


Slide 1

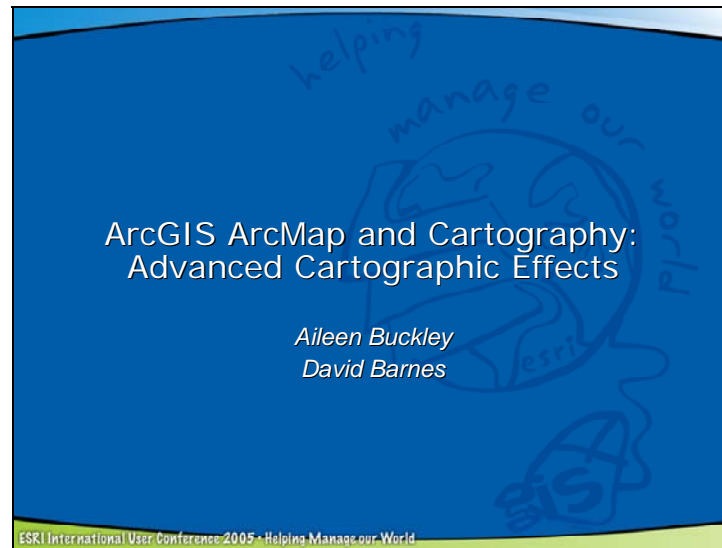


ArcGIS ArcMap and Cartography:
Advanced Cartographic Effects

Aileen Buckley
David Barnes

ESRI International User Conference 2005 - Helping Manage our World

Slide 2

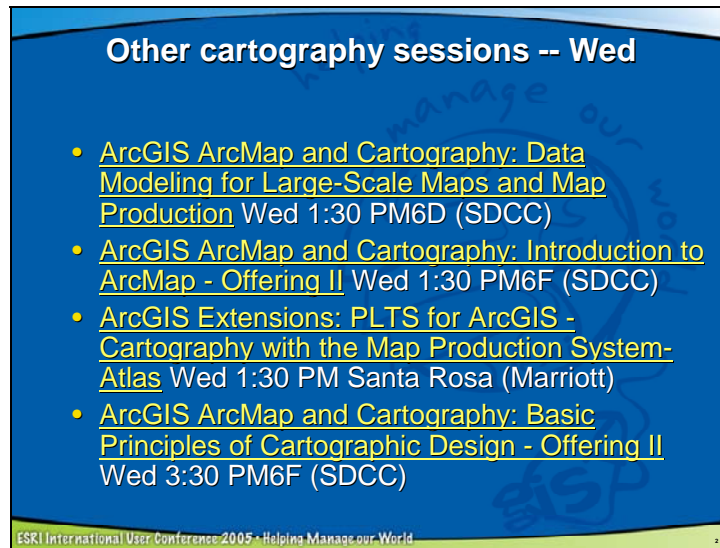


SW OREGON MAP

Welcome to our session on Creating Advanced Effects for Cartography in ArcMap! In the next hour and a half, we'll provide you with information about advanced display and finishing effects in ArcMap to produce high quality maps.

(DEMO: Have the SW Oregon map on the screen and have Spatial Analyst and ArcToolbox Hillshade Toolbox showing and make sure Maplex is on. Have Spatial Analyst settings set. Have Notepad open and the raster calculator statements in it. Set the display of the Hillshade – Swiss Model in Edit mode.)

Slide 3



Other cartography sessions -- Wed

- [ArcGIS ArcMap and Cartography: Data Modeling for Large-Scale Maps and Map Production](#) Wed 1:30 PM6D (SDCC)
- [ArcGIS ArcMap and Cartography: Introduction to ArcMap - Offering II](#) Wed 1:30 PM6F (SDCC)
- [ArcGIS Extensions: PLTS for ArcGIS - Cartography with the Map Production System-Atlas](#) Wed 1:30 PM Santa Rosa (Marriott)
- [ArcGIS ArcMap and Cartography: Basic Principles of Cartographic Design - Offering II](#) Wed 3:30 PM6F (SDCC)

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SW OREGON MAP

Before we start, let me point out that there are a number of other cartography related sessions that you might want to visit. These include ArcMap sessions that will teach you about core functionality in the software and presentations on the Production Line Tool Set or PLTS – an extension for high quality map production.

Slide 4

Other cartography sessions -- Thurs

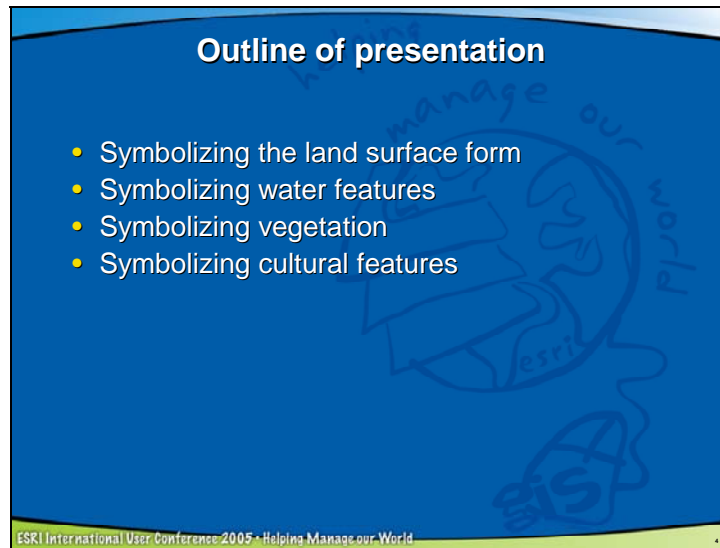
- [Cartography Special Interest Group Meeting](#) Thu 12:15 PM30-E (SDCC)
- [ArcGIS ArcMap and Cartography: Introduction to Query and Analysis - Offering II](#) Thu 8:30 AM6F (SDCC)
- [ArcGIS ArcMap and Cartography: Labeling, Annotation, Editing, and Text Placement - Offering II](#) Thu 10:30 AM6D (SDCC)
- [ArcGIS ArcMap and Cartography: Map Design and Page Layout in ArcMap - Offering II](#) Thu 10:30 AM6F (SDCC)
- [ArcGIS Road Ahead: What's Coming in Cartography at 9.2 - Offering II](#) Thu 10:30 AM6A (SDCC)
- [ArcGIS ArcMap and Cartography: Printing, Exporting, and ArcPress - Offering II](#) Thu 1:30 PM6F (SDCC)
- [ArcGIS ArcMap and Cartography: Thematic Mapping and Statistical Analysis - Offering II](#) Thu 1:30 PM6D (SDCC)
- [ArcGIS ArcMap and Cartography: Advanced Cartographic Effects - Offering II](#) Thu 3:30 PM6F (SDCC)
- [ArcGIS ArcMap and Cartography: Interactive and Web Mapping - Tips and Tricks - Offering II](#) Thu 3:30 PM6D (SDCC)

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SW OREGON MAP

Thursday you will find even more sessions that will show you about mapping with ArcGIS, and be sure to attend the Cartography Special Interest Group meeting over the lunch hour.

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SW OREGON MAP

Now on to our talk. We want to show you a number of really neat methods for high quality mapping:

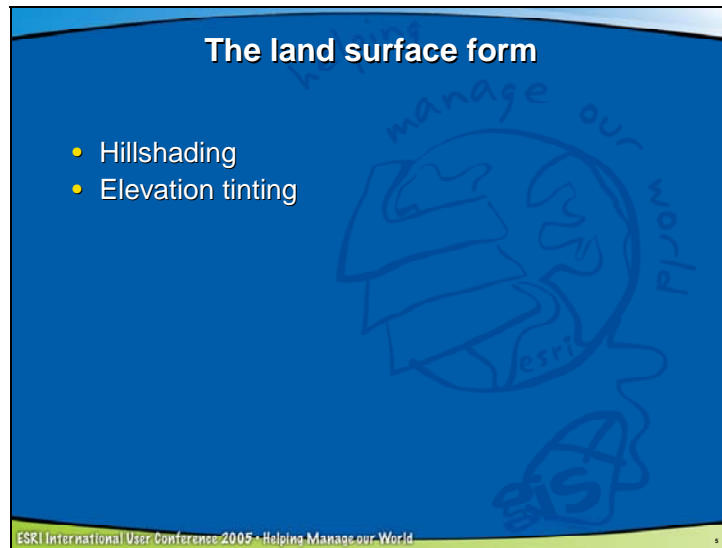
Including how to create a background hillshaded surface and then drape it with colors to show elevation ranges.

We'll describe some interesting techniques for mapping hydrographic or water features.

We'll also show you a way to enhance the vegetation symbology using a method called "bump mapping".

And we'll finish up with a demonstration of some special methods for symbolizing cultural features.

Slide 6



CRATER LAKE MAP

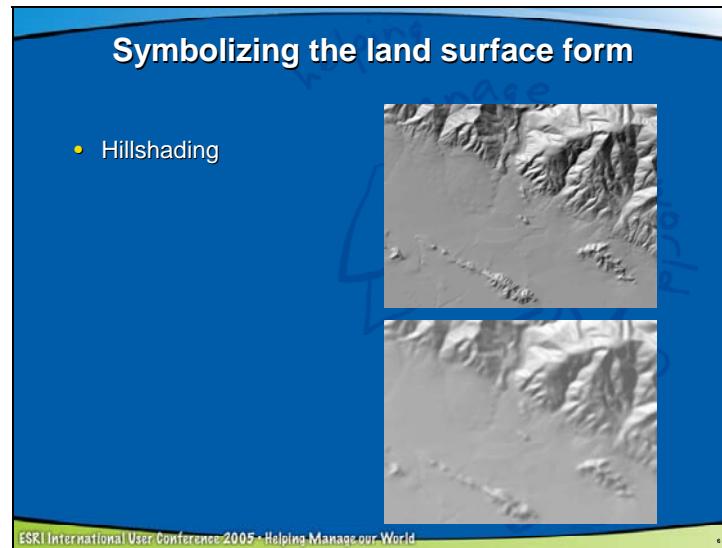
First, let's talk about creating a backdrop for our map. For that, we'll close the SW Oregon map – we'll come back to that in a bit – and open our Crater Lake topography ArcMap document. In this part of the talk, we'll demonstrate some methods for creating that backdrop using some hillshading techniques that are then enhanced with some elevation tints.

DEMO: We'll turn off all the layers in our map except for the default hillshade.

Elevation tinting can be combined with hillshading to simulate vegetation, snow or other land cover.

DEMO: Now let's turn on the elevation tint, which on our map is the DEM layer. We'll move it up above the default hillshade so you can see the result of elevation tinting and hillshading.

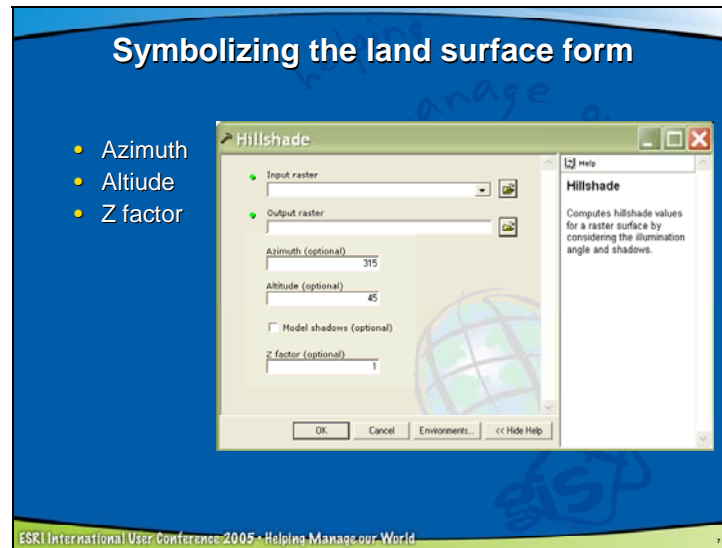
Slide 7



CRATER LAKE MAP

Often you'll see a hillshaded surface that provides an impression of the terrain illuminated from an external light source, like the sun. When hillshading, the **PURPOSE** of the map should be paramount. Sometimes the objective is to emphasize the terrain. Other times you really want to use terrain as a backdrop to show other reference or thematic data. In that's the case, you want the hillshade to capture less of the visual attention of the map reader and serve more as a backdrop.

And of course, the terrain representation should also take into consideration the unique characteristics of the area mapped like the relief and orientation of physiographic features.



CRATER LAKE MAP

So how do you create a hillshade? It's really pretty straightforward if you have Spatial Analyst – or 3D Analyst.

DEMO -- In order to demo this, we'll start by turning off all the layers except our DEM. In ArcToolbox, scroll down to the bottom to see the Spatial Analyst Tools. Click on the Surface tools and then double click Hillshade tool. We'll double click that to open it. Specify the digital elevation model that you want to use – ours is called DEM.

You can see that you can also change the:

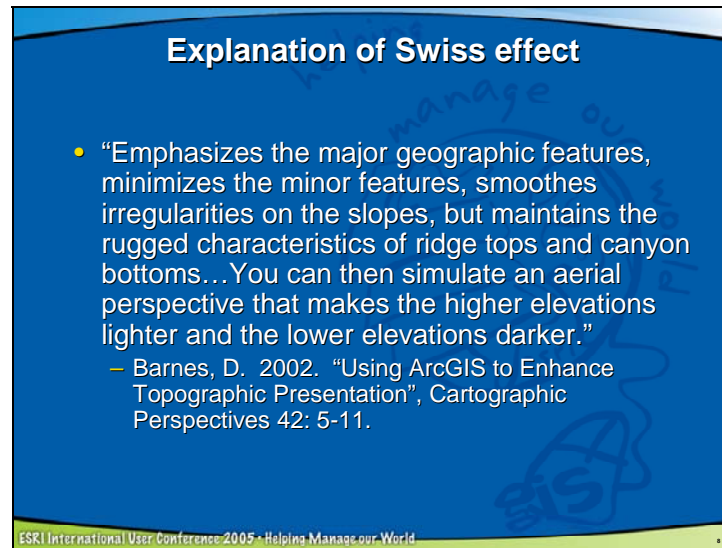
- angle or azimuth and
- height or altitude of the illumination source

to further specify the way the shadows will be cast. And if you increase the:

- Z factor, you'll essentially be creating a display that exaggerates the heights of the surface.

Modeling shadows allows illumination to occur locally even if larger features would normally place smaller features in shadow. We'll click OK to create the hillshade.

You can make some very simple modifications to this method to achieve some rather dramatic results.



Explanation of Swiss effect

- “Emphasizes the major geographic features, minimizes the minor features, smooths irregularities on the slopes, but maintains the rugged characteristics of ridge tops and canyon bottoms...You can then simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker.”
 - Barnes, D. 2002. “Using ArcGIS to Enhance Topographic Presentation”, Cartographic Perspectives 42: 5-11.

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CRATER LAKE MAP

We’ll show you a technique for enhancing the hillshade to create an effect that is similar to what you would see on a Swiss style topographic map. What this method does is to create two new rasters from the input DEM. The DEM and the two new rasters are used together in the final display. It’s a fairly simple process – we’ll work through it with you using Spatial Analyst.

To produce the Swiss effect, we need to use our original DEM and its default hillshade.

DEMO: Using Spatial Analyst’s Raster Calculator, enter the formula $DEM / 5 + Hillshade$. Then click Evaluate.

This display simulates an aerial perspective that makes the higher elevations lighter and the lower elevations darker.

DEMO: Now let’s make the second raster. Click on the Spatial Analyst toolbar and select Neighborhood Statistics. Use the default hillshade as the input raster, set the statistic type to mean, the neighborhood to circle and the radius to 4 cells and click OK.

The output grid generalizes the hillshaded terrain, emphasizing the major geographic features, minimizing the minor features, smoothing irregularities on the slopes, but maintaining the rugged characteristics of ridge tops and canyon bottoms. Now you can combine the grids in your display to get the final effect.

DEMO:

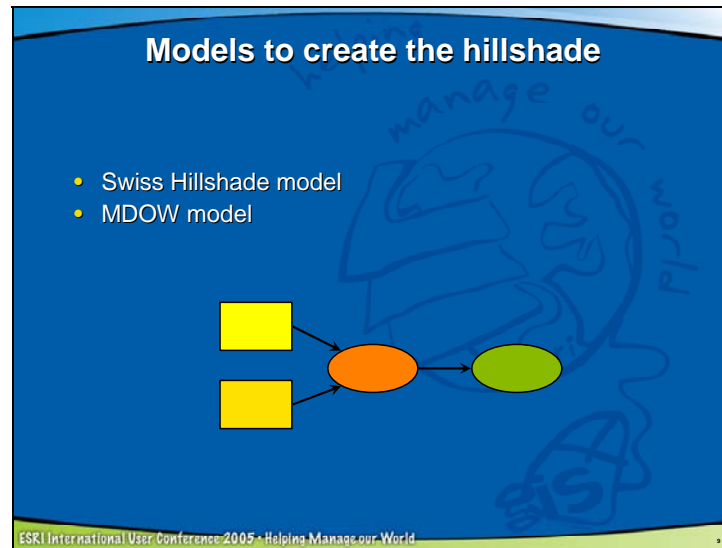
Move the original DEM to above the two rasters we just created and symbolize it with a color ramp to show elevation – we have one we created especially for Crater Lake National Park.

Next, set the transparency to 55%.

In the middle, display the median filter grid with 55% transparency and use a single hue color ramp, like a black to white ramp.

On the bottom, display the raster calculator grid with a black to white ramp and 55% transparency.

The final display produces an effect similar to the Swiss-style hillshade.



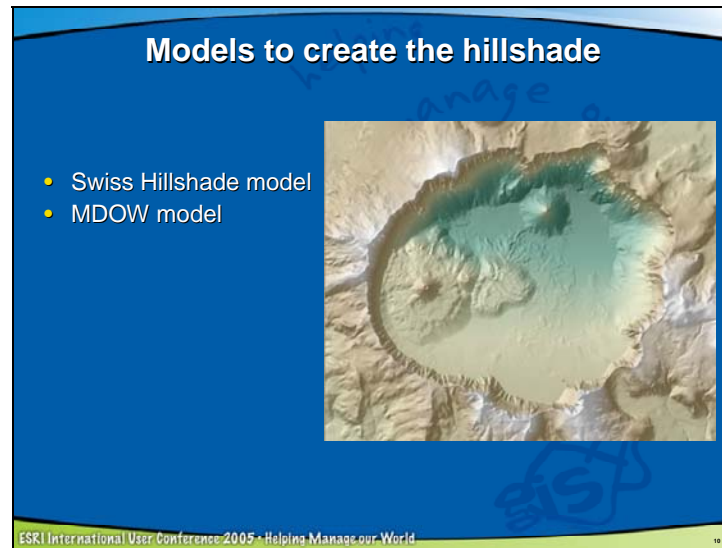
CRATER LAKE MAP

In Arc 9.1 you can actually make this even simpler by constructing a model using the Geoprocessing capabilities of ArcToolbox.

DEMO: We'll show you a model we created for this hillshade method – it's in a toolbox we made called Hillshade Tools. Let's open that toolbox now. To see the model, we'll right-click the Swiss Hillshade Model and click edit.

The steps in the model are simply a combination of Spatial Analyst tools strung together. It also provides some documentation about the method like how to set the transparencies and order of your rasters in the output display.

Our Hillshade toolbox also contains a model we created for doing some Multi-directional Oblique Weighting hillshading.



CRATER LAKE MAP

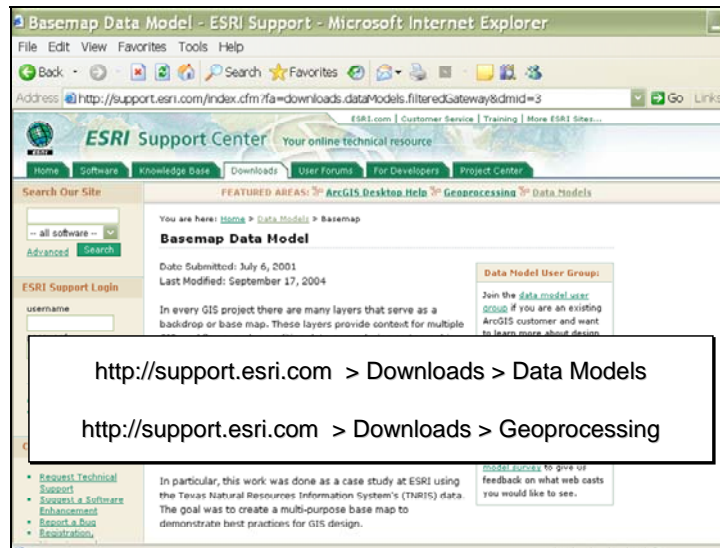
DEMO: Let's right click on it to see what it looks like.

This method shades the surface from four different illumination angles so you can highlight features regardless of their orientation relative to the illumination source.

DEMO: Let's zoom to our bookmark called Named Water Bodies. Then let's scroll in the table of contents to the very bottom to the MDOW hillshade so we can turn it on. When we toggle it on and off you can see how the effects of this hillshade add some definition to the Swiss results, especially in the area along the western shore of the lake where the terrain is steep and mostly in shadow because of the way we originally defined the illumination parameters for the hillshades.

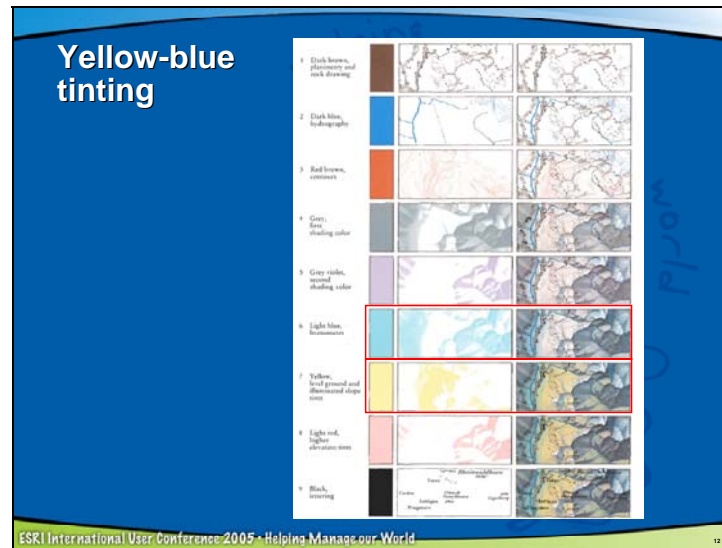
Note that by placing the MDOW hillshade under all our other hillshades we can actually combine the effects of both the Swiss and MDOW methods – we can see the bottom raster because we set the transparency of the bottom raster from the Swiss method to 55%.

Slide 12



We put a link to both of these models on the Base Map Data Model web page on the ESRI Web Site. Here, you can also find other useful tools and hints for mapping and cartography, and look for more as they are developed!

This is probably a good time to tell you that you can stop taking copious notes! We are also posting the entire contents of this presentation including everything that I say, on the Basemap Data Model Web page, so from here on out, you can sit back, relax and enjoy the show!



CRATER LAKE MAP

http://www.reliefshading.com/colors/yellow_tone.html

Applying a yellow to blue color ramp to the hillshaded surface is an effective method for improving the three-dimensional appearance of a shaded relief. This method comes from guidelines by the famous Swiss cartographer, Eduard Imhof.

The gray relief shading is either combined with or replaced by a bright yellow tone on the sunlit slopes and blue-grey in the less illuminated areas. The blue simulates atmospheric haze and provides additional pale blue shadows to add color to the valley floors, flat land, and lower hilly regions. The yellow gives the impression of warmer colors on the sunlit slopes.

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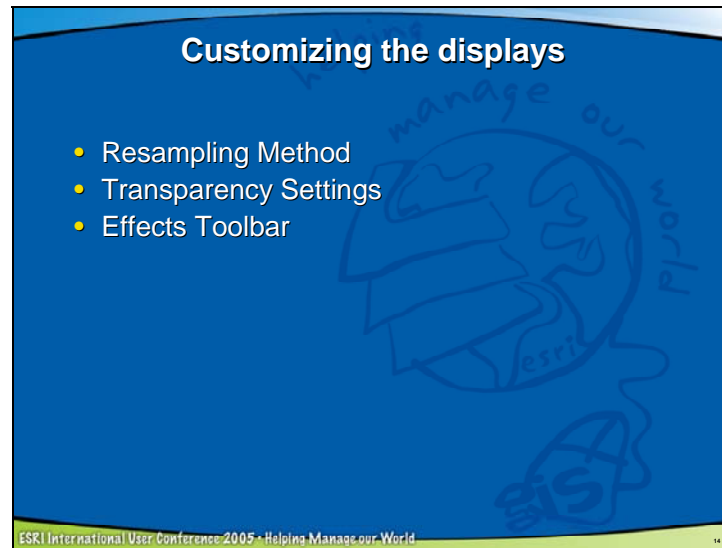
CRATER LAKE MAP

We'll take a look at a color ramp that we're using on our map and then show you how you can easily change it to achieve this effect.

DEMO: To start, let's turn off all layers except the median filter raster from the Swiss hillshade model so we can see things a little more clearly. Right click it to see its Properties and select the Symbology Tab. Then right click the color ramp and select Properties. Note that there is only one color listed but you're really using a ramp that ranges from black to white. Let's change the color ramp now to use two colors that range from blue to yellow. Click on the button to use two colors then click on the first color and select Larkspur Blue. Then click on the second color and select Yucca Yellow. To get the ramp to range between those two colors only, select the CIE Lab instead of the default HSV algorithm.

DEMO: Once we've this modified color ramp, we may want to save it for later use in another map – if that's the case you would right click the ramp again and select "Save to Style" then give it a name and click Save. We've already created one so we won't do that but if you did, when you look in your personal style, you'll find it there.

By the way, the color ramps used in today's presentation will be available on the Base Map Data Model Web Page as well.



CRATER LAKE MAP

Now we want to show you some more tips and tricks for displaying your hillshade and other rasters. Some of them you saw briefly earlier – we’ll talk about them in more detail here. Two main settings are the Resampling Method and the Transparency Settings.

DEMO: To demonstrate this, let’s select our Wizard Island bookmark so we can zoom in and show you how this works. Right-click on the median filter hillshade layer in the Table of Contents and Select Properties. Then select the Display tab.

Here you can change the Resampling setting from the default Nearest Neighbor, which is best for discrete data, like categorical data – for example, land use classes from satellite imagery.

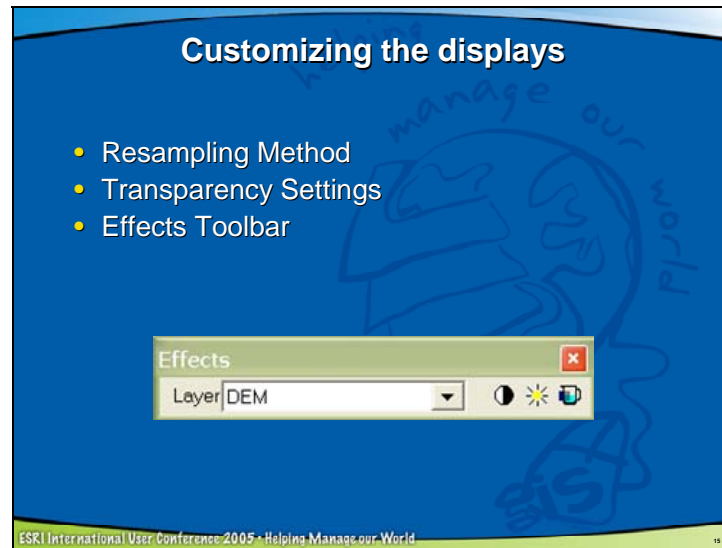
Bilinear Interpolation is better for continuous data, like our rasters. The third option, Cubic Convolution, is also good for continuous data but works best for imagery and photography since it doesn’t smooth as much as Bilinear Interpolation.

While you’re here, you can also set the transparency of the raster – this not only allows other layers to show through – it also tones down the contrast between the brightly illuminated areas

and the darker shadows. Recall that we set this earlier to 55% so that we could see the other two Swiss hillshade method rasters at the same time.

If you also check the option to “Allow interactive display for Effects Toolbar”, you can immediately see the results as you change some of the display settings with that tool.

DEMO: We’ll turn that option on so you can see how the Effects Toolbar works. Click OK to save your settings.

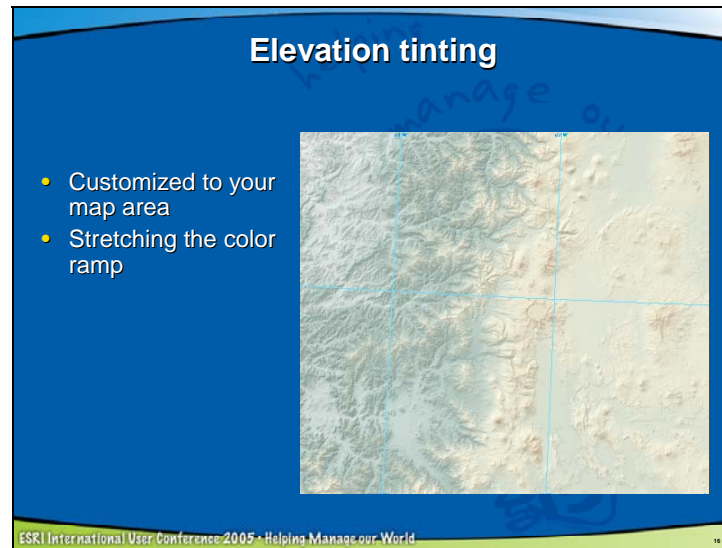


DEMO: Let's pull the Effects Toolbar out in the display area where we can see it a little better. Let's set the raster to our median filter hillshade.

With the Effects toolbar, you can set the contrast and the brightness of your raster display, as well as the transparency. These enhancements are applied to the screen display, not to the original dataset. David can change these settings while I explain them so you can see the effects. Contrast adjusts the difference between the darkest and lightest colors. Brightness increases the overall lightness of the image. This produces an effect similar to changing the color ramp from Black to White to Gray to White. Transparency lets you see other data layers underneath the raster layer. This is the same as setting the transparency on the Display tab of the Layer Properties.

With these tools and the others we showed you earlier, you can create a professional quality elevation display for your map.

Now we're going to work with a map of Southwest Oregon to illustrate how hillshades and elevation tints are used together. This map showcases some of the work by David Barnes, a Product Specialist for ArcMap, and incidentally the person running our demos!



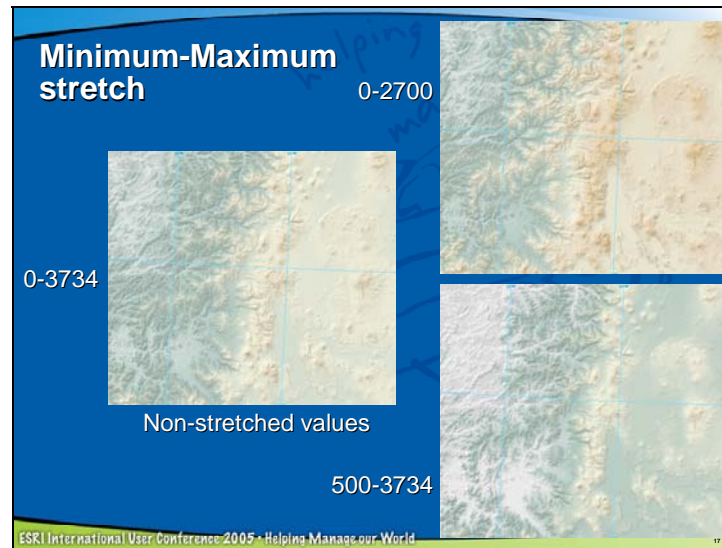
SW OREGON MAP

In addition to hillshading, cartographers often represent the land surface form using a technique called elevation tinting, in which bands of color are used to represent specified elevation ranges. The resulting representation is often overlain on the hillshaded image. The success of the method depends on careful selection of the colors and their appropriate assignment to the elevation ranges. We customized a color ramp for the western U.S. to show the range of elevations from low lying green fertile valleys to higher elevations with rocky sparsely vegetated land cover, up to snow capped peaks in the highest elevations.

DEMO: Now let's see how we customized the color ramp used for elevation tinting with a defined set of color values. We'll right click the elevation layer to see its Properties and click the Symbology Tab. Again, let's look at the properties of the color ramp.

In this case, you can see that there are multiple algorithmic color ramps that together define the full range of colors used for elevation tinting, from the lower elevation colors...in this case greens for valleys to higher elevation colors with white for snow capped peaks. If you wanted to, you could change the colors in any of the individual color ramps, just make sure that the ending color for one is the same as the beginning color for the next. You could add or remove algorithmic color ramps to make more modifications to your elevation tint.

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SW OREGON MAP

Another modification you can make is to stretch the color ramp. You might want to do that if you created your color ramp to extend over a larger area – in that case, the DEM probably has a wider range of high to low values. You can still get the ramp to fit your area by stretching the elevation values in the display.

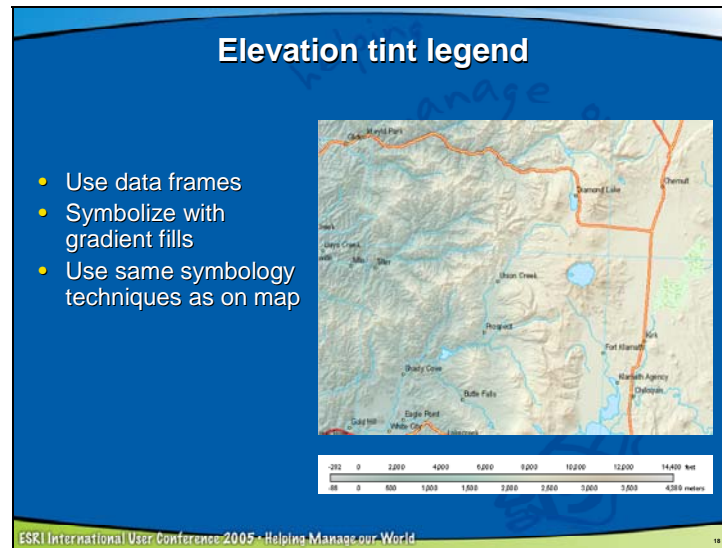
DEMO: We'll right click the DEM layer to see its Properties and click the Symbology Tab. Under the Stretch Type, make sure to select the Minimum/Maximum option. Notice how we now have the ability to change the high and low values.

In this case, the elevation values for the entire DEM range from 0 to 3734 – if higher and lower values were found outside our current area of display, we would want the color ramp to show the range of colors for the entire DEM. You do that by setting the min and max values to those for your current display. Then the colors in the color ramp will show across the range of your minimum and your maximum values.

DEMO: Let's click the check box to edit the high and low values. Here we can see the effects of changing the high value to 2700. When we click on Apply we can see the results. This means

that the white in our color ramp starts at 2700. Let's go back to the layer properties and set the minimum to 500, and again click Apply. We can see that the green at the end of our color ramp is stretched to this elevation.

Because we started out with a color ramp that we created for our area, we really don't need to make these modifications, but at least now you know how they are done.



SW OREGON MAP

On some maps you may want to create an Elevation Tint Legend that shows the same symbology you used to make your map – which as you can see can get a little advanced if you want to create more interesting effects. The objective is to create a legend that contains the same transparency and color ramp specifications as any of the layers used to create your hillshaded–elevation tinted surface.

Say your map had a single hillshade overlain with a single elevation tint that had a transparency. Then you would need to create a legend using two layers displayed in the same order and with the same settings as the hillshade and the elevation tint on the map.

DEMO: We'll zoom to 100% to see this a little better.

We'll talk you through the rest of the steps but to save time, we'll only show you're the results right now.

DEMO: First, you'll want to create a rectangle feature in an otherwise empty polygon dataset. The shape should be similar to how you want the final legend to look. We chose to make a long narrow horizontal rectangle.

DEMO: Next, you would add a data frame that contains two copies of this rectangle data layer. We've named ours "elevation legend" and "hillshade legend". Then you would use gradient fills to symbolize

the rectangles using the same color ramps as on our map. Let's right click the elevation legend layer to see its symbol properties. Click on the symbol and then click on Properties. For this layer, you would use a linear gradient fill with the elevation tint color ramp. Let's cancel this window and then cancel once more. Select the Display tab and we can show you that you need to set the transparency to the value you used on your map for the elevation tint.

We'll cancel this window so we can show you the properties for the hillshade layer next. Again, open its Properties – here you can see the transparency is set for the Hillshade legend as well. Now click on the Symbology tab and click on the symbol again. For this rectangle layer, use the same black to white ramp as the hillshade on your map and then be sure to change the angle to 90 degrees. That's it! We'll cancel out of all these windows so we can see the finished legend.

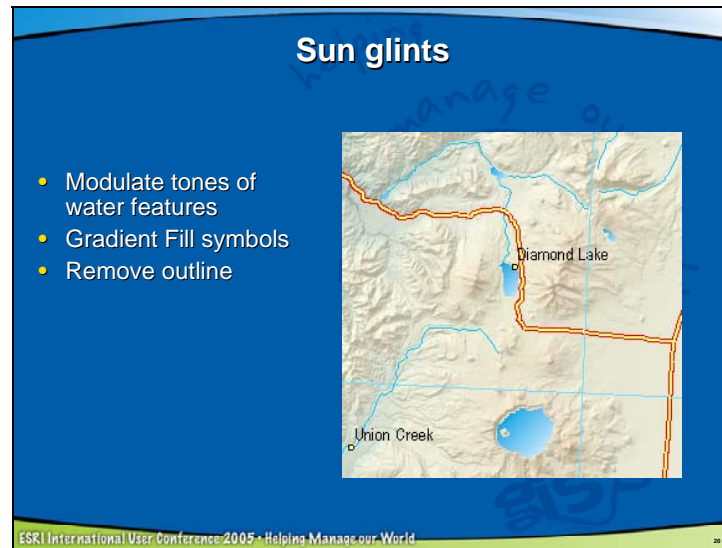
Water features

- Sun glints
- Shoreline vignettes
- Bathymetry
- Named water bodies
- Shoreline labeling

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SW OREGON FOR SUN GLINTS -> CRATER LAKE FOR THE REST

We're now going to switch from symbolizing the land to symbolizing hydrographic and other features on our map. Let's start with the lakes in this SW Oregon map.



SW OREGON MAP

Sun glints are a way to add a more realistic effect to your map by modulating the tone of water features. We rarely see flat tones in nature, so using sun glints simulates the subtle tonal variations caused by the reflection of sunlight off the water surface. To achieve this effect, you need two things: water polygon features and a blue to light blue color ramp.

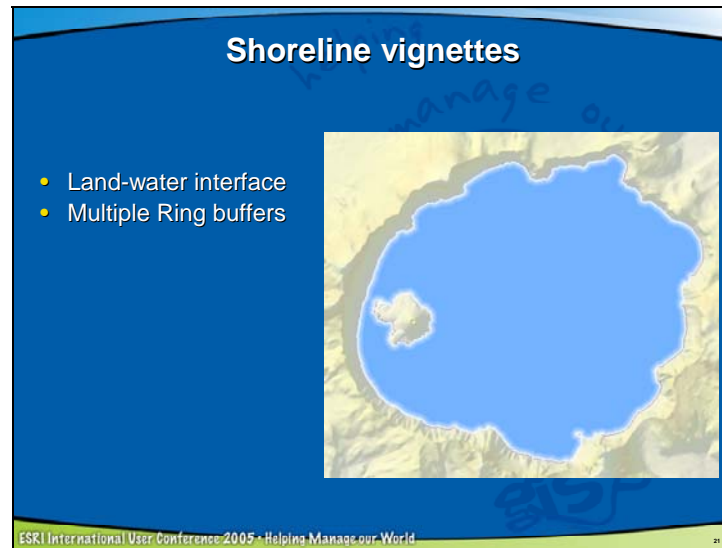
DEMO: For the Lakes layer that contains the water features – ours is called Lakes – click on the symbol and click the Properties button to open the Symbol Properties Editor. Set the Type to a Gradient Fill Symbol. Then click on the Style to select the color ramp – we’ll choose a color ramp that we have already created called Light Blue to Blue for Lake. Let’s right click on it to see it’s properties. Note that it’s an algorithmic color ramp and if we click to take a look at its Properties, we can see that the dark blue is the same color as our rivers and other water features, and the light blue is the color of the water with the sun reflection. Let’s cancel this window and the next to get back to the Symbol Property Editor for the Gradient Fill symbol.

Now make sure the Style is Linear, set the Intervals to 44, set the Percentage to 100, and change the Angle to 135. What this does is to set the smoothness in the color gradation – applies the

gradient fill across 100% of the polygon features and changes the angle of the gradient fill to NW to SE. You can adjust these setting for your particular mapped area.

Finally set the outline of the polygon symbol to zero width so that no outline is displayed. Click OK to all the windows and let's take a look at our results. Let's zoom in now to Crater Lake to take a closer look.

This is a great way to show these lakes at a regional scale, but what if we wanted to focus only on Crater Lake? We'll close our SW Oregon map and open our Crater Lake map to see some other methods for symbolizing hydrographic features.

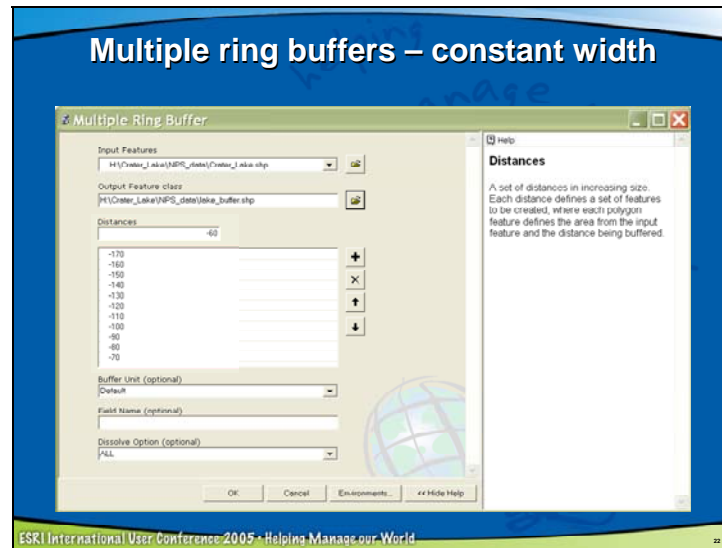


CRATER LAKE

Let's continue with coastal vignettes. We'll zoom to Crater Lake to see how this works. Coastal vignettes are a great way to symbolize water features to emphasize the land-water interface.

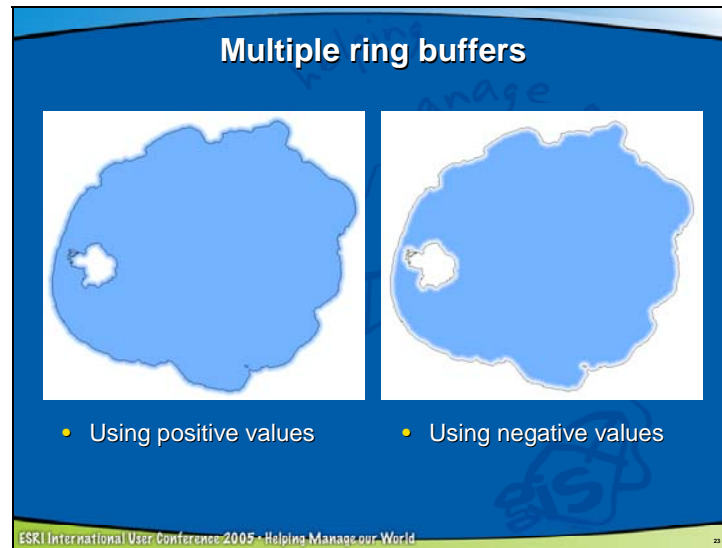
We'll show you how to create these using ArcToolbox. To save time and because this is really straightforward, we won't actually run the tool, but we'll go through it with you!

You can create Buffers with the Arc 9.1 Geoprocessing tool. This tool allows you to make multiple buffer rings which is what we need to create this effect. Let's see how this works.



CRATER LAKE

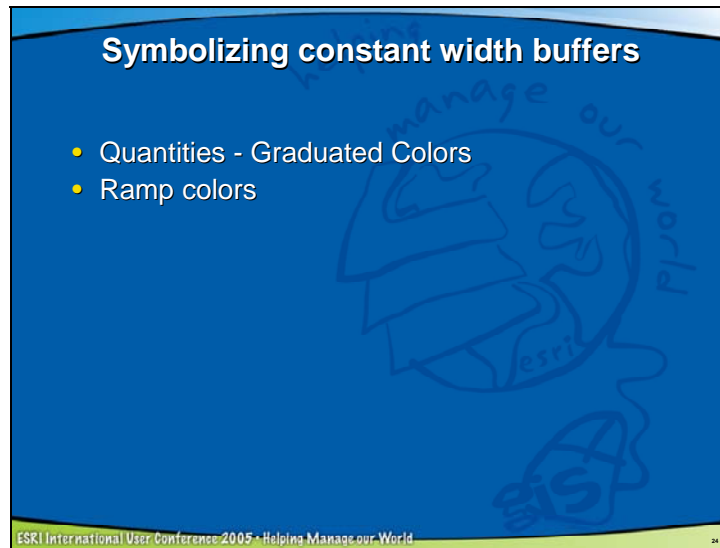
DEMO: In ArcToolbox under Analysis Tools there is a Proximity toolset with a Multiple Ring Buffer tool. Double click the tool and we'll take a look at the parameters. Here you set the distance for each of the buffer rings. To achieve a smooth gradient, it is best to use at least 12 buffers. Notice in our screenshot that we wanted to create buffers of constant width. Also notice that we used negative values...



CRATER LAKE

...this is because of the geometry of the lake polygon we buffered. If we had used positive values, we would have created buffers outside the lake (and inside the island). Whether you use positive or negative values, be sure to input them in increasing order.

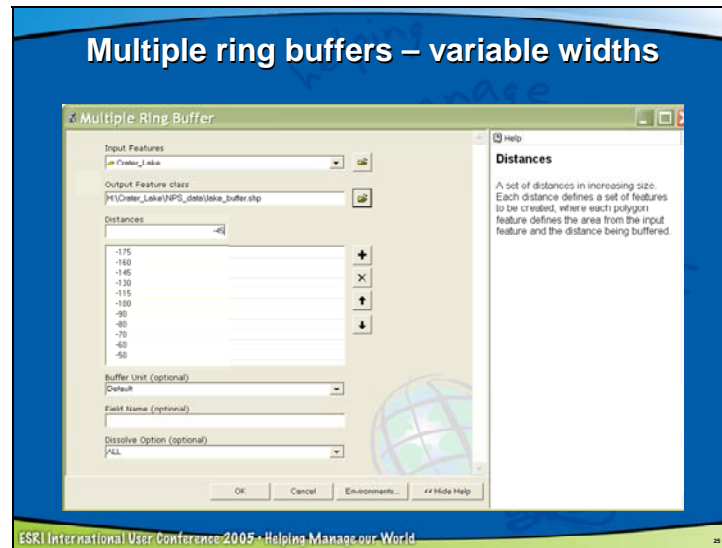
DEMO: Let's cancel the Multiple Ring Buffer tool now. We'll use the bookmark called Zoom to Buffers to take a closer look at the results. When we turn on the lake_buffers_constant layer what you see on the screen is 17 equal width buffers. Let's see how they are symbolized.



CRATER LAKE

DEMO: Right click the lake_buffers_constant layer. In the Layer Properties dialog under the Symbology tab select Quantities and then Graduated colors. Set the Value field to Distance and set the number of classes to 17, then check “Show Class Ranges Using Feature Value”. Then click on the symbol header and select Properties for All Symbols... Change the Outline Color to No Color. Then set the color for the first class to blue and last class to white. Select the first and last classes together using the Control key, then right-click on the color and choose Ramp Colors. This applies a blue to white color ramp to the multiple vector buffers.

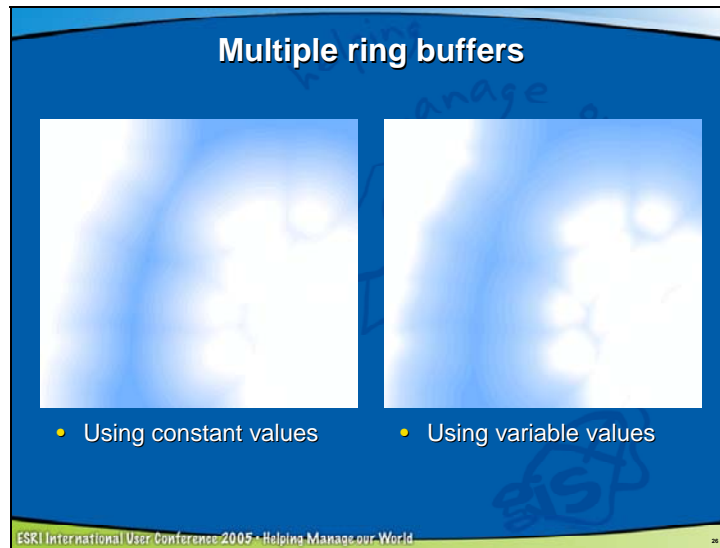
Now let's take a look at our results.



CRATER LAKE

One other variation we could have made is to use variable width buffers instead of buffers of constant width. This is sometimes a nice modification to make to produce smaller gradient steps nearer the shoreline.

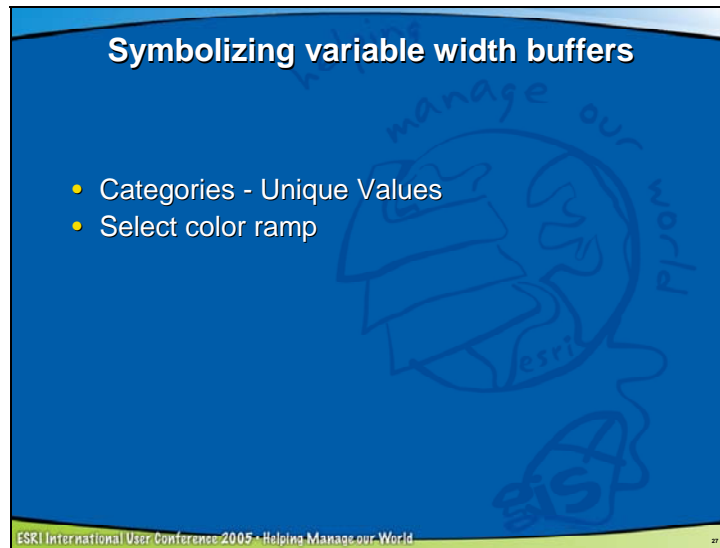
The only change you would have to make in the Multiple Ring Buffer tool would be to vary the sizes of your rings. Notice in our screenshot that we started out with rings that were 15 meters apart farther out in the lake and decreased in width to 10 meters closer to shore. What you can't see in the window is that we also added some rings that were only 5 meters apart right near the shoreline.



CRATER LAKE

DEMO: Notice when we turn the variable width buffer layer on, it looks very similar to the constant width buffers. We'll toggle that layer on and off a couple of times so you can see the differences.

There is a slight variation in the way the multiple ring buffers are symbolized – let's see how that is done.



CRATER LAKE

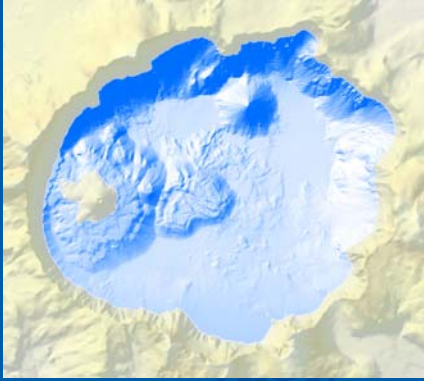
DEMO: Right click on the lake_buffers_variable and open its Layer Properties dialog box. Under the Symbology tab we'll select Categories and then Unique Values. Set the variable to distance then Add All Values. In the Color Scheme drop down, select an appropriate Color Ramp. We created one earlier especially for this layer.

Incidentally, if you have ever noticed that different color ramps are displayed in the symbol selector, that's because for the Color Schemes used in symbolizing categories, the ramps that are displayed are those in your Default Ramps and Dichromatic Ramps categories. The Color Ramps used in symbolizing Quantities with Graduated Colors, as we showed you for the Constant Width Buffers, are those ramps in the two categories: Default Schemes and Spatial Ramps. You manage the category settings in Style Manager.

DEMO: Let's click OK to see how the variable width buffers are now symbolized on our map.

Bathymetry

- Water depth
- Hillshading and elevation tinting techniques

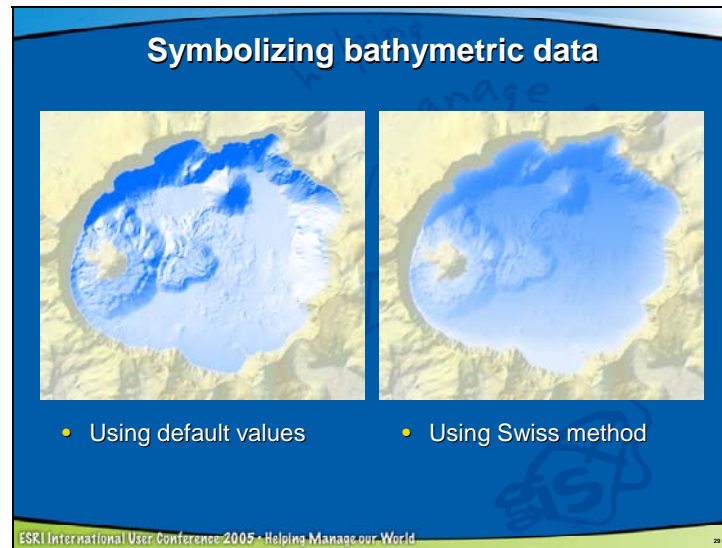


The image shows a bathymetric map of Crater Lake. The water body is represented by a gradient of blue colors, with darker blues indicating deeper areas and lighter blues indicating shallower areas. The surrounding land is shown in yellow and green, with hillshading and elevation tinting techniques used to represent the terrain. The map is set against a dark blue background.

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CRATER LAKE MAP

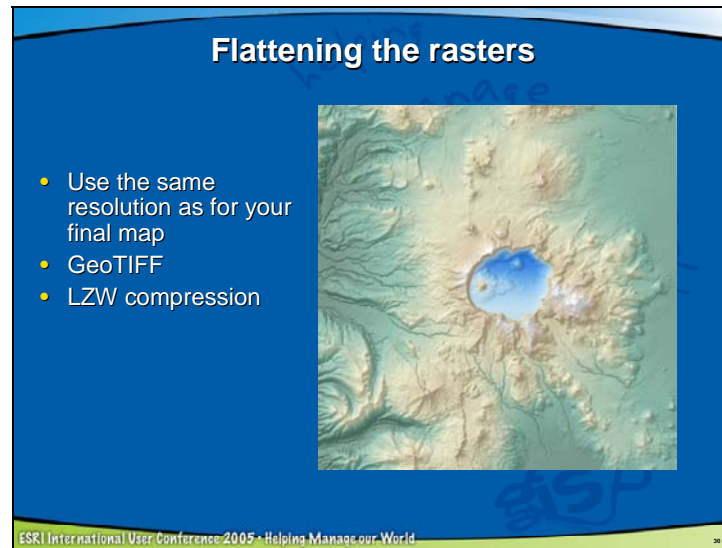
The next method we want to show you for symbolizing water features requires that you have bathymetric data or data like a DEM that shows the water depth relative to sea level instead of elevation of the land surface above sea level.



CRATER LAKE

If you have this kind of data, you can simply use the same hillshading and elevation tinting techniques we showed you earlier to symbolize the land surface. Of course, you will want to use some gradation of blues for your bathymetric elevation tint. And you will most likely want to make sure to use the same technique for hillshading both your land and your water areas.

DEMO: To see the differences, let's use our Bookmarks for Crater Lake and turn on the bathymetry layer. We'll turn on the "Default Bathy Hillshade" layer – this is the layer that was created using the default hillshade values. The results are sharper and contrast with our nicely smoothed and enhanced Swiss hillshade for the land. Now we'll turn off the default hillshade layer and turn on our alternative – the 3 bathymetry layers we symbolized using the same Swiss method we used for the land surface. This looks more consistent for our map. Note – we did make one change in the symbology – we set the transparency for the bottom bathymetry layer to zero to block the other rasters from showing beneath it.



CRATER LAKE

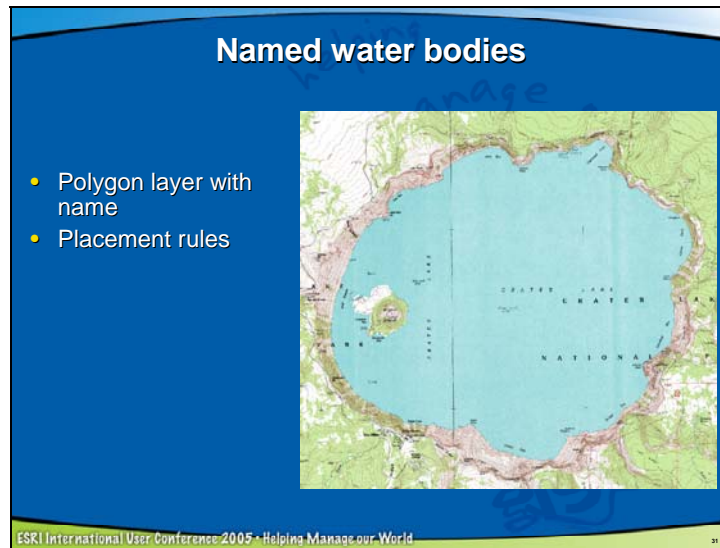
One thing you might want to do at this point is to “flatten the images” so that instead of displaying 6 rasters at once – three for the land and three for the water – you only have to display one. That speeds up the drawing time quite a bit.

DEMO: To do this, make sure that only those rasters you want to flatten are turned on in the Table of Contents. For us, that’s the three bathymetry layers and the three layers for our Swiss Hillshade method for the land. In Data View set the size/shape of the window and the data zoom so it shows the data you want to make into a flattened image. We’ll do that by zooming to the extent of our DEM layer. Then click on File, then Export Map. Type in an output file – we’ll call ours “flat_images”. Then select .TIFF (.tif) from the Save as Type dropdown list. Set the resolution to whatever you want for your final print output – we’ll set it to 300 dpi. Then check the box for “Write World File”. Click on the Format tab and set the Color Mode to 24-bit color and the Compression to LZW. Click the Write to GeoTIFF box and then click OK.

While that is processing, let me tell you a couple of things about flattening images... You can also add into the flattened image any vector layers with transparency that you might want to use as well – if you have text or line work on them, you may not want to include them as that will get

rasterized as well. Also, you can make one additional conversion to try and optimize the layer for display – you would convert the GeoTIFF to an ERDAS .img file format. We'll stop with the GeoTIFF and now we can take a look at the results.

DEMO: Let's turn off all the layers and then click the Add Data button to add the GeoTIFF – notice the error message – this is a good reminder that you will still need to define the projection at some point. You can do this easily by importing the projection information from an existing layer – for example, any of the rasters that went into the flattened image. Other than that, our new layer is ready to go!



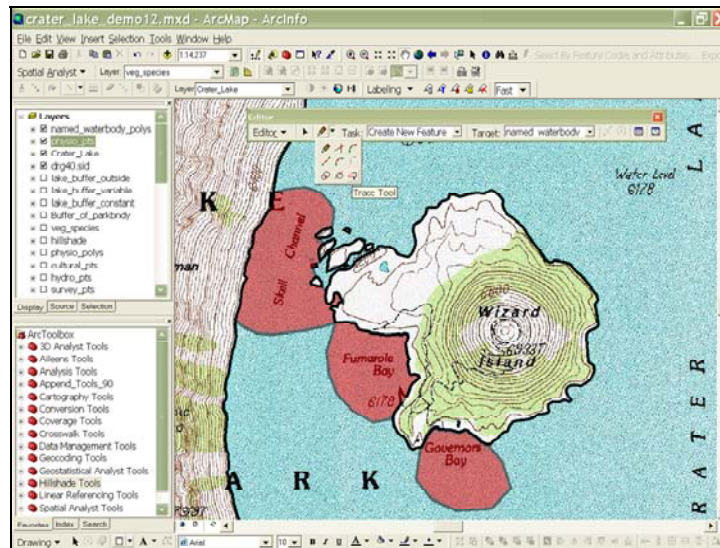
CRATER LAKE MAP

The next thing we want to show you is how to label named water bodies.

DEMO: To show you what we are talking about, let's turn off all the layers in our map and then turn on the digital raster graphic or DRG of the USGS topographic map for Crater Lake. Then let's zoom in using a bookmark we have called Named Water Bodies.

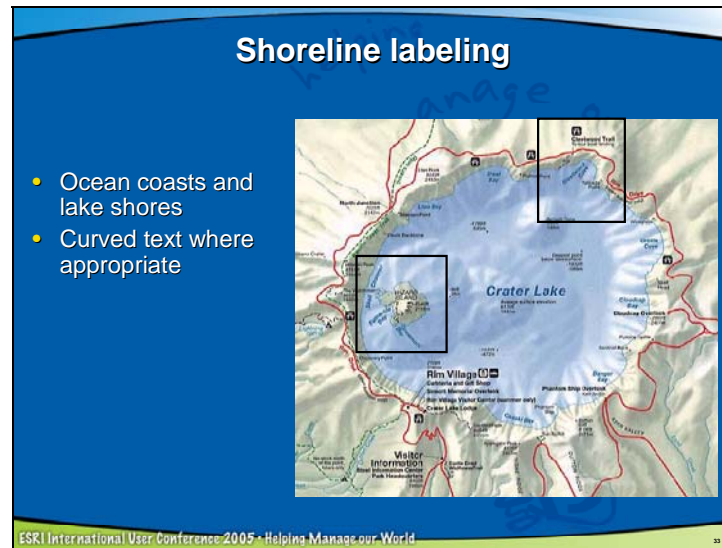
Notice on the USGS map that some of the areas within Crater Lake are labeled. Maps often look incomplete until features such as these are labeled. We were able to label these using a new polygon layer we created called "Named Water Bodies" – let's turn it on to see what it looks like and then let's zoom using a Bookmark into Wizard Island to see how the polygons were constructed.

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CRATER LAKE MAP

Notice that the polys run along the coast and then cut arbitrarily through the water. How did we digitize these? The Shoreline was easy, if you have the lake boundary selected, you can use the Trace Tool in the Editor to follow the shoreline, then you can digitize the lines through the water freehand. How do you know where to draw them? The guideline is simply to be sure to enclose the area in which you want to draw the label. The polygon features are likely to never actually be drawn on a map; instead they are the basis for creating text or annotation for the features. Once you have these features, you are ready to label them.



CRATER LAKE MAP

To show you what we want to do, let's look at one other example – the label placement for these water features on the National Park Service map. If we take a closer look at Wizard Island, we can see how the channel and bays are named. In the northeast part of the lake, the Cleetwood Cove label is also curved to better fit within the space available. This curved text placement is common especially along horizontal ocean coasts and lake shores where normal placement of text would result in text overlapping. Now let's zoom to our Named Water Bodies bookmark again and we'll show you how this effect is achieved.

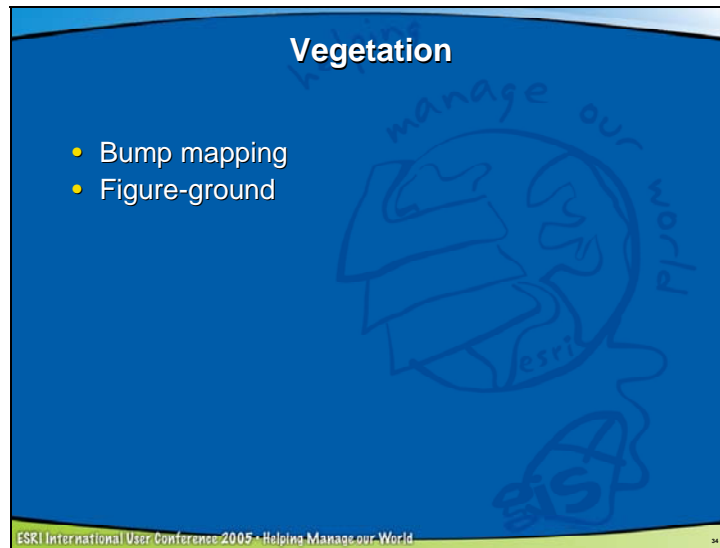
DEMO: To see how the labels were created, we'll use the Label Manager. And because we're using some advanced labeling options, we'll click the Labeling dropdown arrow to turn on the option to Use the Maplex Label Engine. If you want to use the techniques we show you in this part of the demo, you'll need to have Maplex installed.

Now click the first icon on the Labeling toolbar – this opens Label Manager. Note that we have two additional label classes in our "Named Water Bodies" layer. One is for channels and one is for Bays & Coves. Let's take a look at the Channels label class first. If we click the Expression button we can see that an Advanced expression is being used – this expression makes sure that

the properties for this label class are used to only label features that are Channels. Click Cancel to get back to the label properties. Note that we have blue Ariel 12 pt. Italic font. Click on Position and you can see that we want the label to curve along the long axis of the features. Now click Properties and click on the Label Fitting Property tab. Here you can see that we have unchecked the Stack Labels option.

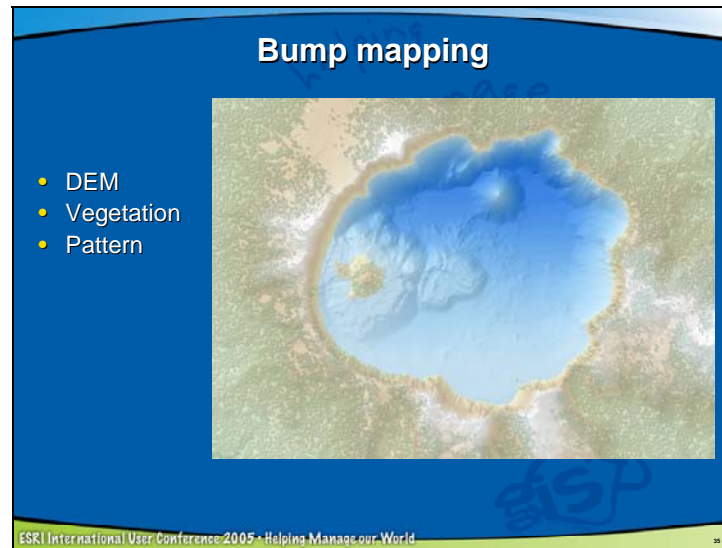
Let's take a look at the next label class for Bays & Coves. Click on Expression – the VB script here selects only those features that are either Bays or Coves. Click cancel and here you can see that we have the same font as for channels. Click Properties, and under the Label Fitting Strategy tab you can see that we want stacked text. Click the Stacked Text options and you can also see that Label Justification is set to Constrain to Center – so the label is center justified. The stacked characters have a forced split at the space – this is done by setting the stacking character to a space and checking the Forced Split option. Under Limits, we set the maximum number of lines to 2. The rest of the options are still set to the defaults.

If we cancel and close all these windows we can see the resulting text on our map.



CRATER LAKE MAP

Now let's talk a bit about symbolizing vegetation features. We'll focus on two things – a technique called bump mapping and how that can further be used to help enhance figure-ground.



CRATER LAKE MAP

As with sun glints, if you want to add realism to your map, try to find ways to modulate the tones of your features. For vegetation, one way to do this is using a technique called bump mapping, which produces an effect that looks like tree tops in vegetated areas.

DEMO: We'll zoom into our Bookmark called "Bump map" so you can see what this looks like.

You can modify the method you use to make the tree tops look more deciduous, more coniferous or even like shrub or grassland. This is essentially done in four steps: 1) create the random pattern for the density of the trees or other vegetation, 2) modify it to look like coniferous, deciduous or other land cover, 3) apply it to the appropriate land cover areas, and 4) symbolize it.

The two layers you need for input are your digital elevation model and a raster of the vegetation. You will also create a layer for the random pattern for the vegetation.

We'll show you how this can be done using a methodology that Jeff Nighbert of the Oregon BLM developed for ArcGIS.

Bump mapping

- `(eucdistance(con(($rowmap mod int(normal() * 5 + 10) eq 0) and ($colmap mod int(normal() * 5 + 10) eq 0),255),##,60,##) * (-20 / 10) + 120`
- `hillshade(con(isnull([park trees]),[bathy_dem_ft],[bathy_dem_ft] + [pattern]),315,45)`
- <http://qis.esri.com/library/userconf/proc03/p0137.pdf>

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CRATER LAKE MAP

DEMO: In Spatial Analyst, you would use the Raster Calculator. You want to enter the first formula on the screen here:

```
(eucdistance(con( ($rowmap mod int(normal() * 5 + 10) eq 0) and ($colmap mod int(normal() * 5 + 10) eq 0),255),##,60,##) * (-20 / 10) + 120.
```

Because it's pretty complex, we saved it in a Notepad file so we can just copy and paste it into the Raster Calculator window. Let's open Notepad so we can use that file. We'll copy the formula into Raster Calculator and compute the new raster. This is now creating our random tree pattern.

What this does is to create a random pattern that is spaced about 20 cells by 20 cells and it also creates coned shaped features around the randomly located points. The expression also sets the height of the cones to 120 feet.

DEMO: Let's turn on the Pattern layer so we can see the results. If we zoom in to our Pattern bookmark, we can see that the cells look like randomly placed trees with tops that are a bit cone-like.

Note the values in the Table of Contents. The top of each tree is 120 ft high and the bottom is 0. 120 is a pretty normal height for coniferous trees in the Pacific Northwest. You should modify the values to be similar to the types of vegetation in your mapped area. Now we want to add these values to our DEM. To do this, we also need a raster layer of tree cover within the park boundary where trees = 1 and no trees = null. We'll turn on our park_trees layer so you can see the layer we created with these values.

Bump mapping

- $(\text{eucdistance}(\text{con}(\text{\$rowmap mod int(normal() * 5 + 10) eq 0}$ and $(\text{\$colmap mod int(normal() * 5 + 10) eq 0}$),255),#,#,60,#)) * $(-20 / 10) + 120$
- $\text{hillshade}(\text{con}(\text{isnull}([\text{park trees}]$), $[\text{bathy_dem_ft}]$), $[\text{bathy_dem_ft}] + [\text{pattern}]$),315,45)
- <http://qis.esri.com/library/userconf/proc03/p0137.pdf>

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CRATER LAKE MAP

DEMO: Then we need to go back into the Spatial Analyst Raster Calculator so we can enter the next formula we need:

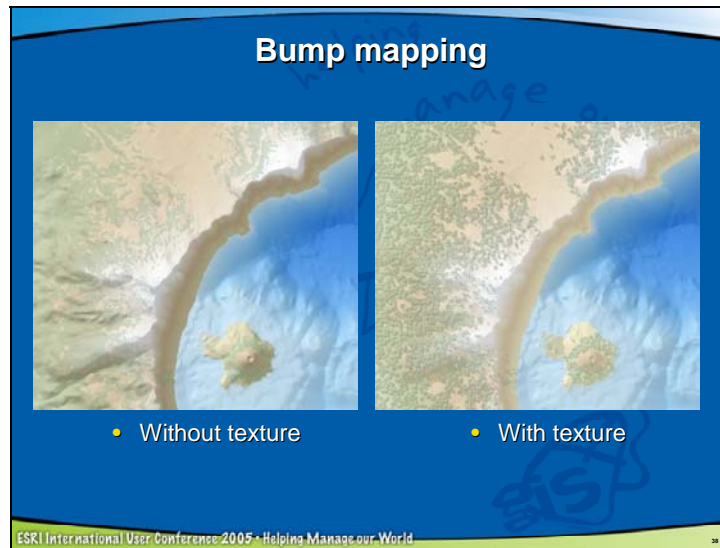
$\text{hillshade}(\text{con}(\text{isnull}([\text{park trees}]$), $[\text{bathy_dem_ft}]$), $[\text{bathy_dem_ft}] + [\text{pattern}]$),315,45)

Again we can copy and paste this formula using Notepad. We'll copy the formula in and click OK to start the calculation.

What this does is to modify the DEM by adding the new higher values for the trees to the original DEM values, and that is then hillshaded. All of this is done with this one calculation.

DEMO: The result is a "bump map" which we can show you when we turn off the Pattern layer and turn on our Bump Map layer.

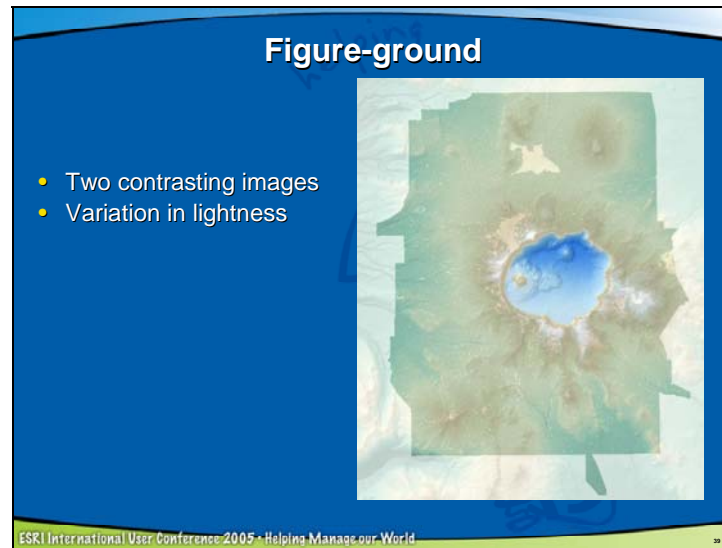
More information on this technique, including how to modify the pattern so it looks more like deciduous trees or more like rocks can be found in Jeff's article at the URL at the bottom of the PowerPoint slide. The bump map formulas are also in Jeff's article.



CRATER LAKE MAP

Now you are ready to symbolize!

DEMO: Start with the vegetation layer to color just the areas with trees. Our vegetation layer is called Park Trees which we will now turn on. Let's right click it to take look at the Properties. On the Symbology tab, set the color to green to show trees, then on the Display tab set the transparency to 80%. Click OK to all of these, then let's turn on our other flattened raster layer to show how the trees look on top of the land surface that we symbolized earlier.



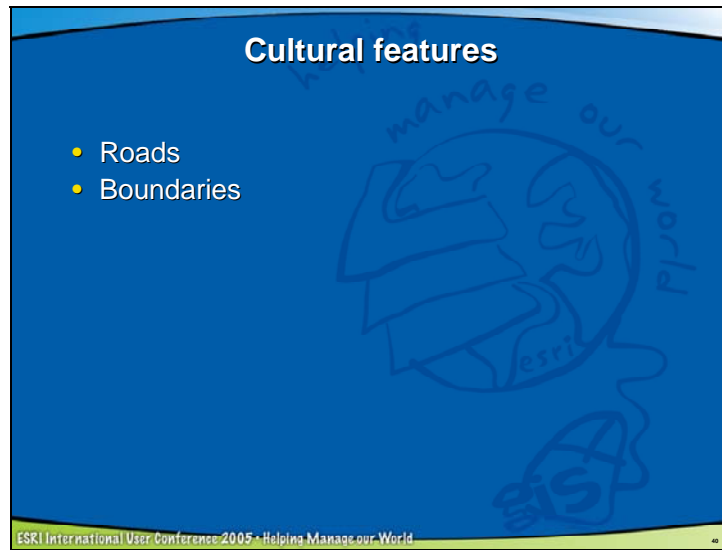
CRATER LAKE MAP

We made one additional modification to our map to enhance what cartographers call the figure-ground relationship. This essentially organizes the display into two contrasting images: the figure, on which your eye settles, and the amorphous background around it. Cartographers have figured out many ways to enhance this effect – the one we want to show you here mimics the work of Tom Patterson, a cartographer for the National Park Service, but it is modified to be used in ArcGIS. The technique requires one additional layer that contains a polygon to show the area outside the park boundary. We created one for this purpose called “Notpark”.

DEMO: Let’s turn on the Notpark layer, zoom to its extent and then right click on it to take a look at its Properties. Under the Symbology tab, set the Symbol color to White, then under the Display tab, set the transparency to 50% and click OK to accept these settings.

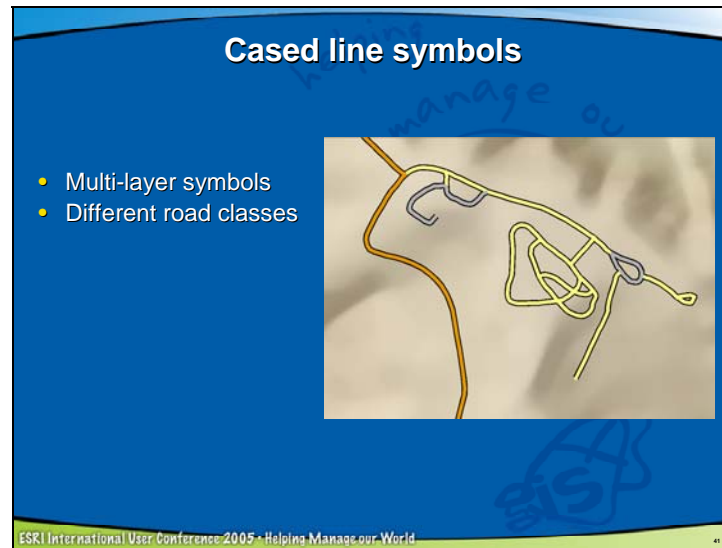
The result is to subdue the colors outside the park without modifying the symbology within the park. Now your eye should be drawn toward the area of interest – in this case, Crater Lake National Park.

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CRATER LAKE MAP

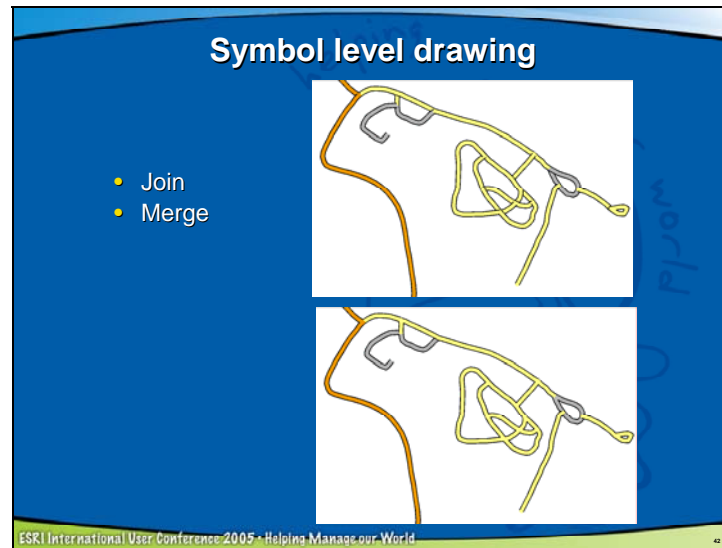
We'll finish up with two additional mapping methods – these are for cultural features including roads and boundaries. We'll start with roads.



CRATER LAKE MAP

DEMO: Let's turn off all layers except the Roads layer. Then let's zoom in using our Roads with Casings bookmark. Notice how our roads look – this symbology can be improved using what is called Symbol Level Drawing. We'll right click the Roads layer to see its Symbol Properties. Double click on the Secondary highway symbol and the click on Properties to see how it is defined. In the Preview window, we'll zoom the Preview to 400%, then we'll click on the bottom layer of the symbol – this is a 1.7 pt black line. Click on the top layer and you can see that it is a 1.1 pt orange line. The bottom layer is slightly larger than the top layer so the black shows up along both edges of the orange – this is what is called a cased symbol and it's a common symbol type for roads. We'll cancel to get back to the Symbology window. Let's move the dialog box to the bottom left part of the screen so we can see the changes we apply. Here we'll click on the Advanced button at the right under the symbols and we'll click on Symbol Levels. In the Symbol Levels window, check the box to "Draw this layer using the symbol levels specified below".

Symbol level drawing gives you control over the drawing order of feature symbology. With symbol level drawing, you can set three different drawing parameters – how to join features with the same symbol, how to merge features with different symbols and how to order the symbols or parts of the symbols. Now let's use Symbol Level Drawing to blend the symbology of the road symbols in our map.

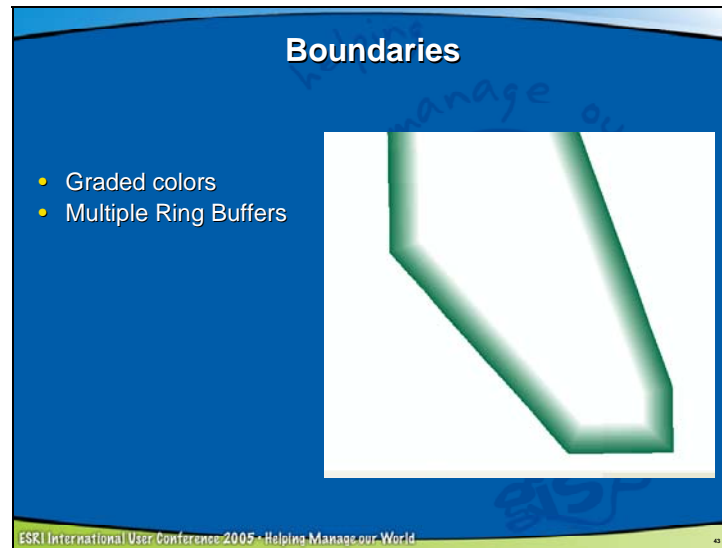


CRATER LAKE MAP

DEMO: First, we want to achieve a blending effect for all features drawn with the SAME symbol. This is done with Join. Let's turn on Join for the Improved, Paved road types, then click OK then Apply. Notice how the roads in the center are joined now. We want this effect for all roads, so in Symbol Level Drawing let's click join for the other 2 road types as well.

The next thing we want to do is to achieve a blending effect for features drawn with DIFFERENT symbols – for this we'll use Merge. The important thing to remember about Merge is that when you check the Merge box next to a symbol it is blended with the symbol directly ABOVE it in the symbol list. Since we want to merge Improved, Paved Roads into the Secondary Highways we need to move the Secondary Highways above the Improved, Paved Roads. Turn on Join for Secondary Highways and click Merge for Secondary Highways and Improved, Paved Roads. When we click OK and Apply, we can see these symbols are now merged.

The last thing we need to do is change the drawing order of the features. Let's move the Parking roads types above the Improved, Paved Roads so parking areas become more evident on our map. Then click OK and OK to see our final road symbology.

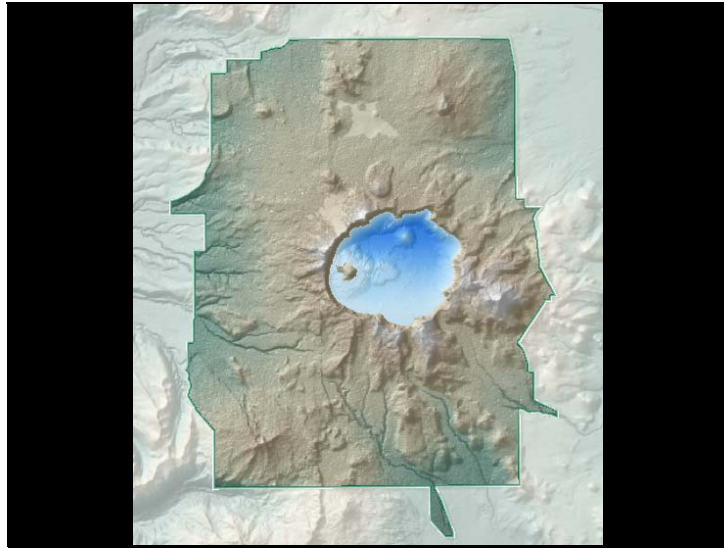


CRATER LAKE MAP

The last thing we'll show you is how to create a graded color boundary. This is a nice effect for boundaries that you want to appear to blend into the map. For our map, we want the outside of the Park boundary to be distinct and the inside of the boundary to blend into the background. If you had to symbolize a more indeterminate boundary, you could make further modifications so both sides blended and the line would look like it was indistinct.

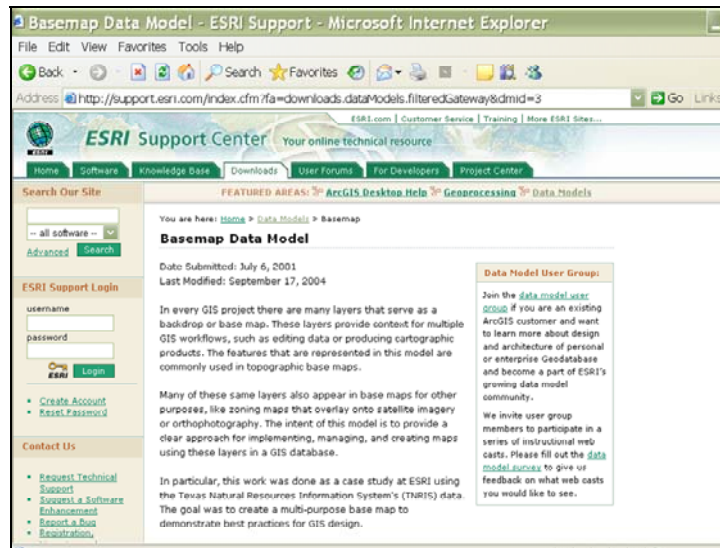
DEMO: Let's zoom to our Park Boundary bookmark which was created using the 20 Multiple Ring Buffers of Constant Width that we showed you earlier. Let's see how we can symbolize these better. Double click the Park Boundary Buffers layer and make sure you are symbolizing the layer with Quantities that are Graduated Colors. Change the number of classes to 20 and right click on any symbol example and select Properties for All Symbols... and set the Outline Color to No Color. Click on the first symbol and change it to white, then click on the last symbol and pick a nice dark blue-green. Then use the Control Key to select both the last and the first colors and right click to Ramp the Colors. Click OK and OK to see the final effect. Then let's zoom back to the extent of the Park Boundary layer to see the final boundary.

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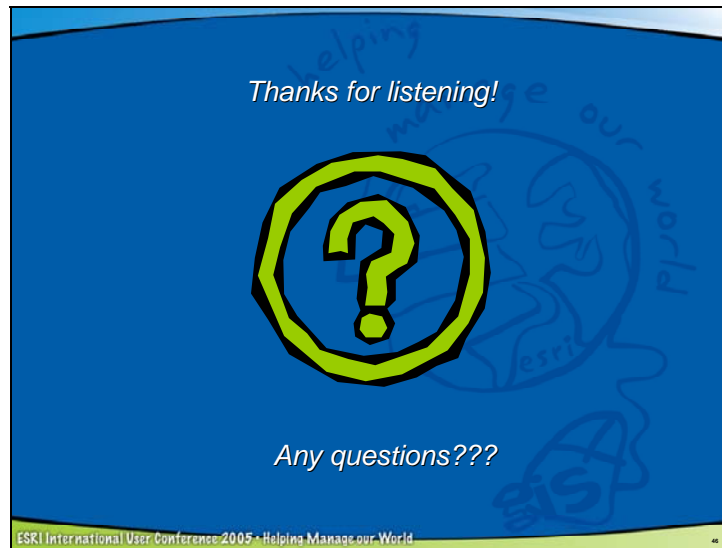
Let's let David open up his SW Oregon map with the sun glints one more time. And while he is doing that I have a screen shot of the Crater Lake map here. These two maps illustrate the advanced cartographic effects we talked about in this presentation. This brings us to the end of our talk, but before we go...

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... we want to remind you about the Base Map Data Model Web Page – we hope you will visit it to collect some of the info we showed you here!

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Hopefully, you will have learned some new tricks to help you create better looking maps more efficiently. If you have any questions about anything we talked about here, we'll be happy to answer them.

And before you go, please take a minute to complete a survey form – we do use them to plan next year's sessions to better fit your needs.

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... we want to remind you about the Base Map Data Model Web Page – we hope you will visit it to collect some of the info we showed you here!