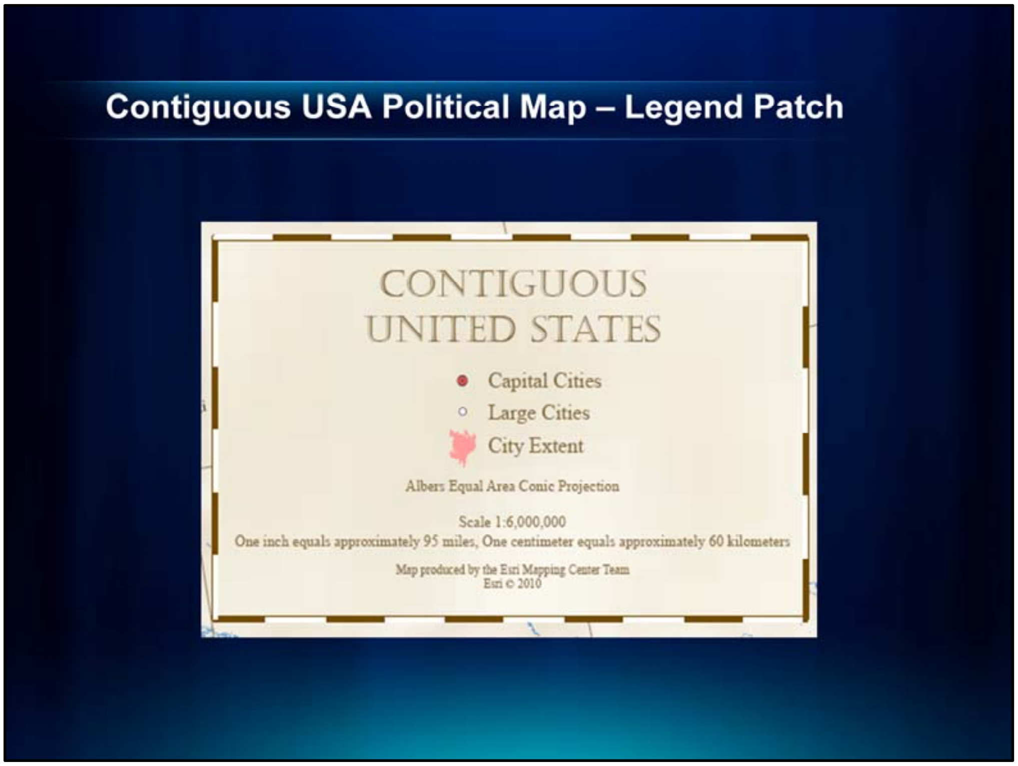
As you will notice, there is a graticule on the map. This was set to draw at 5 degree intervals, like on the Atlas of True Names. You will also see that we have incorporated a decorative neat line with an alternating white/brown dash pattern. To do this, we modified the properties of the graticule.

First, right click on the data frame and go to Properties and then click on the Grids tab. We are going to highlight the Graticule and then click on Properties. On the bottom of the Reference System Properties, click on Properties for the Border. In the Symbol Selector, let's click on Edit Symbol…

As you can see, the symbol we are using is a multi-layer one. The symbol on the bottom is a simple line symbol that is dark brown with a 3.4 line width. The top symbol is a white Cartographic Line Symbol, its width is 2.6. The reason the top white symbol is thinner than the bottom line symbol is so we get a casing. The white symbol has to be a Cartographic Line Symbol in order for us to set the dash pattern. The pattern for the line is set under the Template tab of the top, white line.

To get the dash pattern like it appears on the original map (with equal parts white to brown), we first brought the line pattern marker to the ninth major tick by dragging the gray square. This sets the length of the pattern.

Then, we clicked on the white squares until right before the fifth major tick. This determines how much of the brown line is visible underneath the white line. This gives us the even brown/white dash pattern.

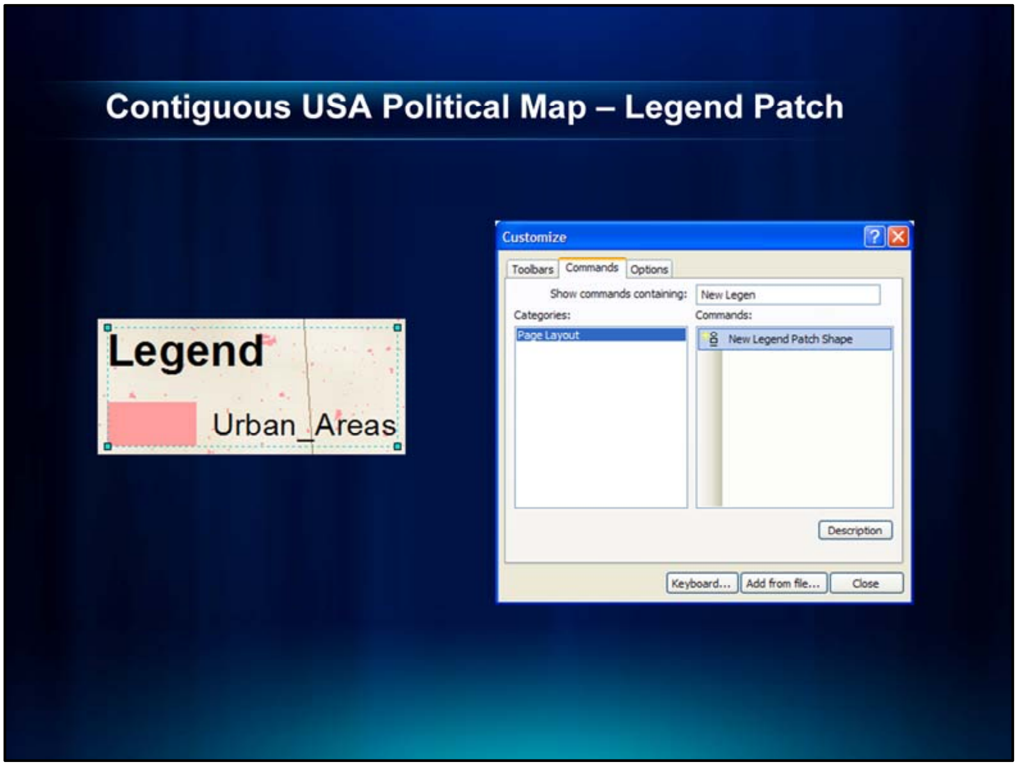


Creating a Legend Patch

Now, I want to move over to the legend and show you how we created this patch shape for the symbol representing cities.

The default shape that comes out is a rectangular box and as we can tell by looking at this map, none of the urban areas symbolized look like boxes. They are pretty irregularly shaped polygons.

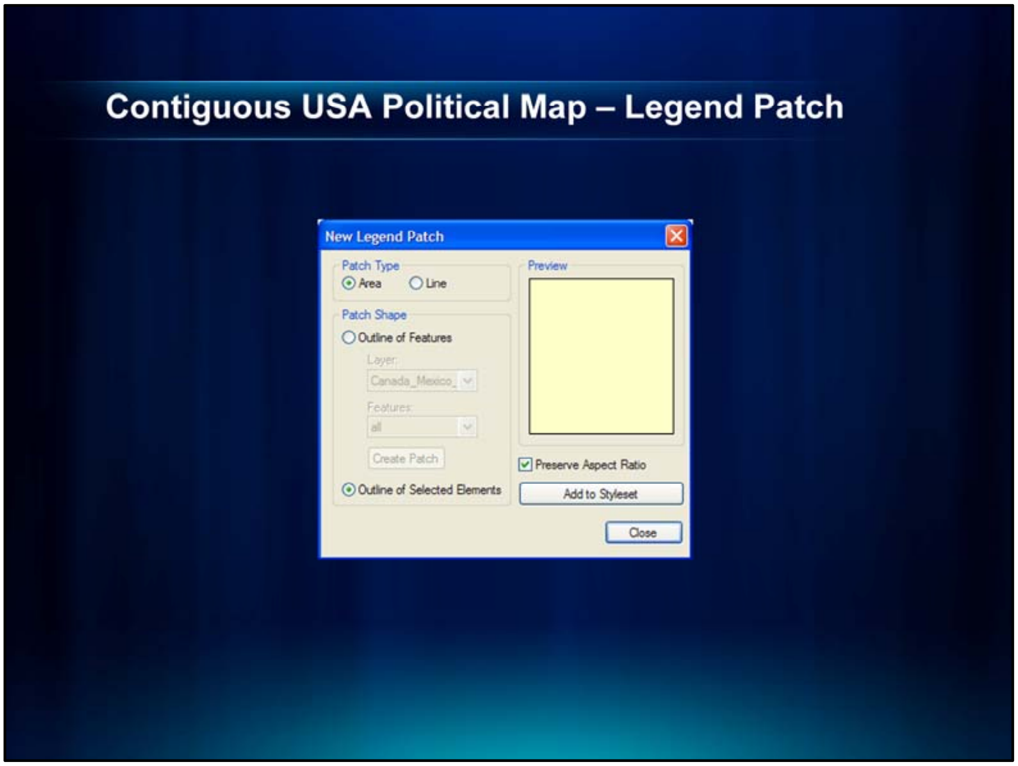
Adding a custom legend patch to the legend is great way to make the items in your legend reflect a more realistic depiction of the features they represent on the map.



To see how we can do this, I am going to first shut off all of the layers in the map document. Then, I am going to turn on only the UrbanArea feature class.

First, let's go ahead and insert a default legend (Insert > Legend > Accept the defaults). As we can see, our legend has that rectangular polygon. Let's look at how we can make this shape look like one of the city polygons in the map.

To do this, we are first going to add the New Legend Patch Shape tool. Click on Commands in the top bar menu, then click on Customize Mode… On the Commands tab, we'll search for "Legend Patch Shape". Similar to how we dragged the icon for the Buffer Wizard to one of our toolbars, we'll do the same thing with the New Legend Patch Shape tool.



Let's open the tool and take a look at what we need for inputs.

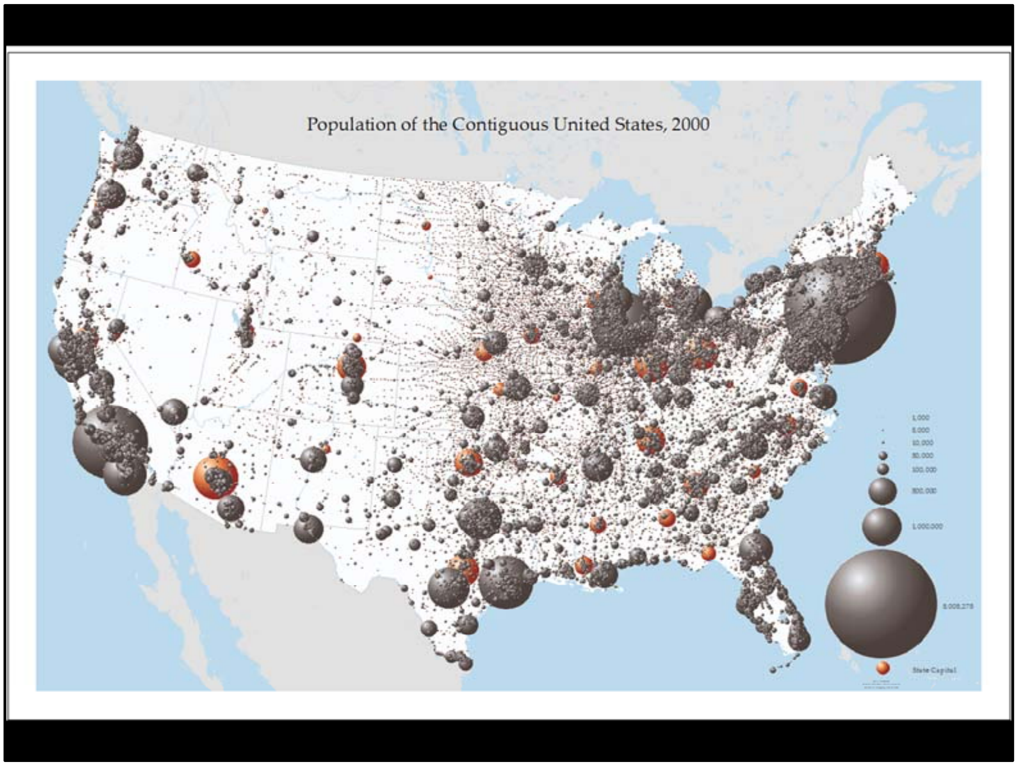
As you can see, we need to define the Type of patch which for us is Area. We also need to define which features we want to use for our Patch Shape.

Ok, let's go back to the Map Document to see how we can define which shape we want to use. I am going to use the Select Tool and select a shape that I want in my Legend. Let's go ahead and select this one here.

Now, let's go back and open the New Legend Patch Shape tool. For Patch Type, we'll select Area. In the Patch Shape portion of the window, in the drop-down for Layer, we'll select UrbanAreas. In the drop-down for features, we'll select "Selected". Then, we'll click the button Add to Stylesheet. We'll name the new patch Urban Area and then click OK. Then we'll click Close.

Then, we'll right click on our legend and go to Legend Properties. On the Legend tab, in the Patch area, we'll expand the dropdown for Patch and select our Urban Area patch that we just created. As you can see, our legend now has an urban area patch instead of the default rectangle.

Ok, now I am going to pass it over to Jaynya who is going to show you some cartographic effects on a U.S. thematic map. Thank you!



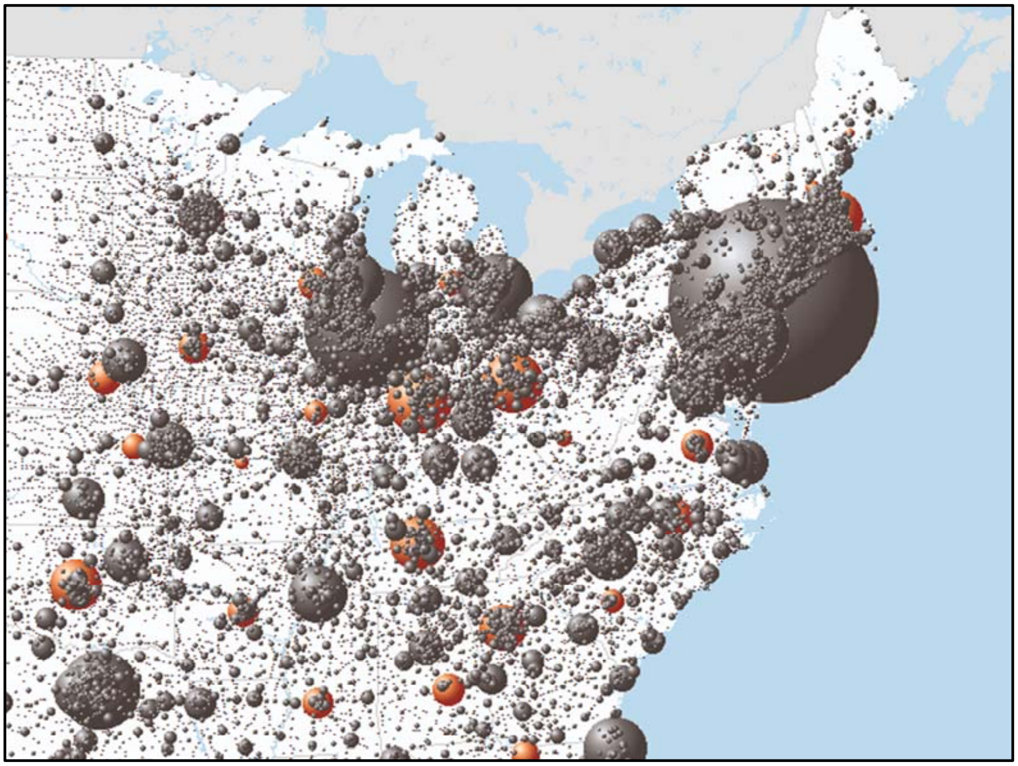
JAYNYA – 10 MINUTES

Thanks Mamata!

This is our thematic map of USA population which is intended for use as a printed map.

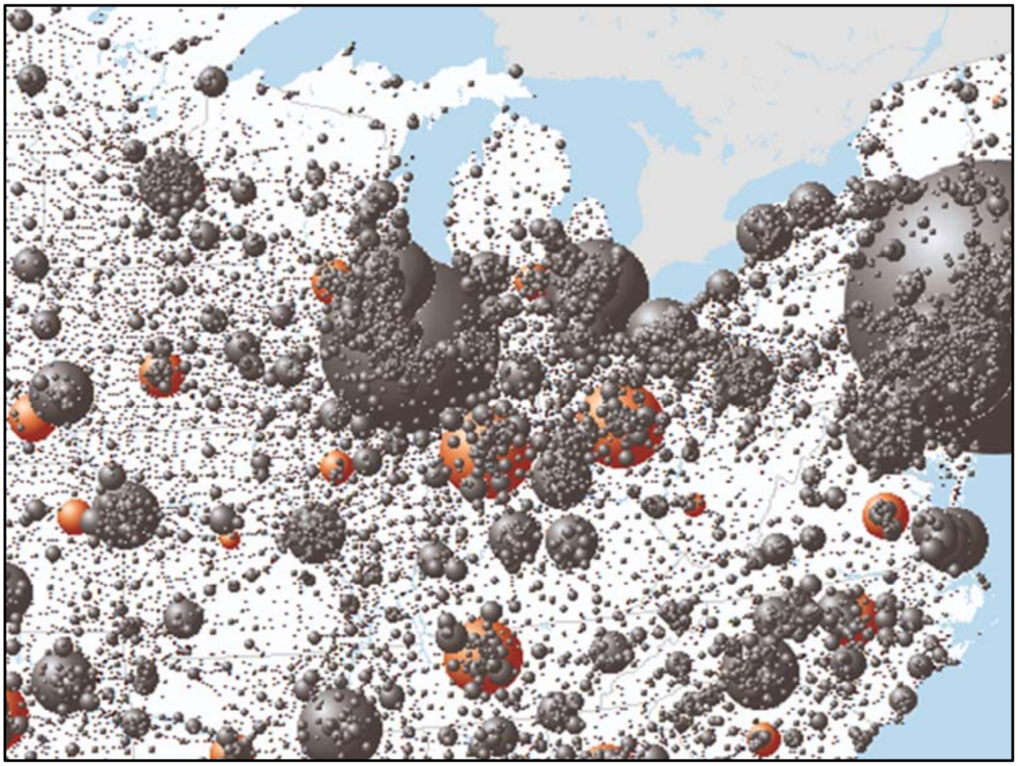
The spheres on this map are proportional to the population of the city in the year 2000.

The red spheres highlight the state capitals.

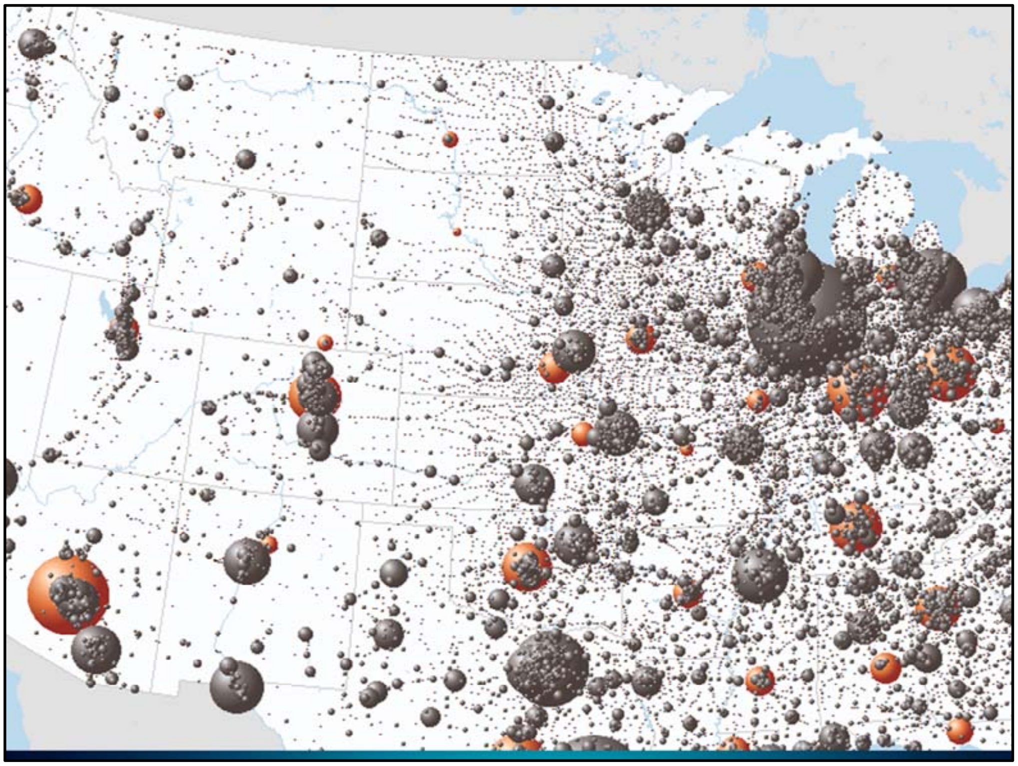


There are a number of reasons that we used the spheres to show this distribution:

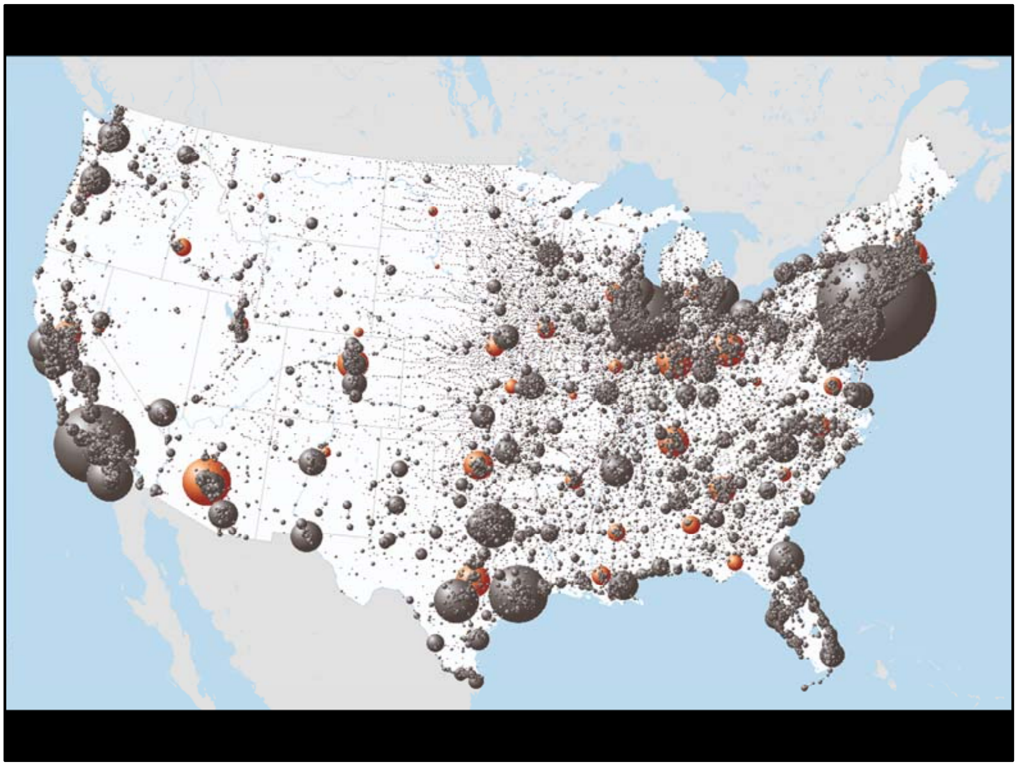
First, 3D symbols are often used to represent a large range of data. For example, in our data set, the values range from 1000 to over 8 million in New York City. (Places smaller than 1000 are shown with a simple black filled circle.) Using these symbols, a place with 10,000 people will be 10 times larger than place with 1000 people, and a place with a million people will be 1000 times larger.



The second reason to use 3D symbols is that you can see overlapping point symbols. This is because the color gradation within the spheres lets you see the edge of the symbol. This is very helpful for this map because there are many cities being symbolized so the symbols overlap quite a bit, especially in metropolitan areas.

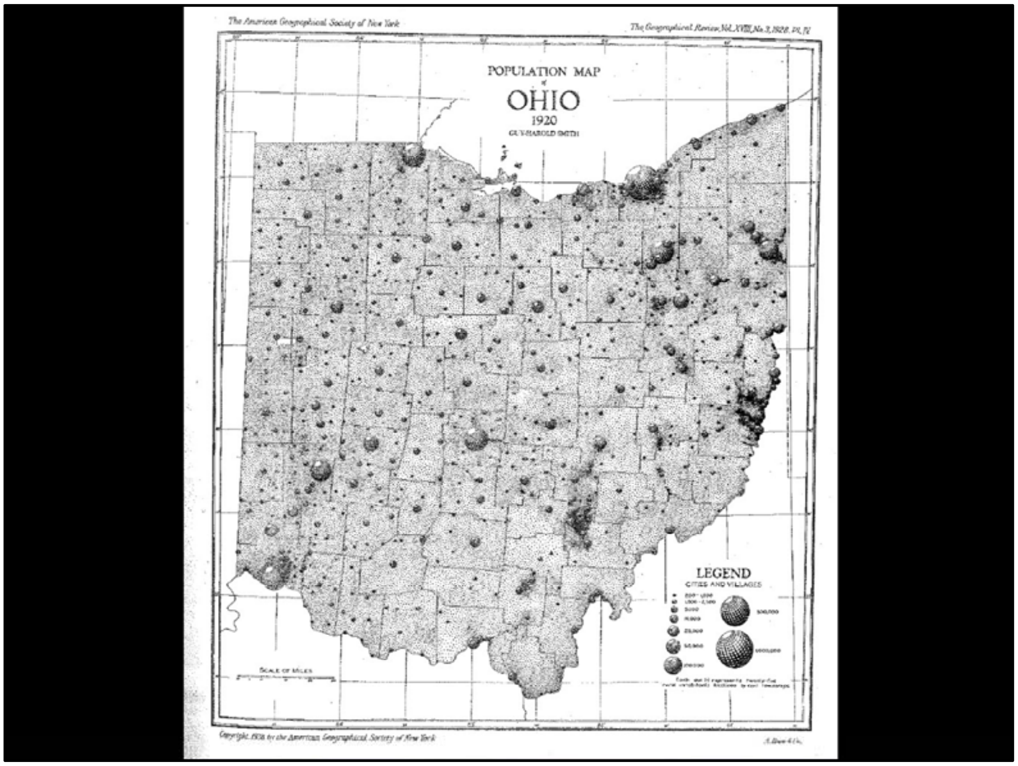


Another good reason to use 3D symbols is that <u>even the smallest 3D symbols</u> are more easily <u>seen</u> than the <u>smallest 2D symbols</u>.



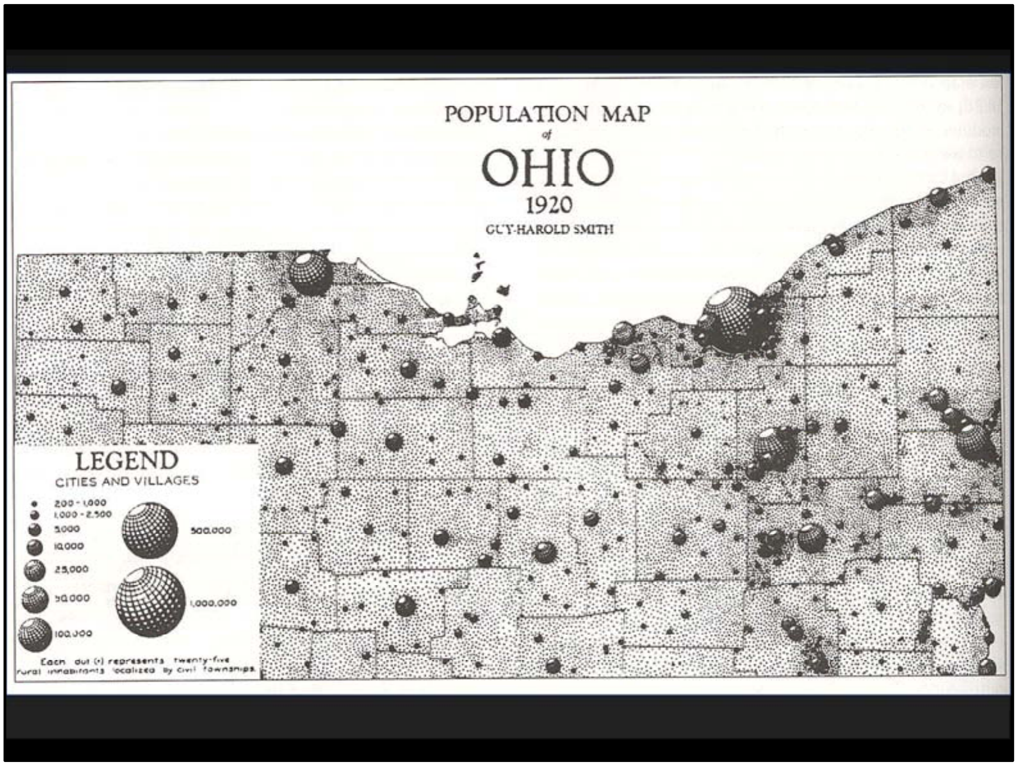
Finally, 3D symbols are eye-catching because they add an extra level of dimensionality to the map.

The result is that this map lets us see the density of cities around metropolitan regions, as well as their relative populations. And we are also able to see the distributions outside of the more highly populated areas with ease.



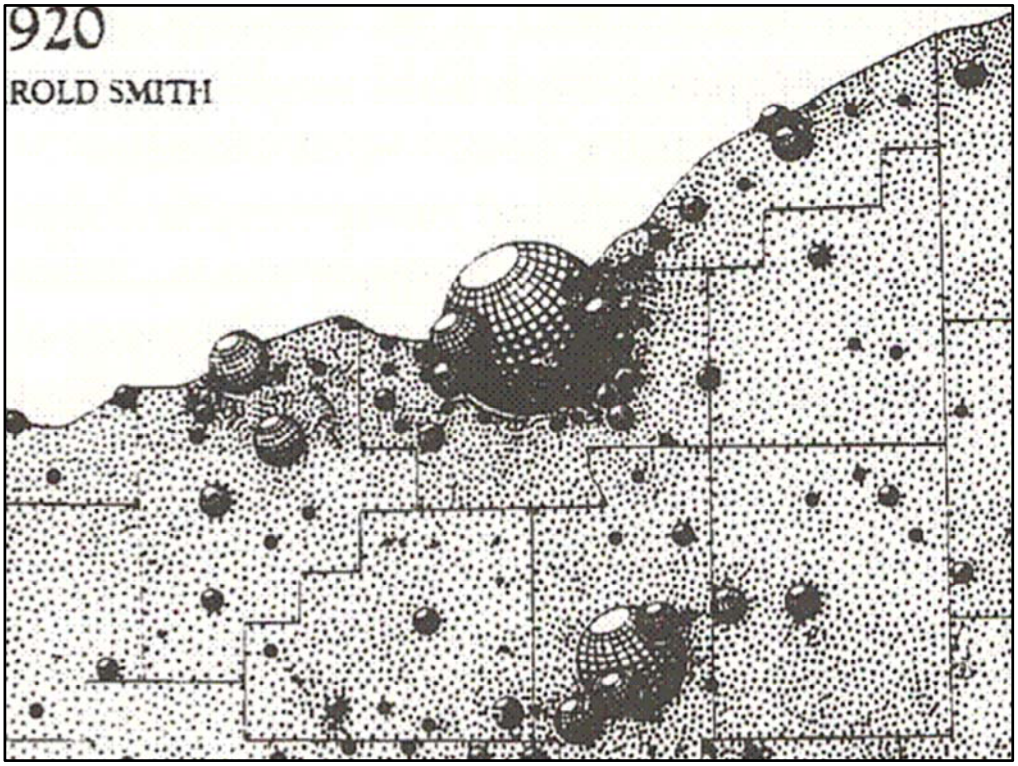
Our map was inspired by a map published nearly a century ago – it's the Population Map of Ohio, 1920 compiled by Guy-Harold Smith, published in the *Geographical Review* in 1928.

Guy-Harold Smith was a man of the science and he mastered the art of cartography. He chaired the Department of Geography at Ohio State University for 29 years, and was the advisor of someone you may be really familiar with, Arthur Robinson who later went on to become a very famous cartographer for many reasons, including the creation of the map projection that is named after him.



Here’s a close up of the map, so you can get a sense of the symbology and techniques he used.
Consider that at <u>that</u> time, maps were compiled using pen and ink!

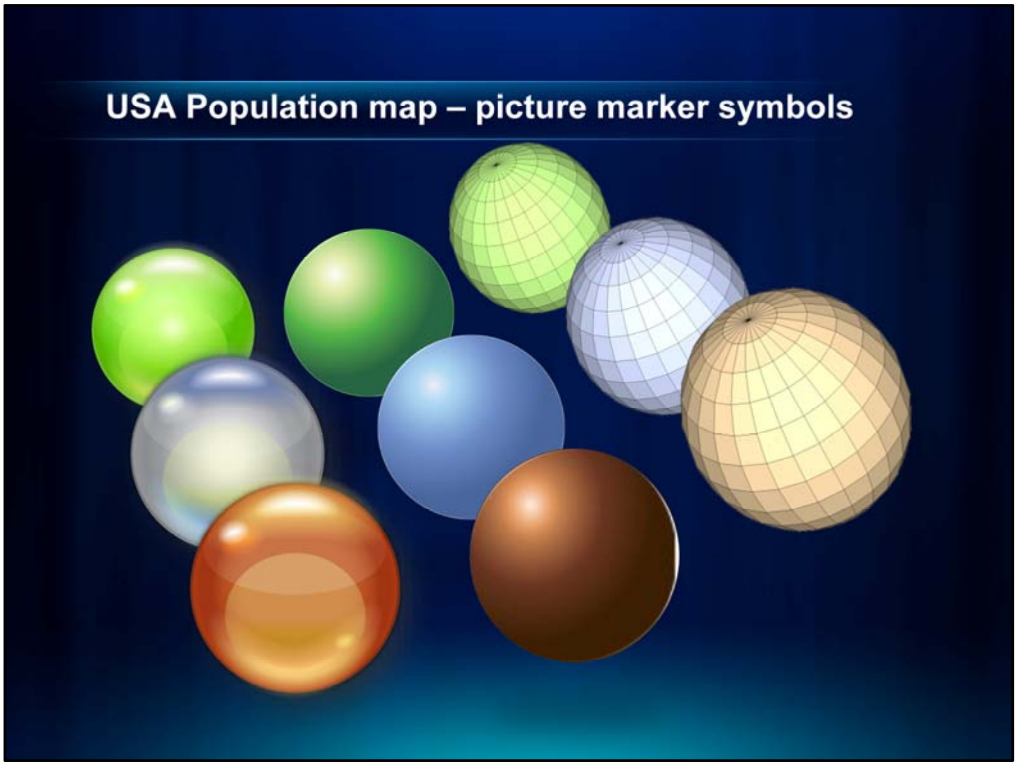
Smith used some very intricate hand-drawn netted globes to represent the population in the <u>cities</u> and <u>villages</u> of the state. As with maps today, the 3D symbols he used helped to create a very eye-catching map.



When you first see this map, you might think that he used a stipple fill pattern for the background. But, if you read the legend you will find that each and every dot actually represents a location with rural inhabitants.

Using this symbology promotes the effect that cartographers call "figure-ground" in which the map is immediately distinguishable visually from the background.

Done effectively, as we see here, this draws the reader eye to the main map area, the State of Ohio.

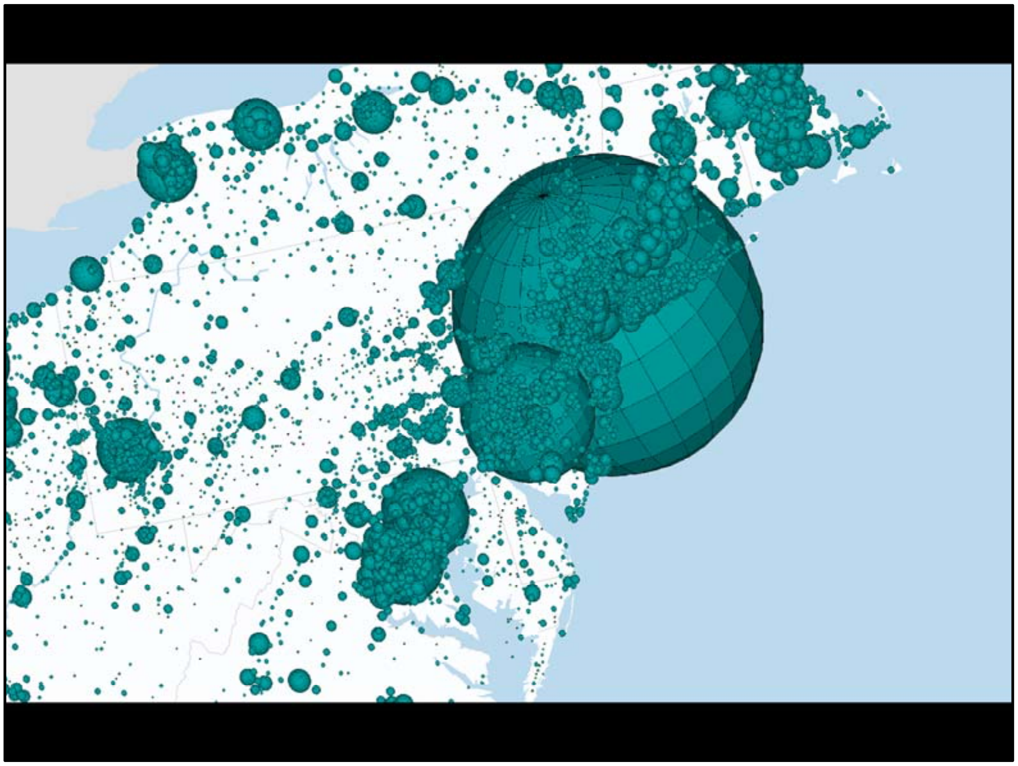


We decided to experiment to see if we could replicate the use of these netted spheres on a map that we created with ArcGIS. Then we tried using some other 3-dimensional symbols.

All of these will soon be available for you to download from the Mapping Center ArcGIS Resources page. The download will include a style file with picture marker symbols defined using the graphic files I created to make these symbols.

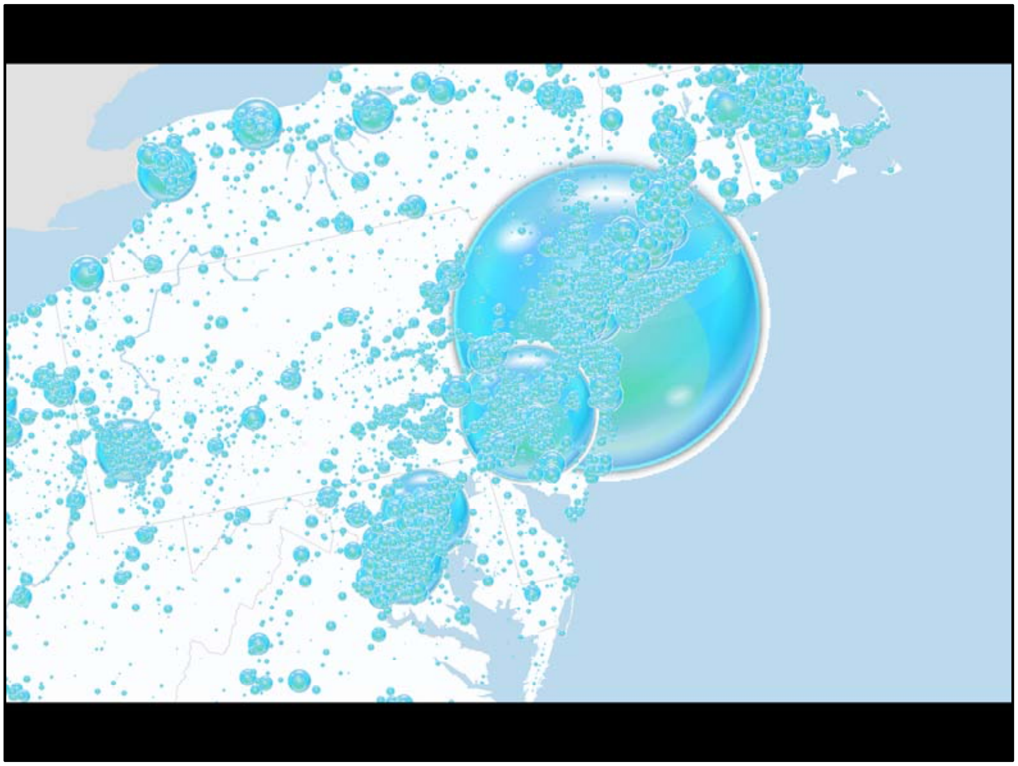
I used SketchUp 7 and Adobe illustrator CS4 to create optimized bitmaps and .emf files which we could then use in picture marker symbols.

After creating these symbols and testing them on various maps, we came to the conclusion that "simple" is still best. To demonstrate why, we will quickly show you some sample maps.



Here you see an example of the netted globes. They don't look too bad at the larger sizes, but the line work for the graticule is too fine to hold up at the smaller sizes.

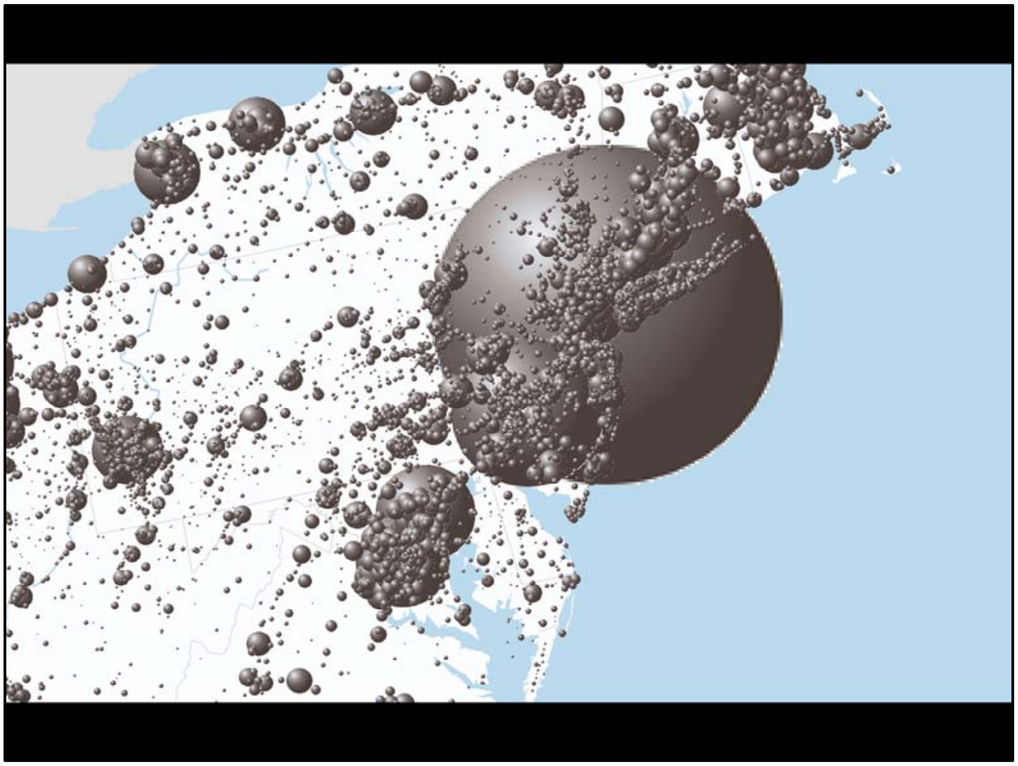
However, the darker tone around the edge did help overlapping symbols to be seen. So this may have worked with some additional modifications to the image used in the picture marker symbol.



The bubbles were complex symbols with reflections and highlights on the surface.

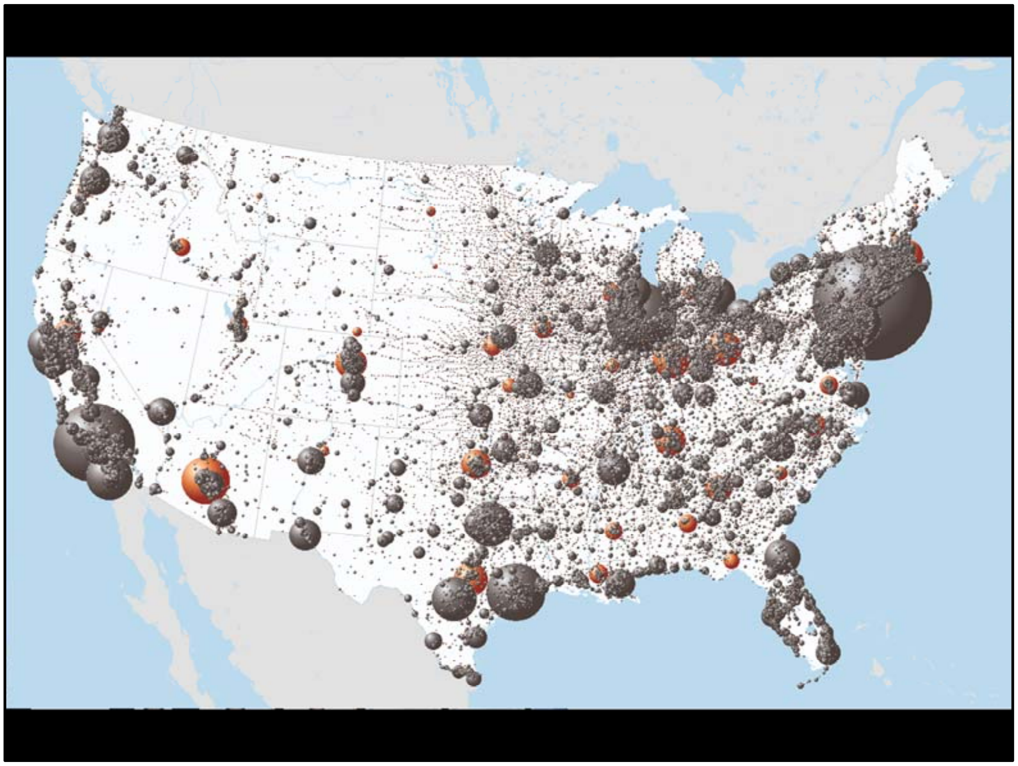
It was harder to see overlapping symbols because of the variation within the bubble and because the colors around the edge were not very different from the colors within the symbol.

Finally, the shadow around the edge caused extra white pixels to be included in the image.

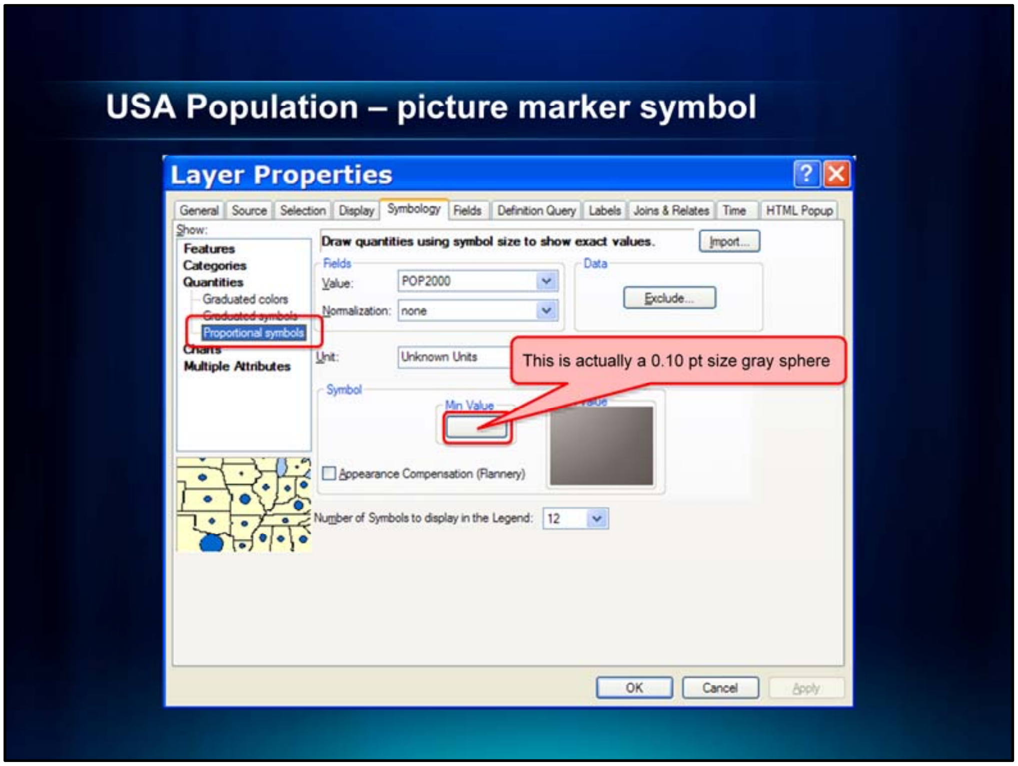


So we went back to using the simple spheres.

With these symbols, we could see the overlap quite clearly, and the simplicity helped the map reader focus on the distribution rather than the symbol.



For this map, we opted to use gray spheres because we also wanted to highlight the capitals using a more vibrant color, and because we think the gray colored spheres relate well to the industrialized urban areas.

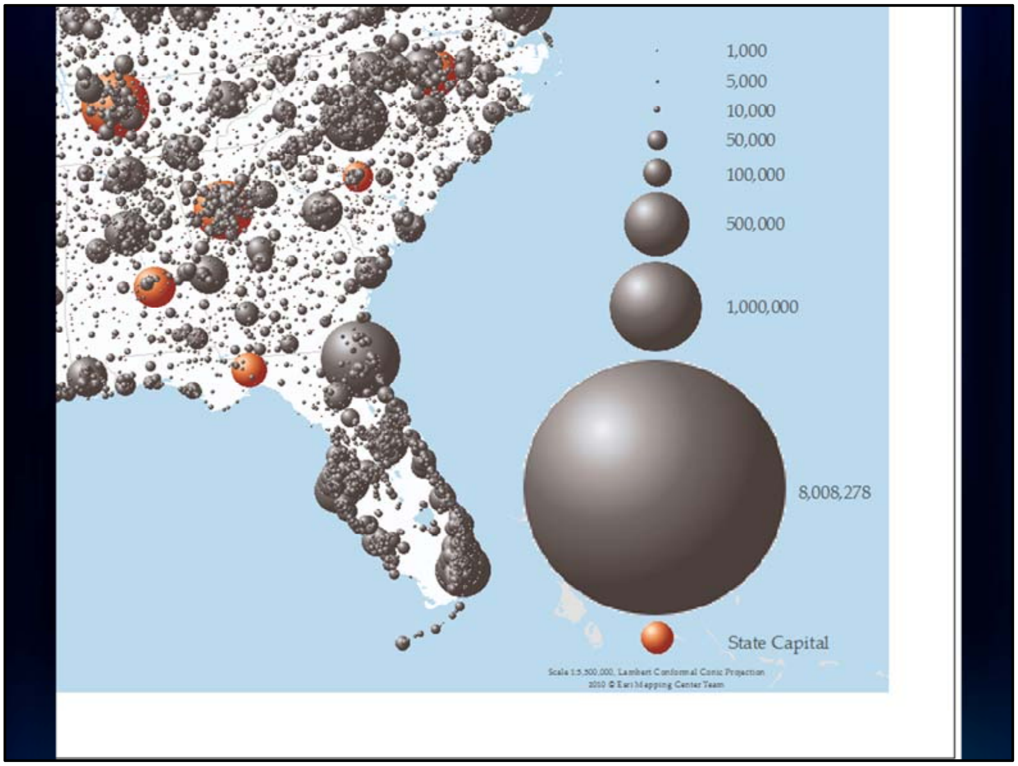


Let's take a look at the picture marker properties for the spheres. (Change slide to show the large Population Sphere)

If we were to open the properties for the Cities layer and look on the Symbology tab, you can see that we are showing the population in 2000 using Proportional Symbols. The layer Properties window would look like this.

When you use Proportional Symbols, you set the sizes by varying the minimum value. All larger sizes will be calculated based on this value. So you have to try a few different settings until you get the size you want. Our minimum value is quite small because of the large range in our numeric values.

There is one other thing we want to show you on this map – it relates to our custom legend. I'm going to pass it over to Aileen now so she can show you our last demo.



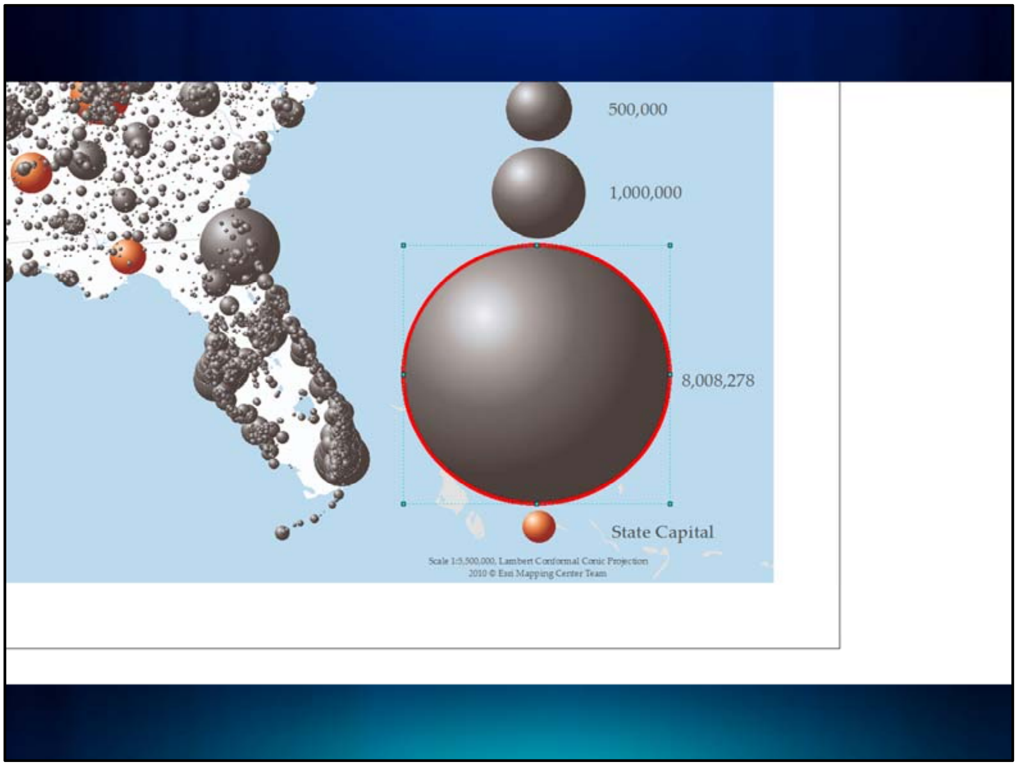
AILEEN – 5 MINUTES

Thanks, Jaynya!

To make this legend, we first inserted a default legend, then we converted it to graphics and rearranged the elements so they looked like we wanted them to. This means that the legend is no longer live linked to the data, but we have the control we need to be able to make it look like we want. One other thing we did to make this legend was to replace the largest default circle, which was for 10,000,000, with the largest circle for the distribution shown on our map, which is just over 8,000,000 for New York City.

Let's go into ArcMap to show you how you can do this. We'll turn off all layers except Cities so this will draw faster. To get the New York city symbol, we'll use the Select by Attributes tool to select from the Cities layer the feature whose Name = 'New York'.

Then we can right click the data frame and select Convert Features to Graphics. We'll use the option to draw both the converted features and the graphics and we'll click OK. When this is done redrawing, we'll use the Select tool to double click the data frame to focus it, right click the graphic and select Cut. Then we'll click the data frame again to unfocus it, right click and select Paste. Now we have the last element we need to create the final legend.

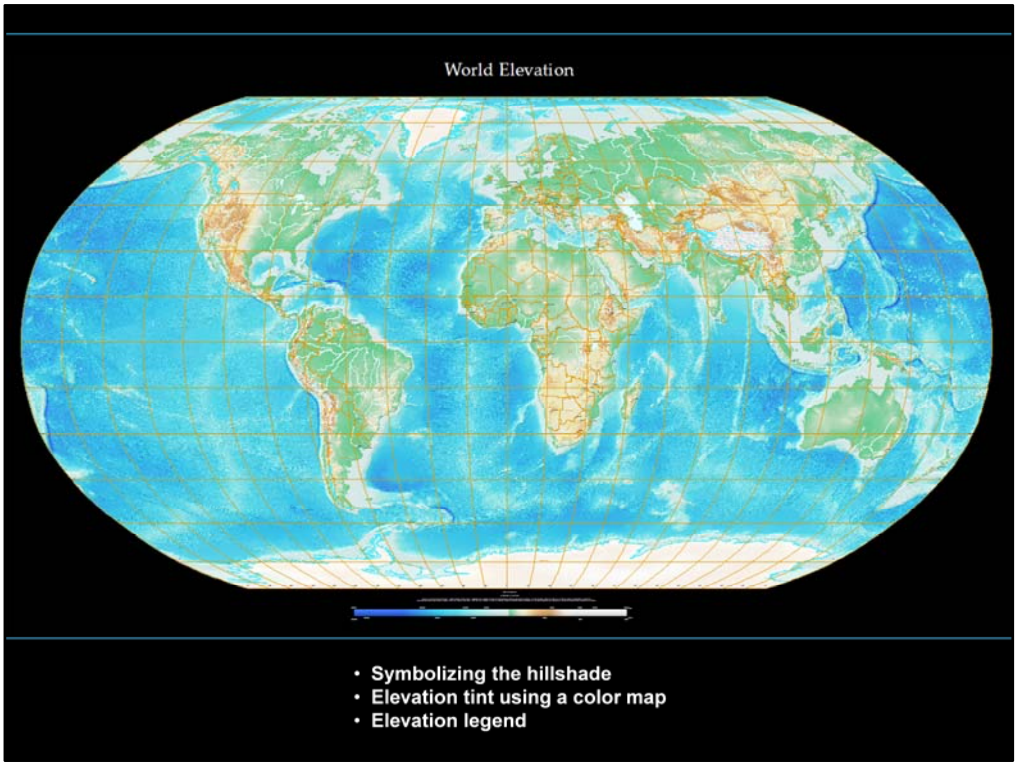


Well – almost! Let's zoom in to see the legend a little better. If we look closely, we can see that the edges of the sphere are pixelly – and in fact it is partly this white edge that allows us to see the overlapping symbols more clearly, which is evident here in southern Florida. But this pixellation is too obvious on the largest circles, so we need to clean it up.

This is easy. I just use the Ellipse tool on the Drawing toolbar to draw an outline around the sphere. Then we can change the color to match the color of the ocean – RGB 187, 218, 237 (HSV 203, 21, 93). We can also increase the line width so that it covers up all the pixels we want it to – we'll change this to 6 pts.

Let's pan up to the location of New York City on this map. You can see that we have the same problem here. To fix this, we'll use the Curve tool to just draw the edge of the sphere that is in the ocean. Once we have drawn this, we can again change the line color and width so that it covers up the offending pixels.

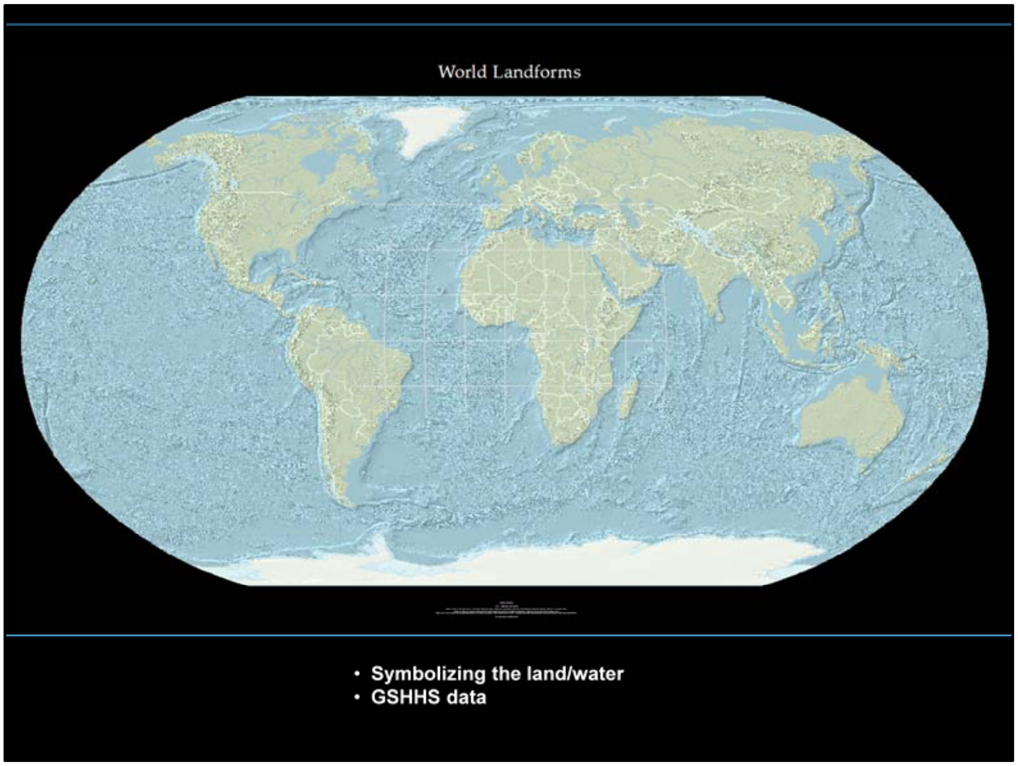
So that brings us to the end of our last demo.



Let's take a minute to review the maps we have seen and the tips and tricks we have talked about.

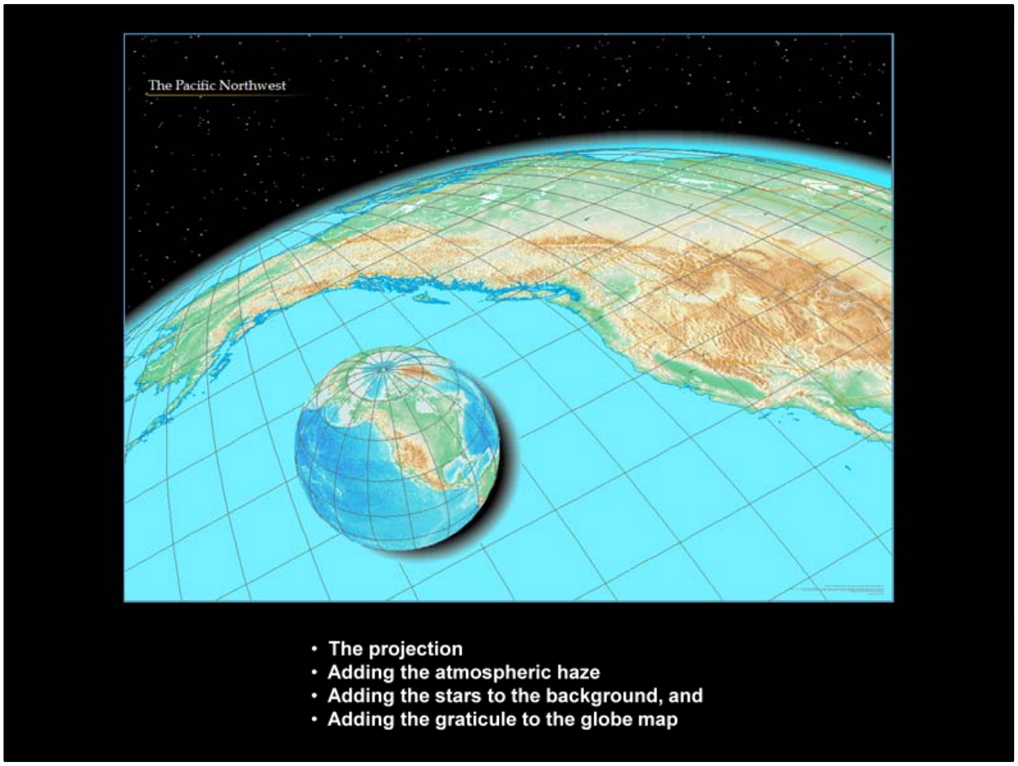
We started with the World Elevation Map – we talked about:

- Symbolizing the hillshade using a contrast stretch
- Using a color map file to symbolize the elevation, and
- Creating the elevation legend



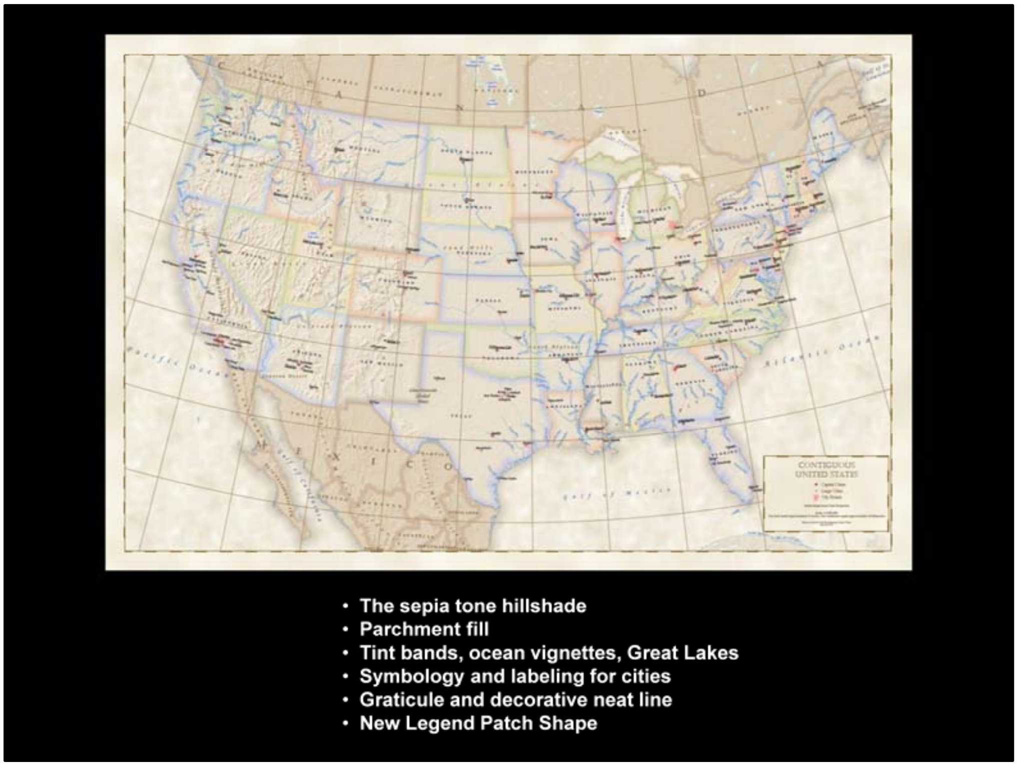
Then we saw a derivative map – World Landforms. For this we discussed:

• symbolizing the land and water with simple tints, and
• we demo'd the GHSSH data set.



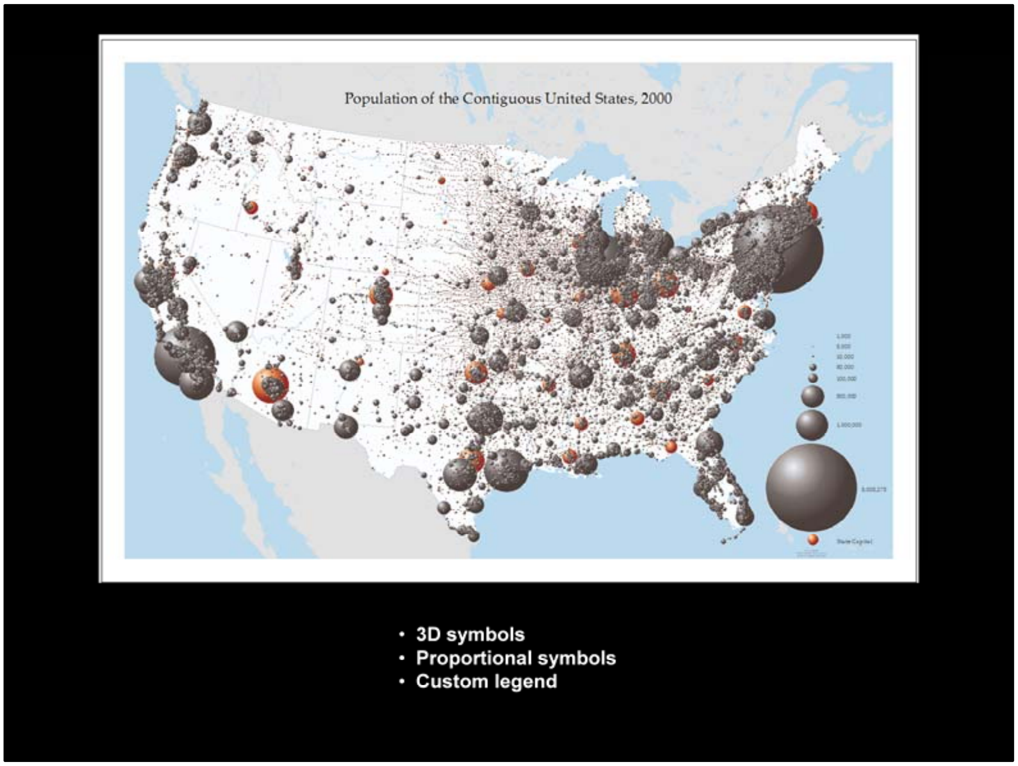
Then we showed you the Pacific Northwest map. For this map, we discussed:

- The projection
- Adding the atmospheric haze
- Adding the stars to the background, and
- Adding the globe map



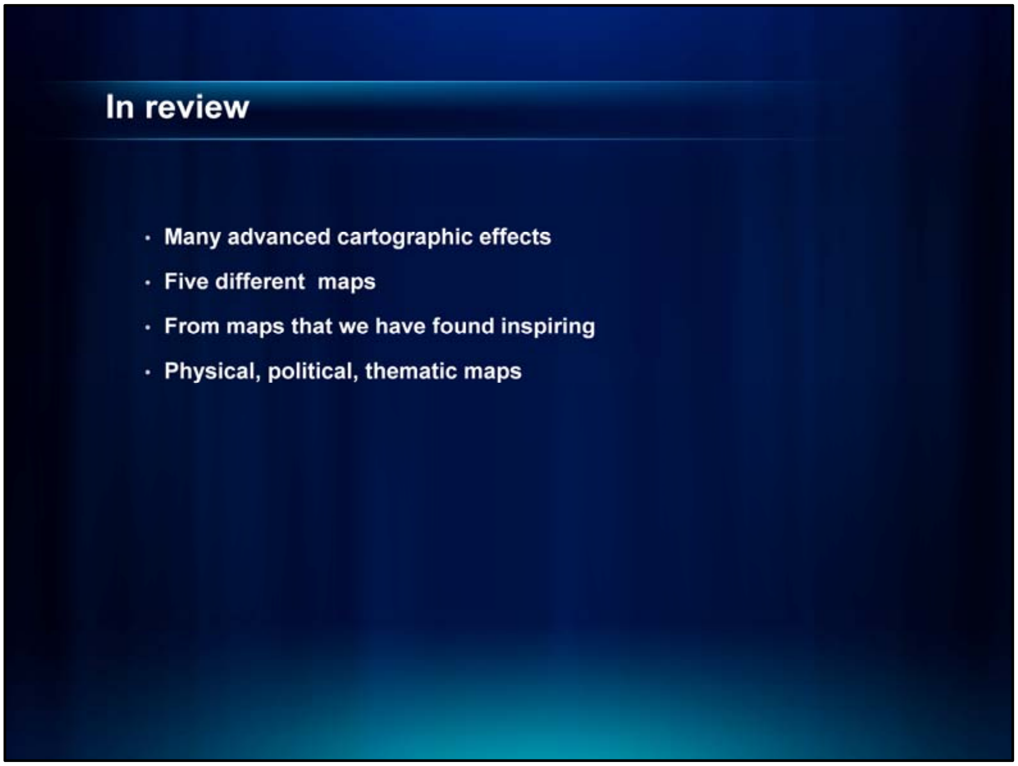
Then we moved on to the USA Political map. For this map, we introduced:

• The sepia tone hillshade
• The parchment fill on the background
• Using the Buffer Wizard for tint bands, vignettes, and the Great Lakes
• Symbology and labeling for cities
• The graticule and decorative neat line
• And how to create a custom legend patch shape for a legend item



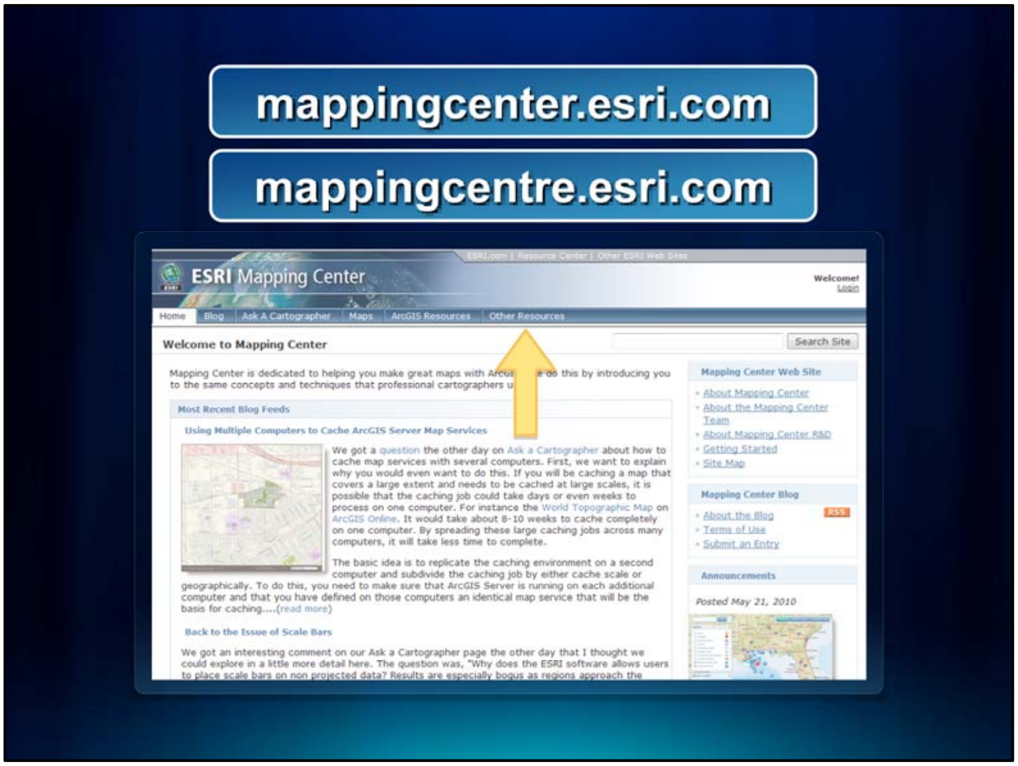
Then we saw the US Population map which allowed us to discuss:

- the use of 3D symbols like spheres, gridded globes and bubbles
- the use of proportional symbols, and
- how we customized the legend for this map.

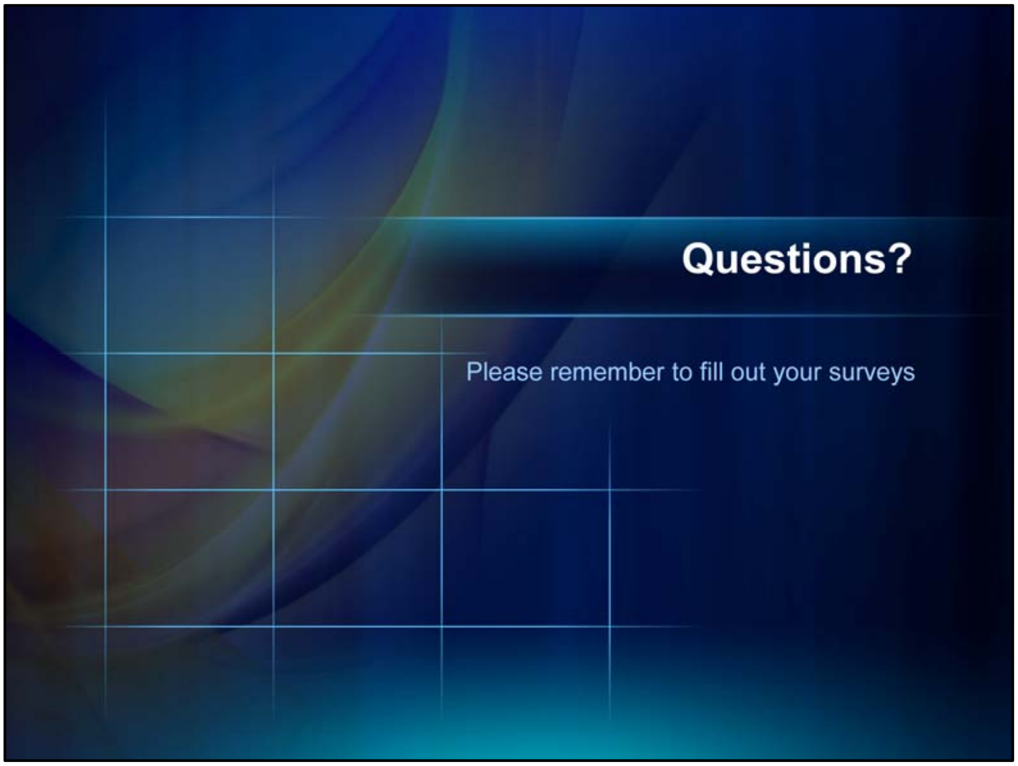


So to wrap up, we have covered a lot of ground. We showed you a number of cartographic effects on four maps we made that included a range from physical to political to thematic maps.

We certainly hope we have succeeded in demonstrating to you that you can make beautiful maps – with GIS!



As we mentioned in the beginning, this presentation with all the bottom notes will be posted on the Mapping Center web site on the Other Resources tab. Look for it there in a couple of weeks.



We encourage you to fill out your surveys to let us know if you found this presentation helpful, and what we might be able to do better in the future to help you.

We thank you very much for your time and attention, and now, we're happy to take any questions you may have.