



Exercise 1

Introduction to Spatial Analyst



Objectives

The goal for this exercise is to create a map for the Crooked Creek Subwatershed that illustrates the distribution/dominance of coniferous (evergreen) and deciduous (broadleaf) vegetation.

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Part 1: Activate the Spatial Analyst extension and toolbar

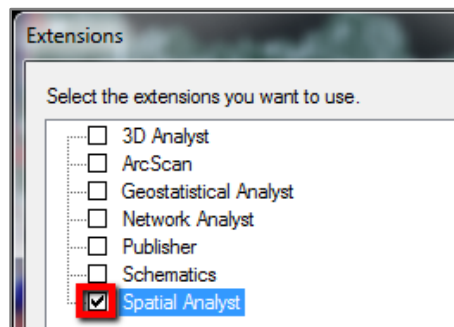
Spatial Analyst is a tool designed to work with the cell-based structure of raster datasets. The advantage of using a cell-based structure over other GIS structures such as vector datasets is that raster data can represent a continuous surface (e.g., elevation). In addition, raster data uses a uniform storage structure regardless of whether the dataset depicts points, lines, or polygons. This uniformity becomes important when you want to work with and/or analyze multiple data types in the same environment.

A. Start ArcMap and open the Spatial Analyst Map Document.

1. Start **ArcMap**.
2. In the ArcMap Getting Started dialog, click **Browse for More**, then browse to the ...**Data** directory.
3. Highlight the **Spatial_Analyst.mxd**, right-click and select **Open**.

B. Activate the Spatial Analyst extension.

1. From the ArcMap's Main Menu, select **Customize**, choose **Extensions**.
2. Enable the checkbox adjacent to **Spatial Analyst**.



3. **Close** the Extensions window.
 - i. You can access Spatial Analyst's functionality in one of two ways: Through the Spatial Analyst tools in ArcToolbox or through the Spatial Analyst toolbar.

C. Activate the Spatial Analyst toolbar.

1. From the *ArcMap's Main Menu*, select **Customize | Extensions | Toolbars**.
 - i. From the list, highlight **Spatial Analyst**. The toolbar appears.



2. Dock/undock the toolbar as needed.

An important part of geospatial/raster analysis is understanding the datasets you intend to use for your analysis. The raster datasets in the ArcMap project are derived from Landsat imagery, and provided to us from the Interagency Vegetation Mapping Project (IVMP). Landsat is a U.S. satellite used to acquire remotely sensed images of the Earth's surface and surrounding coastal regions. The IVMP provides remotely-sensed maps of vegetation and canopy cover for the entire range of the Northern Spotted Owl habitat.

As you might guess, the Conifer layer represents the distribution (% crown cover) of coniferous trees. The QMD layer represents tree size class (in inches) for both deciduous and coniferous vegetation. QMD = Quadratic Mean Diameter – is a formula used to calculate the tree size class (in inches) based on tree diameter at breast height (DBH).

D. Examine the QMD dataset.

1. Turn on only the **QMD** and **Crooked Creek** group layers.
2. Zoom to the full extent of the map. (Notice the spatial extent of the imagery extends beyond the subwatershed (outlined in blue).)
3. In the TOC, expand the contents of the **QMD** layer. Nearly all the cells in the QMD layer are symbolized by a shade of green. Darker shades represent larger tree size classes. Further down you'll find classes representing land use. Why did ArcGIS use these color schemes?

The IVMP raster datasets are associated with Colormap tables allowing ArcMap to automatically symbolize the unique values stored with the data.

ArcMap renders raster data in five ways...

Unique Values – different colors are assigned to each unique value

Classified (single band) – different colors are assigned to classified categories of values

Stretched (single band) – a range of continuous colors are assigned to a range of values

RGB Composite and Stretched (multiband) - draws a three-band composite representing continuous values

Colormap – a special type of Unique Value renderer associated to a Colormap table (*.clr), providing a consistent color scheme across different GIS platforms.

QUESTION - What do the blue cells represent? _____

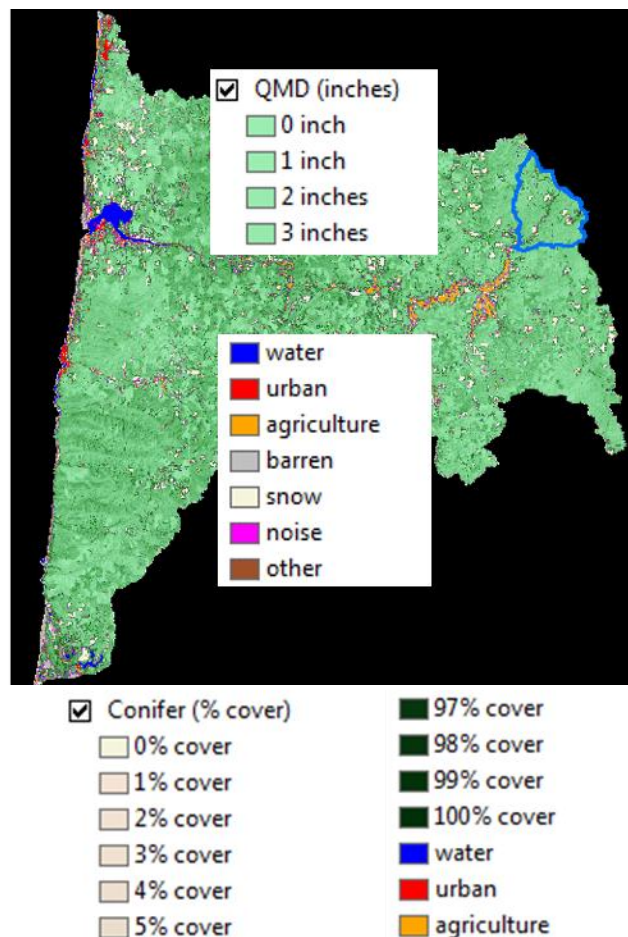
QUESTION - What do the black cells represent? _____

ANSWER: Blue = water. The black cells represent NO DATA (null value) cells may be colored black or not colored at all. Cells with NO DATA either have no information or insufficient information about the imaged area. NO DATA values are also applied to cells outside the “masked” area.

4. Collapse the contents of the QMD layer.

E. Examine the Conifer layer.

1. *Turn on* and move the **Conifer** layer to display above the QMD layer (if needed).
2. *Expand* the contents of the **Conifer** layer.



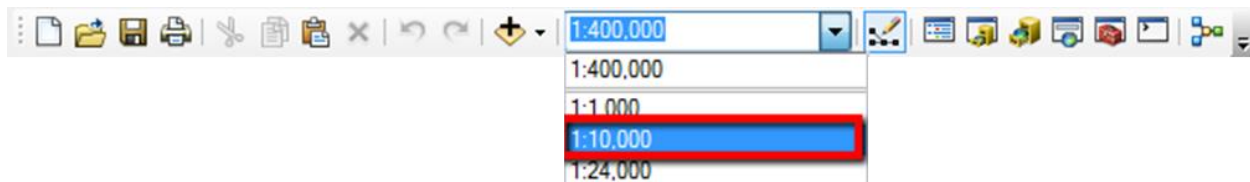
3. Similar to the QMD layer, the Conifer layer contains cells symbolized by shades ranging from light pink to dark green. Darker shades representing higher percentages of crown cover.
4. *Collapse* the contents of the **Conifer** layer.

Part 2: Examine the Properties of a Raster Dataset

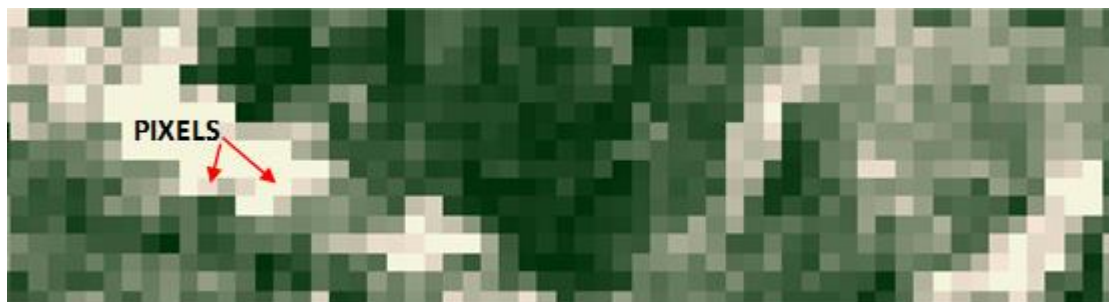
Now that you can visualize the percentage of coniferous coverage, it's time to look in more detail at the properties of the dataset. For example, as we interpret the Landsat Images, how much surface detail can be distinguished in each cell?

A. Reduce the data frame's scale to examine the raster's cells.

1. From ArcMap's *Standard toolbar*, update the scale to **1:10,000**.



The individual picture elements (or pixels) are the cells that make up the layer. Each pixel contains a value that represents a value (percentage of crown cover in the Conifer layer or the diameter of trees in the QMD layer).

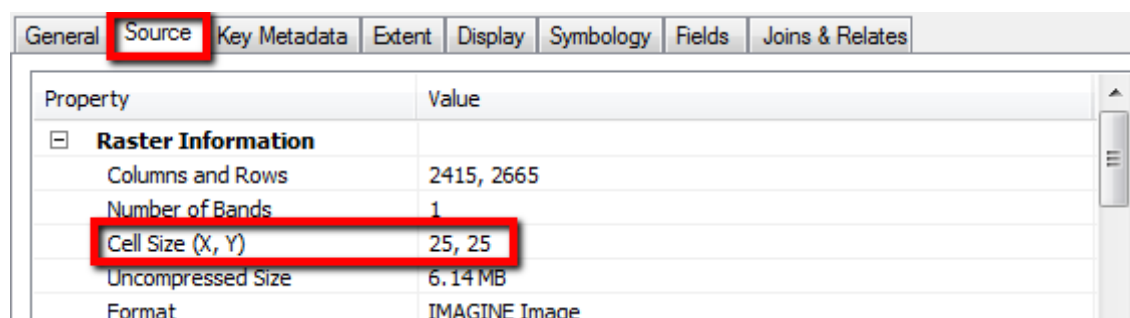


B. Determine the resolution of a raster.

Observe the *Properties* of the **QMD** raster layer.

1. Open the **QMD** layer properties. (Right click on the layer in the TOC| select **Properties**.)
2. Activate the **Source** tab.

QUESTION - What are the X, Y cell sizes? _____ , _____



Because the cells in the raster dataset are square, the X and Y cell sizes are the same. Unfortunately, the units used for the cell size are not reported, but they will match the map units provided by the layer's spatial reference.

What are the dataset's Linear Units? _____

Hint: Expand or scroll to Spatial Reference.

<input type="checkbox"/> Spatial Reference	NAD_1927_UTM_Zone_10N
Linear Unit	Meter (1.000000)
Angular Unit	Degree (0.0174532925199433)
False_Easting	500000
False_Northing	0

Based on the cell size and linear units, both the Conifer and QMD layers have a cell resolution of 25 meters. Resolution determines the size of the smallest feature that is represented by the raster. So, you won't be able to see individual trees, but will be able to resolve stands of trees that cover at least 625 square meters (25 m x 25 m), or ~0.15 acres.

3. What is the *status* of the layer? **Permanent** or **Temporary**?

i. Hint: See Raster Information.

A Permanent status indicates the layer is saved to the hard drive.

4. Is the dataset **single band** or **multiband**? _____ (see Raster Information)

A single band tells us that the satellite's camera imaged the area in a single spectral band. In general, derived products such as the Conifer and QMD layers tend to be single band datasets. A multiband layer indicates the area was imaged in different spectral bands (blue, green, red, infrared). ArcMap can combine up to three bands.

5. What is the value for **Source Type**? _____ (See Data Source)

Although valid arguments can be made that the percentage of coniferous coverage is continuous data, ArcMap has interpreted the collected data as being discrete. You will find most raster datasets can be interpreted as having both discrete and continuous data.

6. Are the cell values **whole numbers** or **decimal**? _____ (See raster Info / pixel type.)

<input type="checkbox"/> Raster Information	
Columns and Rows	2415, 2665
Number of Bands	1
Cell Size (X, Y)	25, 25
Uncompressed Size	6.14 MB
Format	IMAGINE Image
Source Type	Thematic
Pixel Type	unsigned integer
Pixel Depth	8 Bit

The term "unsigned integer" indicates the cell values have no signage (+ or -) attached to the whole numbers. It is assumed all values are positive. For raster datasets containing negative integers, the data type is set to "signed integer." An example of the layer with signed integer values would be a temperature layer.

7. Activate the **Fields** tab.

8. How many attribute fields does the Conifer layer have? _____

General	Source	Key Metadata	Extent	Display	Symbology	Fields	Joins & Relates
Primary display field: Value							
Name	Type	Length	Precision	Scale			
Value	Long	9	9	0			
Count	Double	19	0	0			
Class_name	String	32	0	0			
Red	Double	19	0	0			
Green	Double	19	0	0			
Blue	Double	19	0	0			
Opacity	Double	19	0	0			

Only raster datasets with an Integer data type can display an attribute table (often referred to as a Value Attribute Table or VAT). The table will always have a Value field and a Count field. The Value field contains the numeric value stored in each cell. The Count field represents the number of cells for each unique value.

C. Update the visible extent of the Conifer and QMD layers to match the extent of Crooked Creek Subwatershed.

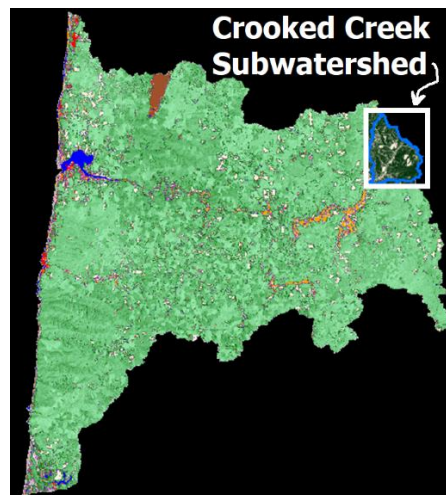
1. From Conifer's layer's properties, select the **Extent** tab.

Because our deciduous/conifer map is for the Crooked Creek subwatershed, we can limit the extent of the imagery to just the area surrounding the subwatershed. Limiting a layer's spatial extent has the advantage of faster refresh times, and it focuses the user's attention on the area of interest.

1. Set the extent to: **the rectangular extent of Crooked Creek subwatershed** using the dropdown. Click **OK**.

General	Source	Key Metadata	Extent	Display	Symbology	Fields	Joins & Relates
You can specify the geographic extent of this layer's data source that will be represented by this layer							
Set the extent to:				the rectangular extent of Crooked Creek subwatershed			

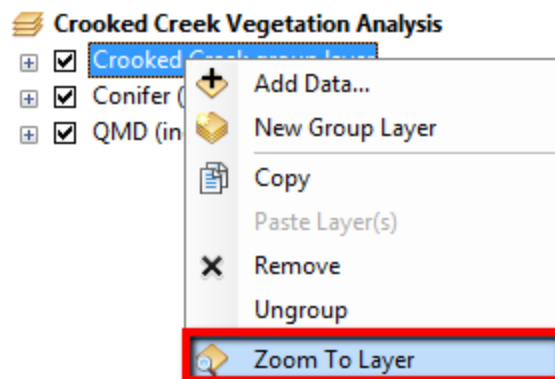
2. Zoom to the **full extent** of the map. The Conifer layer is still displaying, but only the extent of the subwatershed.



2. On your own, set the extent of the QMD layer to match the rectangular extent of the Crooked Creek subwatershed.

FYI: Setting the extent of a dataset does not clip the actual image stored on the hard drive.

3. Zoom to the extent of the **Crooked Creek group layer**. (Hint: right click the Crooked Creek Group layer | Zoom to Layer).

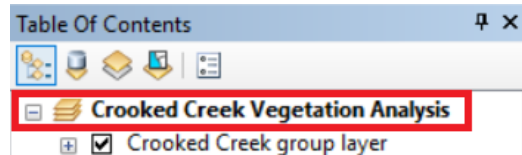


Are the Conifer and QMD layers reduced to the boundaries of the Crooked Creek subwatershed?

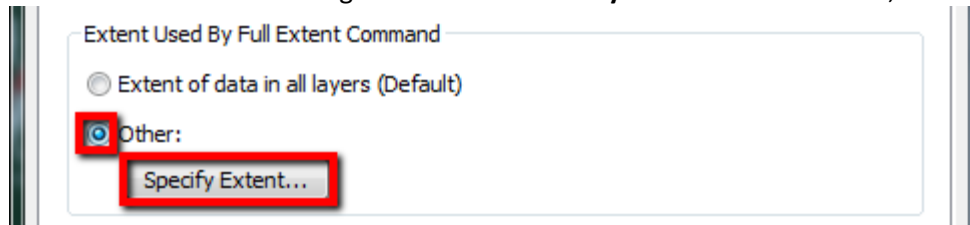
You might be inclined to say "no" to that question. There are obviously cells that extend beyond the subwatershed. Remember a raster dataset is always stored as a rectangle. Even if you clipped the raster dataset to the subwatershed boundary, cells of "NO DATA" are still used to complete the dataset's rectangular appearance.

D. Change the extent used by the Full Extent Command.

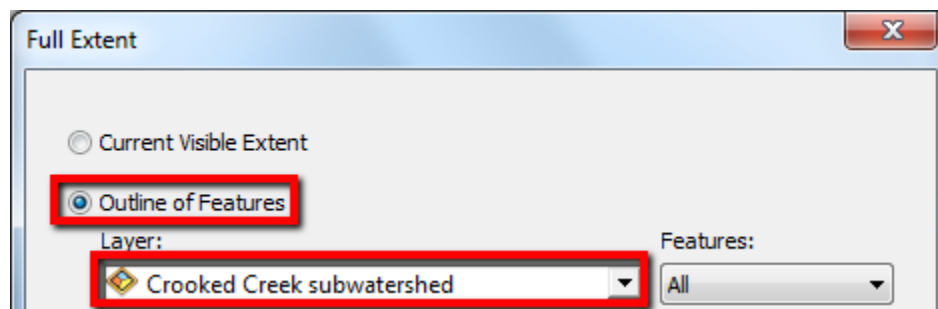
1. Open the **Data Frame Properties**. (Right click on the data frame **Crooked Creek Vegetation Analysis**. Select **Properties**.)



2. Select the **Data Frame** tab.
 - i. Near the middle of the dialog under **Extent Used By Full Extent Command**, select **Other**.



3. Click the **Specify Extent** button.
4. From the Full Extent window, enable **Outline of Features**, then select **Crooked Creek Subwatershed** from the dropdown.
5. Click **OK**.

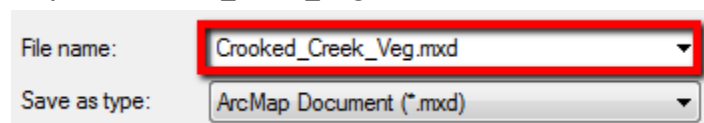


6. Click **OK** again to accept the parameters and close Data Frame Properties.
7. Click the **Full Extent** button.

The Full Extent button now zooms to the Crooked Creek Subwatershed.

E. Save the Map Document.

1. Save the map document in the following location and name:
.../Data/Workspace/Crooked_Creek_Veg.mxd.

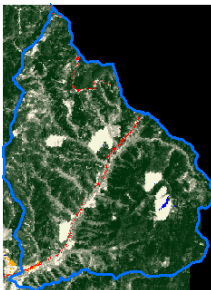


You now have a map illustrating vegetation distribution within the subwatershed. Let's continue to modify the layers to determine the distribution of old-growth trees.

Part 3: Symbolize Datasets based on cell values

OLD GROWTH ANALYSIS SCENARIO

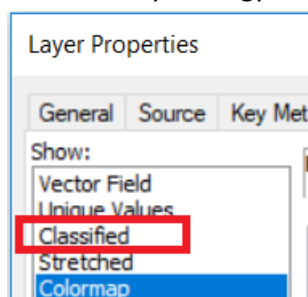
The classified values in the Conifer layer represent percentages of conifer crown cover. If we assume that old growth occurs when conifer crown cover is greater than 70%, and the tree diameter (DBH5) is greater than 20 inches, then we need to modify both the Conifer and QMD layers to display specific ranges of percent cover and tree diameter.



Like vector datasets, a raster dataset can be symbolized through the layer properties. In this step, we will discontinue the use of the Colormap and classify cell values based on the location of old growth trees.

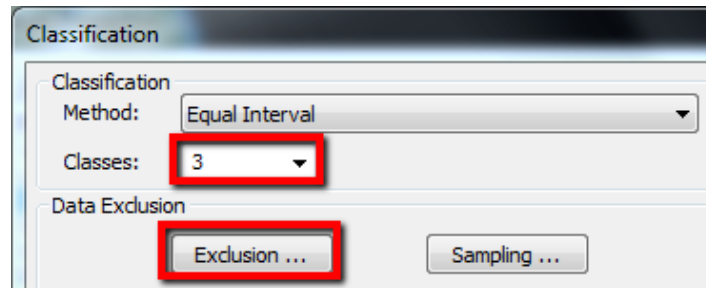
A. Re-symbolize the Conifer layer

1. Open the **Properties** of the **Conifer** layer.
2. Activate the **Symbology** tab.
3. Under the Symbology tab's "**Show:**" column, select **Classified**.



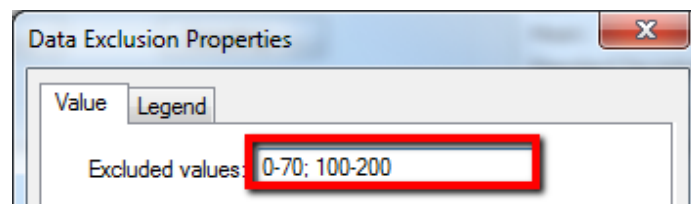
You may wonder why the values go to 200 when they represent “percent” crown cover. Percent values only go to 100. If you remember from looking at the classification earlier there are additional values for things like water, snow, barren, agriculture, etc. The values from 101 to 200 are all values unrelated to conifer crown cover percentages. We will omit those values in our analysis by defining the classification parameters of the Conifer layer

4. Select the **Classify...** button.
5. Change the number of classes to **3**.



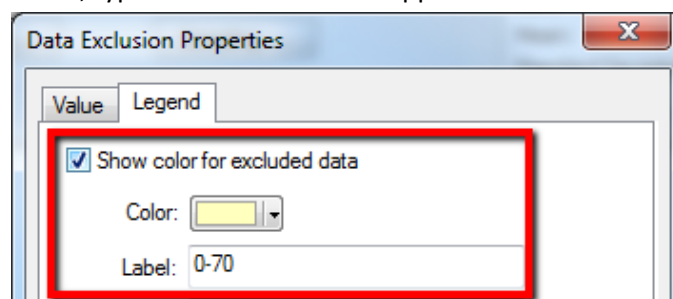
Since we only want tree crown cover greater than 70% (100% coverage is the maximum). So, we can exclude percentages less than or equal to 70, and those percentages greater than 100.

6. Select the **Exclusion** button.
7. For *Excluded values*, enter: **0-70; 100-200**.



As you will see, the value of 100 is not excluded even though you just typed the number in the Data Exclusion window. Whether it's a bug in the program, or because it is the first number in a range of numbers, ArcMap assumes you want to exclude values greater than 100, but not 100.

8. From the *Data Exclusion Properties* window, activate the **Legend** tab.
9. Enable the checkbox to “**show a color for excluded data.**”
10. Change the “exclusion” color to **Yucca Yellow**.
11. For the Label field, type **0-70**. This label will appear in the **Table of Contents** and/or Legend.



12. Click **OK**. The histogram in the Classification window redraws to the new exclusion range.
13. Review the **Classification Statistics** from the upper right corner of the Classification window.

Classification Statistics	
Count:	1567442
Minimum:	71
Maximum:	100
Sum:	137,965,922
Mean:	88.01979403
Standard Deviation:	8.897549676

QUESTION - What is the Minimum value? _____ %

QUESTION - What is the Maximum value? _____ %

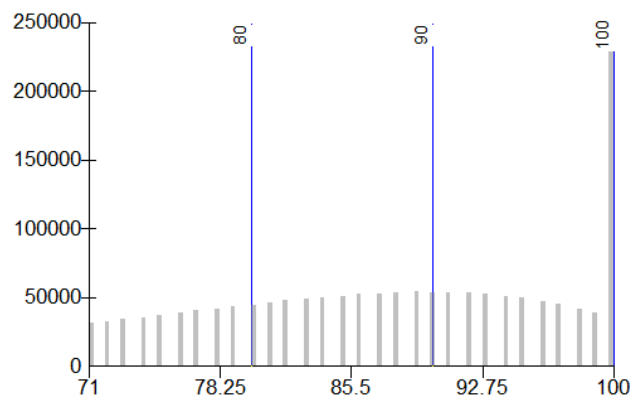
ANSWER: If the classification range is from 71% to 100%, you're good to go. Otherwise, ask the instructor for assistance.

14. Enter new Breaks Values of **80, 90, and 100**, by clicking on the existing break values.

Break Values
 %

80
90
100

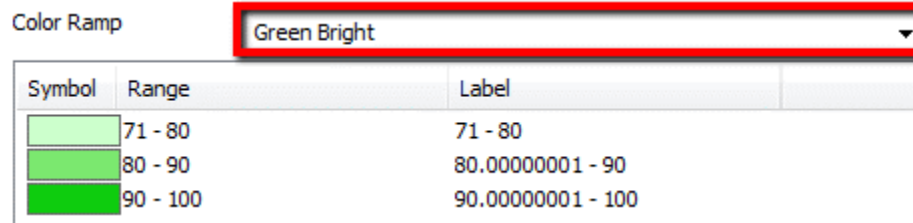
A histogram illustrates the distribution of percent conifer cover. Since we excluded percentages less than or equal to 70, and those percentages greater than 100, only values between 70 and 100 display.



15. Click **OK** to return to the Layer Properties dialog.

16. From the Color Ramp drop-down list, choose Green Bright.

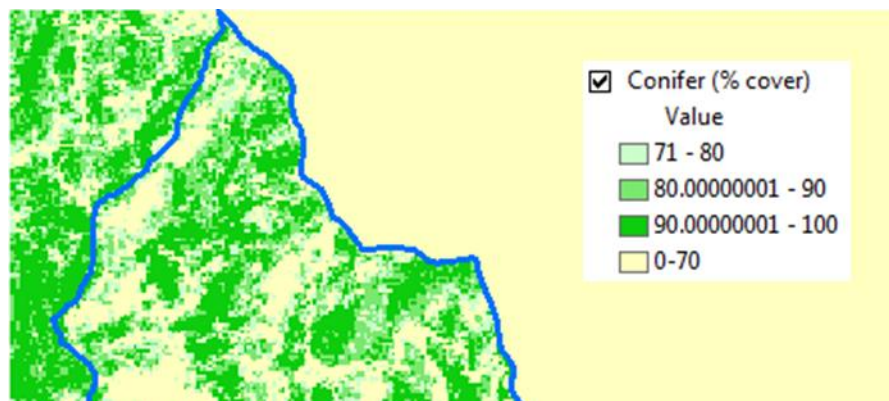
HINT: Right click Color Ramp | select **Graphic View**; then you can type the letter "G" to advance to color ramps beginning with the letter G.



17. Click **OK**.

Drawn in the Data View are those cells with conifer trees between 71% and 100% crown cover. Also, in Yucca Yellow, are those cells excluded from the map display.

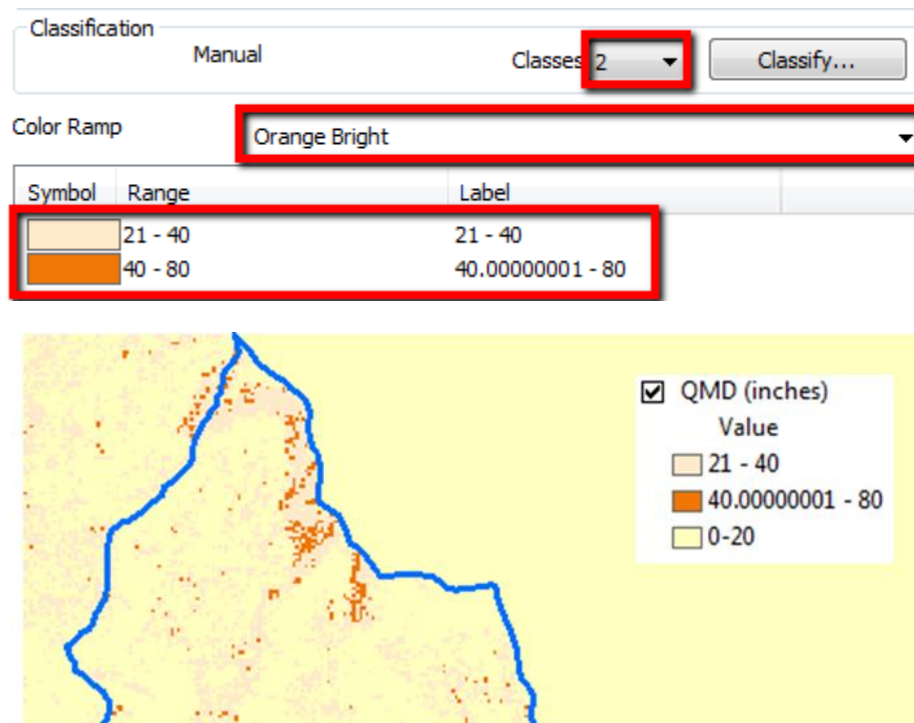
18. Turn off the Conifer layer.



Now, let's classify the QMD layer to display tree diameters greater than 20 inches. For the QMD layer, there are no tree diameters greater than 75 inches, and values greater than 100 are used for non-vegetation values (e.g., water). Therefore, for this exercise, you will exclude DBH values less than 20 inches, and also those values greater than 80 inches. In the "real" world, you would probably classify at a different value range (e.g., 20 to 100 inches).

B. Define Classification parameters for QMD layer.

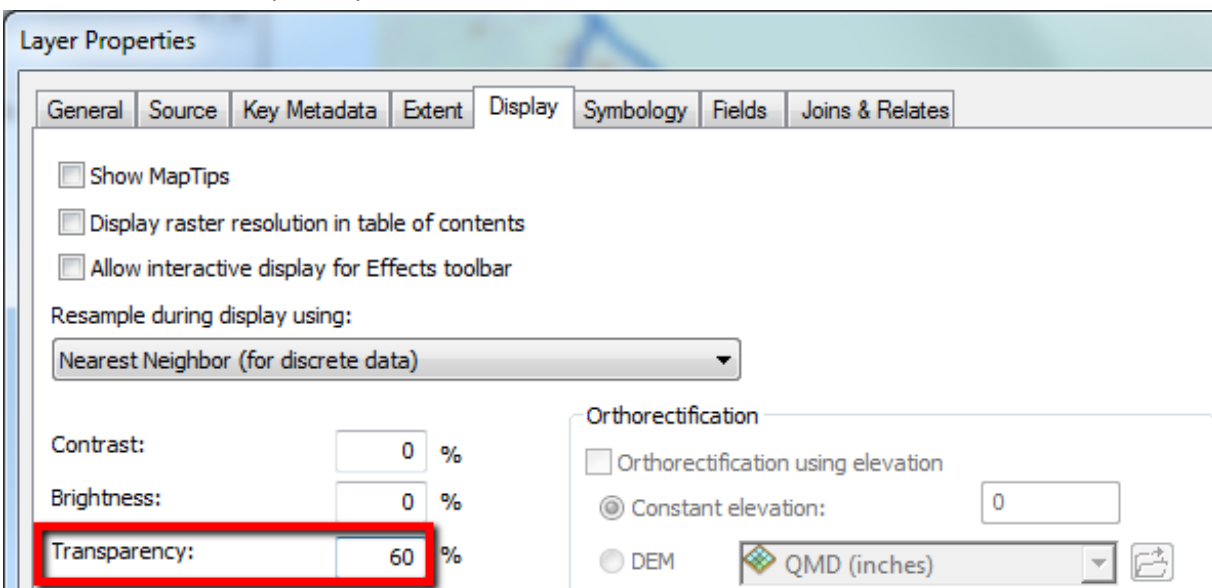
1. Turn on and open Layer **Properties** for the **QMD** layer.
2. Apply the following symbology parameters:
 - *Show* = Classified
 - *Number of Classes* = 2
 - *Exclude* the following ranges: 0-20; 80-200
 - Show the *Exclusion color*, and set the color to Yucca Yellow
 - *Exclusion label* = 0-20
 - Type in new *Break Values* = 40 and 80
 - *Color ramp* = Orange Bright.
 - Ensure your parameters match those below and click OK.



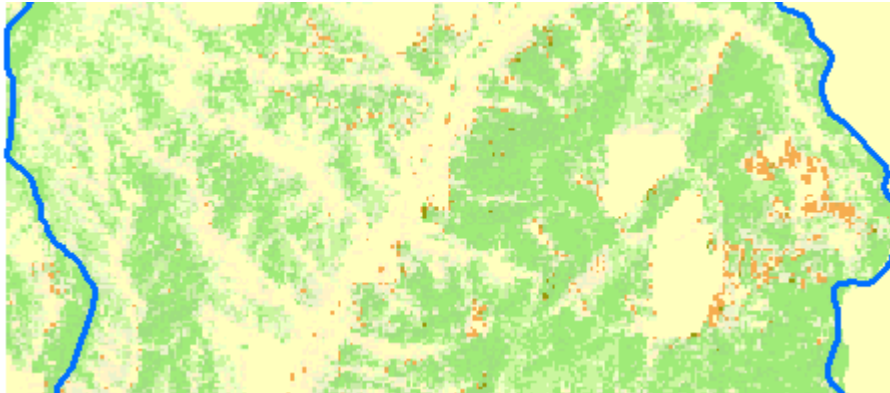
Displayed in the Data View are tree diameters between 20 and 80 inches. To visualize old growth, we need to see the distribution of both the Conifer and QMD layers simultaneously. We can visualize the layers simultaneously by applying a transparency to one of the layers.

C. Adjust the Transparency of the Conifer layer.

1. Turn on the **Conifer** layer and open its **Layer Properties**.
2. Activate the **Display** tab.
3. Set the Transparency to **60%**, and click **OK**.



Transparency can be used with any symbolization type, but it is especially useful for drawing raster layers with other layers on your map. Adding transparency to the top layers allows you to see them while still viewing underlying layers. Areas where the Conifer and QMD features overlap, meet the Old Growth Crown Cover criteria. NOTE: You can also set transparency for group layers.



4. **Save** the map.

You have just set up the map to visually analyze the Old Growth features. In the next steps you will combine the Conifer and QMD layers into 1 raster.

Part 4: Set up the Analysis Environment

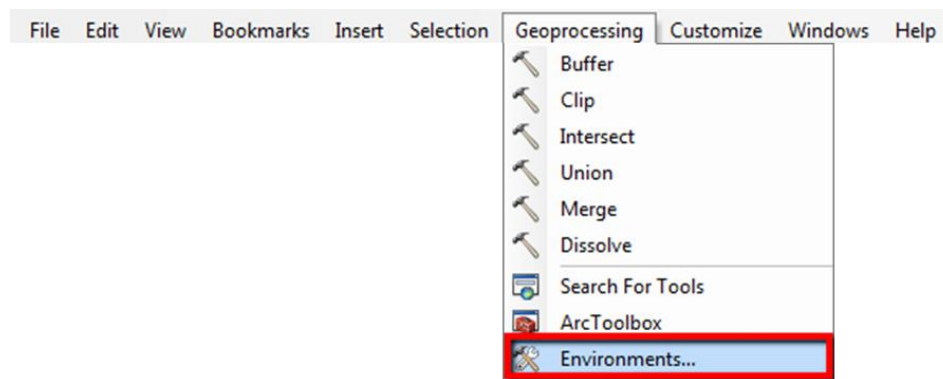
To combine the results of the Conifer and QMD layers, a new raster dataset has to be created.

Good habit: Before you begin using the functions provided with the Spatial Analyst extension, you should always set up your analysis environment. The analysis environment includes specifying a working directory and establishing an analysis mask and cell size. Let's start with the working directory. As the name implies, the working directory is where the results of the analysis are saved (including temporary files).

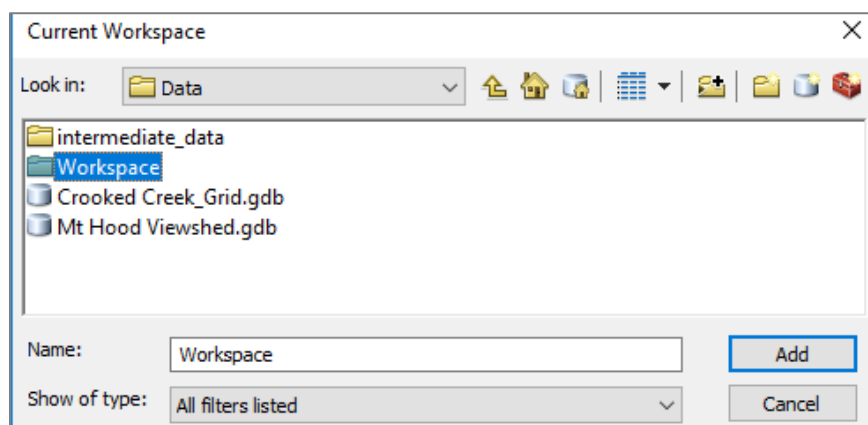
Environment settings can be set at three levels. We are setting up application level settings so any geoprocessing operation performed in this MXD will use these environment settings. Environment settings can be set up in Catalog to apply to every MXD. Environment settings can also be set up for individual tools and for models.

A. Specify a Workspace to save analysis results.

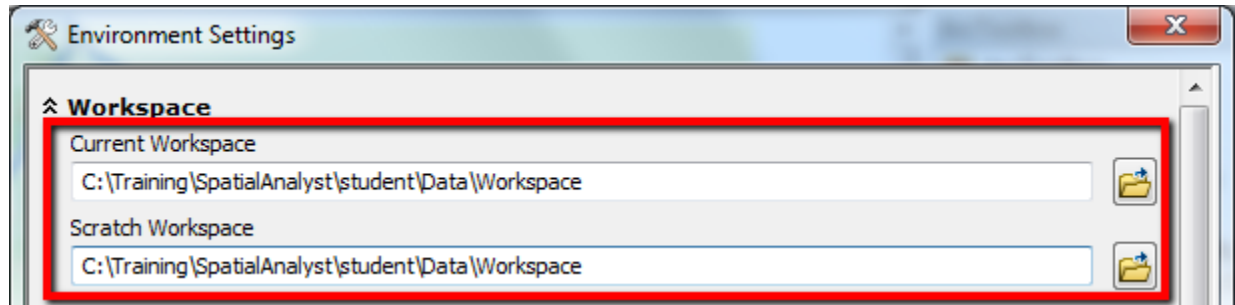
1. From the **Geoprocessing** menu, select **Environments**.



2. Expand the **Workspace** section.
3. Set the *Current Workspace* and the *Scratch Workspace* both to...**\Data\Workspace** in your course data. Select the folder icon, navigate to the **\Data** folder and Single click on the **Workspace** folder so that it's name appears.



4. Select **Add**.



GOOD TO KNOW: The ESRI default location for your analysis results is your user profile's temporary directory, usually *C:\Documents and Settings\<user name>\Local Settings\Temp*.

NOTE: A few of the Spatial Analyst functions provide an option to save the results to a directory location other than the working directory. The scratch workspace is used in these processes. This can be useful if you want to sort your analysis results into different folders.

B. Specify an output Coordinate System for analysis results.

1. Expand the **Output Coordinates** section.
2. Choose **Same as Input** for the Output Coordinate System.

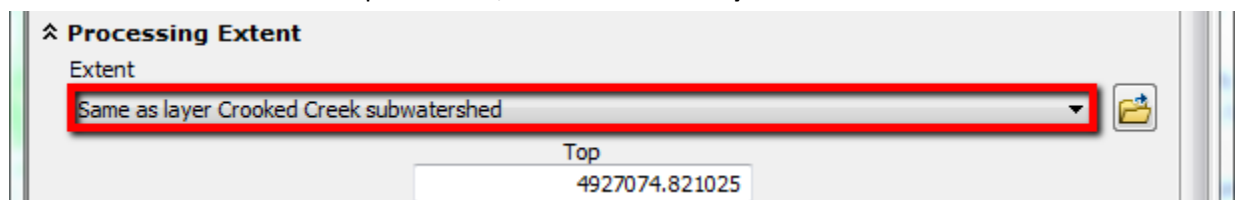


WARNING: Inaccurate coordinate values have occurred in output rasters using a different datum from the input datum (e.g., input = NAD27; output = NAD83). All input and output raster layers should use the same coordinate system. Do not use Spatial Analyst to re-project an output dataset. Because we are using WODIP datasets with a NAD27 datum, we'll continue to use the default Coordinate System setting, "Same as Input".

C. Set the Processing Extent.

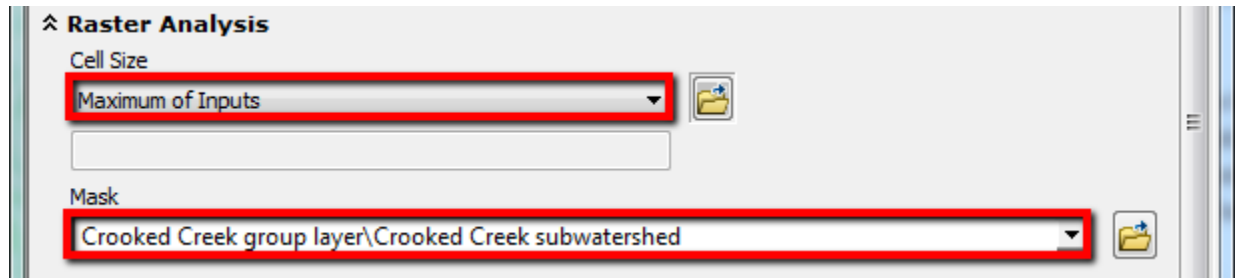
Next we set the Processing Extent, which is the spatial extent of any analysis. The Processing extent differs from the Analysis mask in that it defines the rectangular size of the output raster dataset. Remember, all raster datasets are rectangular.

1. Expand the **Processing Extent** section.
2. From the Extent drop-down list, choose **Same as layer Crooked Creek subwatershed.**



D. In Raster Analysis Set the Raster cell size and mask.

1. Expand the **Raster Analysis** section.
2. For the **Cell Size**, select **Maximum of Inputs**.
3. Choose the **Crooked Creek subwatershed** layer for the mask.



The Analysis mask is a layer that defines the study area of the analysis. For our analysis, the study area is the Crooked Creek subwatershed. Any Spatial Analyst process that you execute will only occur on cells within the Analysis mask. Any cells outside of the Analysis mask will be assigned a value of NO DATA.

4. Click **OK**.
5. Save the Map. The Environment Settings you just set are saved with the map document.

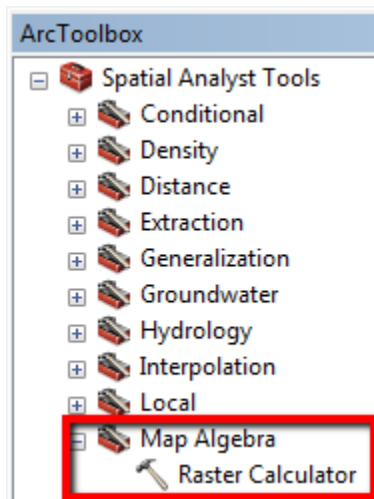
CAUTION: It is possible to specify a smaller cell size than the smallest input cell size. However, the resolution of the output cannot be more accurate than the input datasets. If you specify a cell size of 50 meters when the input raster datasets are 100 meters, then you will create an output raster with a cell size of 50 meters, but the accuracy is still 100 meters.

Part 5: Raster Calculations

Now that the analysis environment is set, we can use the Raster Calculator to output a new dataset showing the location of old growth vegetation. We will perform a Boolean operation (true or false)—testing each cell against a user-defined calculation.

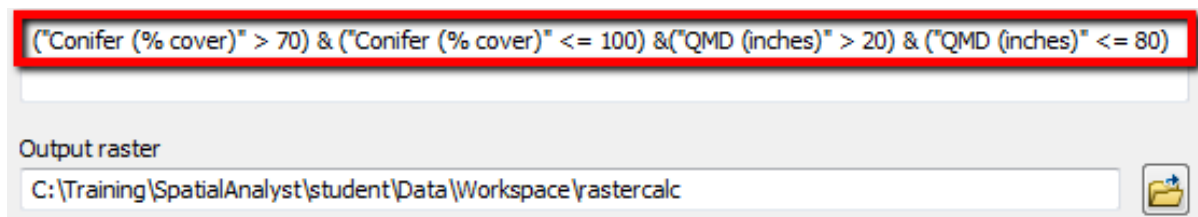
A. Open the Raster Calculator.

1. Open **ArcToolbox**.
2. From **ArcToolbox** select **Spatial Analyst Tools** | **Map Algebra** and double click on **Raster Calculator**.



The Raster Calculator processes the Value field of the input datasets. Remember the Value field is the actual cell value, and it is always numeric. Tip: Most expressions can be built by clicking on the layer names and buttons. Little typing is required.

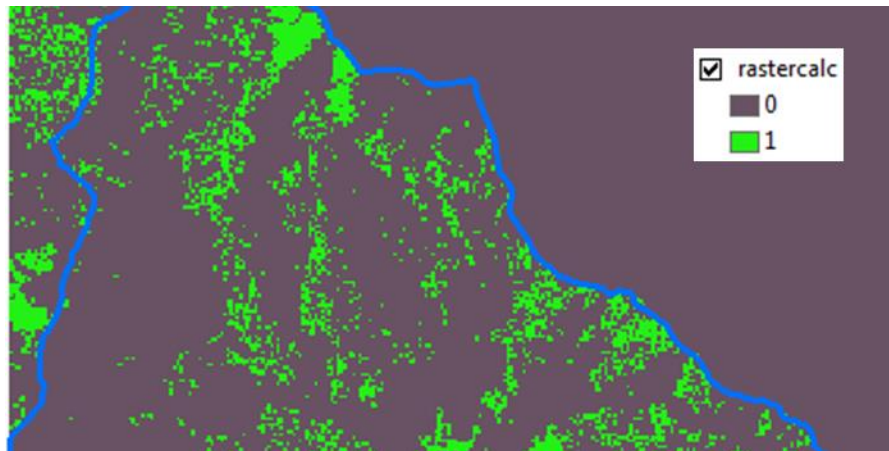
3. Enter in the following in the expression box: ("Conifer (% cover)" > 70) & ("Conifer (% cover)" <= 100) & ("QMD (inches)" > 20) & ("QMD (inches)" <= 80)



4. Accept the default output name and click **OK**.

In a few moments, the Raster Calculator closes, and a new layer called **rastercalc** is added to the TOC. You could have saved it to a different name by typing it into the output raster window.

Because we performed a Boolean operation, the cell values of the Calculation layer are either zero (false) or one (true). Where the conditions of the expression were met, the output cell was assigned a value of one. These cells represent the location of old growth vegetation.



5. Turn off both the **Conifer** and **QMD** layers.

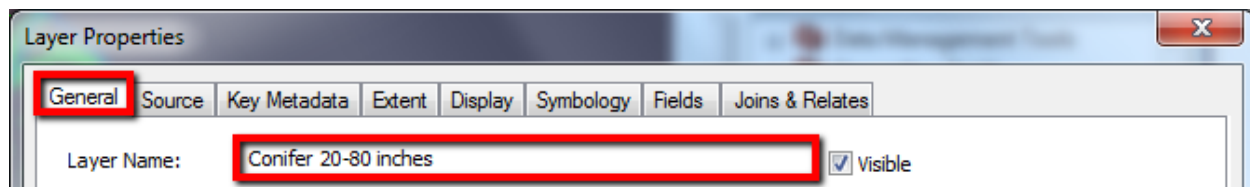
B. Examine the rastercalc's Properties.

1. Open the **Layer Properties** for **rastercalc**.
2. Activate the **Source** tab and verify the parameters of the dataset match the following:
 - *Cell Size* – **25 meters**
 - *Spatial Reference* – **NAD_1927_UTM_Zone_10N**
 - *Pixel Type* – **Unsigned Integer**

QUESTION - What is the status of the layer? Permanent / Temporary?

For most instances, the results from a Spatial Analyst process are temporary. There are some exceptions. A temporary raster dataset can be made permanent by right clicking on the layer's name in the TOC, and choosing **Make Permanent**.

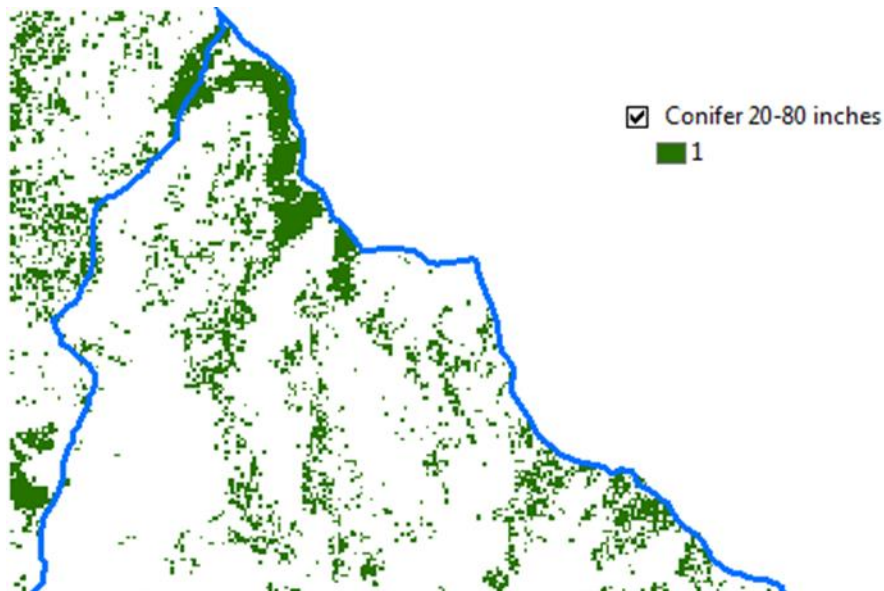
3. Activate the **General** tab.
4. Change the name of the layer to **Conifer 20-80 inches**.



5. Activate the **Symbology** tab.
6. Remove the **0** value class. (Select the row | Select **Remove**.)
7. Change the color for the **1** value to **Fir Green**.

Symbol	<VALUE>	Label	Count
	<all other values>	<all other values>	
	1	1	15300

8. Select **OK**.



The Data View and Table of Contents update to reflect the chosen parameters. Next, let's compare the output raster, Conifer 20-80 inches, with a raw Landsat image.

C. Compare the Conifer 20-80 inches with a raw Landsat image.

1. Add the **ALSEA_Landsat_1996.img** raster dataset from the ...\\Data folder to the map.

This image was acquired by a Landsat 5 satellite in 1996. Notice there are three color assignments displayed in the Table of Contents (TOC). This is a multiband layer where each spectral band has been assigned to one of three color guns: red (R), green (G), or blue (B). Some ArcMap sessions may display the word "Band_<#>" in the TOC; while others display the word "Layer_<#>." Both names refer to the spectral band and its color gun assignment.

SPECTRAL BAND	EM SPECTRUM	WAVELENGTH (μ-meters)	RESOLUTION (meters)
1	Blue	0.45-0.52	30
2	Green	0.52-0.60	30
3	Red	0.63-0.69	30
4	Near infrared	0.76-0.90	30
5	Mid infrared	1.55-1.75	30
6	Far infrared	10.40-12.50	120
7	Mid infrared	2.08-2.35	30

A Landsat 5 satellite records surface reflectance (light) values in seven channels at differing wavelengths of the Electro-Magnetic (EM) spectrum. For example, Band 1 records blue light. The table displayed is a breakdown of Landsat 5's spectral bands, the type of EM spectrum each band records and the images spatial resolution. ArcMap displays Landsat imagery using a combination of three spectral bands.

2. Open the Properties for the **ALSEA_LANDSAT_1996** layer.
3. Activate the **Symbology** tab.

What are the images three spectral band assignments for each color gun?

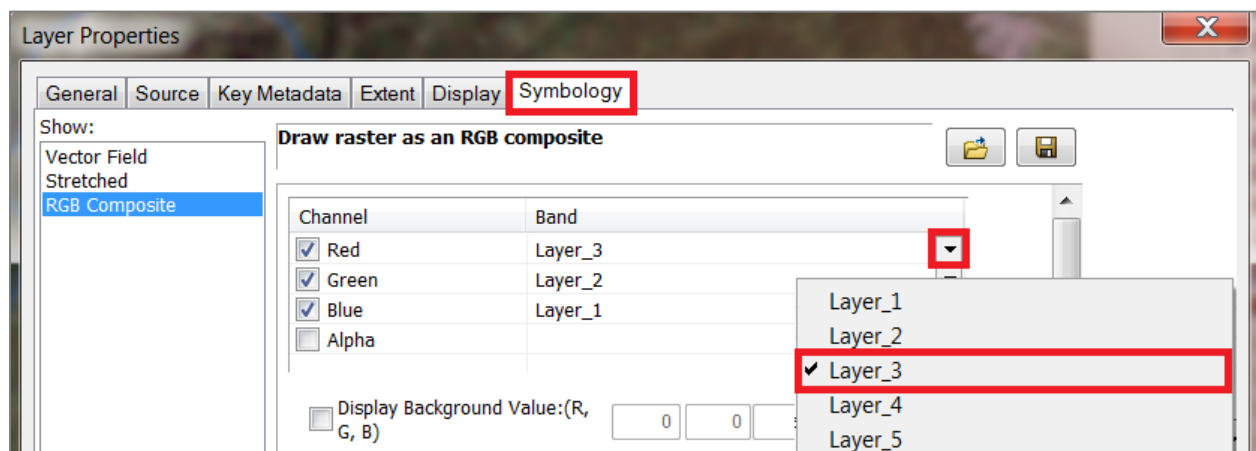
Red = ____ Green = ____ Blue = ____

Answer: 1, 2, 3

QUESTION - Based on the spectral bands you wrote down, compare these values to the spectral band number listed in the table above. Is ArcMap displaying a true-color image?

ANSWER – No. For a true-color image, ArcMap has assigned incorrect bands to the RGB color guns. For a true-color display the Red color gun should be Spectral Band 3, and the Blue color gun should be Spectral Band 1. Fortunately, through the raster layer's properties, it is relatively simple to change the spectral band assignment. Notice you can isolate individual bands by turning the other spectral bands off.

4. Update the bands to display **TRUE COLOR**; red as red, green as green and blue as blue. Refer to the following screen capture, change the Red color gun to Band_3 (Layer_3), and the Blue color gun to Band_1 (Layer_1). Open the layer properties, then the symbol tab. Use the dropdown arrow to the right to change the bands.



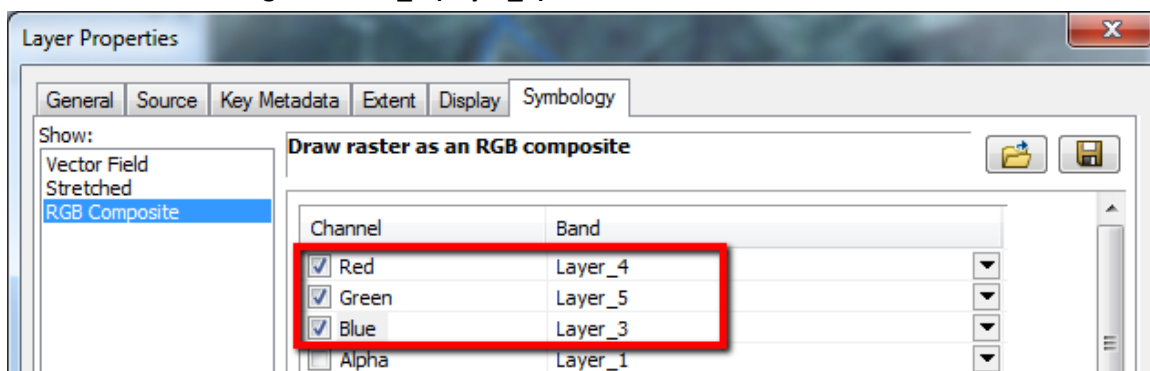


5. Click **OK**. The image displays as true color.

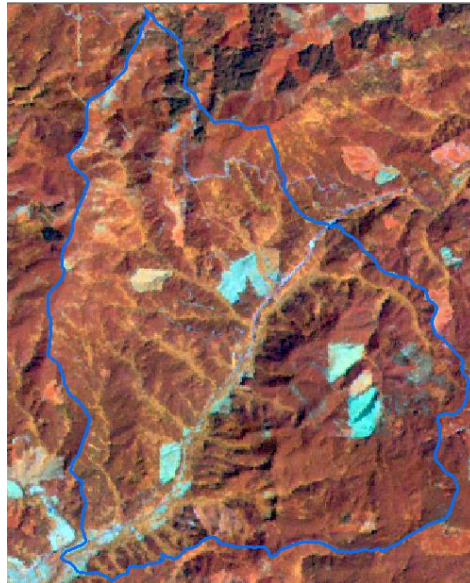
For purposes of identifying forest cover, the natural color scheme lacks enough contrast to differentiate conifer from deciduous vegetation. Visual interpretation for forest cover is best done with a combination of spectral bands 3 through 5.

6. Go back into the layer **Properties** and change the Bands of the *ALSEA_LANDSAT_1996* layer to the following:

- Red color gun = **Band_4 (Layer_4)** (infrared band)
- Green color gun = **Band_5 (Layer_5)**
- Blue color gun = **Band_3 (Layer_3)**



7. Click **OK**. A false color image is displayed now, with the infrared band highlighting vegetated areas.



8. Use the following table to interpret the colors:

COLOR	FEATURE
Dark Blue	Water
Dark Green & Dark Brown	Older Conifer
Red & Light Brown	Younger Conifer
Pale Yellow	Broadleaf; riparian drainages; regenerating clear cuts
Turquoise	Recent clear cut; agriculture
Medium Blue	Urban/pavement

9. In the Data View, make a visual assessment by locating areas of older conifer (i.e., dark green and dark brown pixels).
10. Move the **Conifer 20-80 inches** layer *above* the **1996 Landsat** image in the table of contents.
11. Compare the 1996 Landsat image with the "Conifer 20-80 inches" layer by turning the Conifer 20-80 or Landsat image layer off, and back on. Dark brown/green areas on the image denote "Older Conifers".

QUESTION - Do you think the "Conifer 20-80 inches" layer we calculated is too conservative compared to dark brown/green areas visible in the 1996 Landsat image?

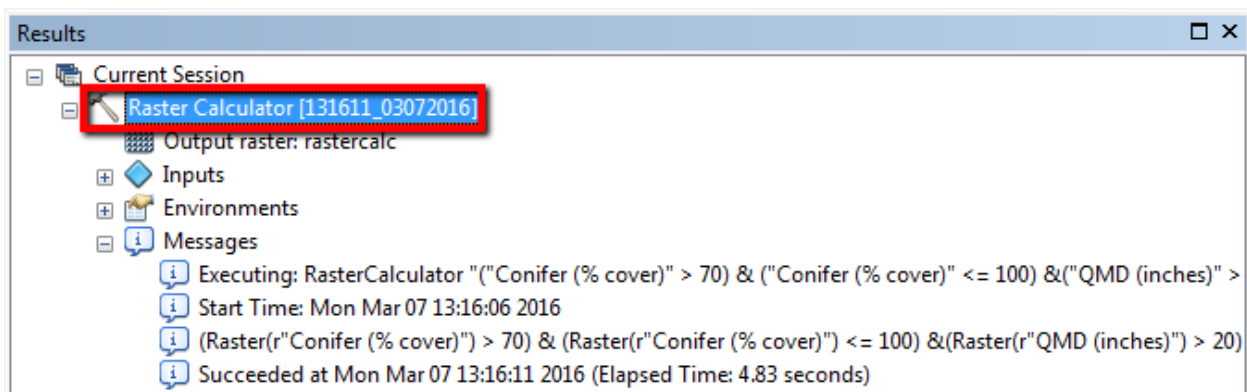
Although, the method of comparison between the two layers is subjective, it does appear fewer green cells are present in the "Conifer 20-80 inches" layers as compared to the more abundant dark green/brown cells of 1996 Landsat image. Assuming the calculation we did earlier was too conservative, let's repeat the raster calculation, but this time allow for a greater range of crown cover (e.g., > 50%).

12. Turn off the **ALSEA_LANDSAT_1996** layer.

D. Repeat the raster calculation to increase the range of crown cover.

There are several ways to rerun the calculation. You can open the Raster Calculator and enter the entire expression again; you can copy the expression and paste it into the expression box – if you thought to save it somewhere you can copy from. Or you can reuse all of the information from the last time you ran it (if you are still in the same session of ArcMap) because ArcMap keeps track of the geoprocessing tools you run in a session. We can access those records in the **Results** window. The **Results** window lists all of the tools you have tried to use in the current session and what happened when you ran them. It contains the errors if a tool did not work as well as information on what happened if it did work.

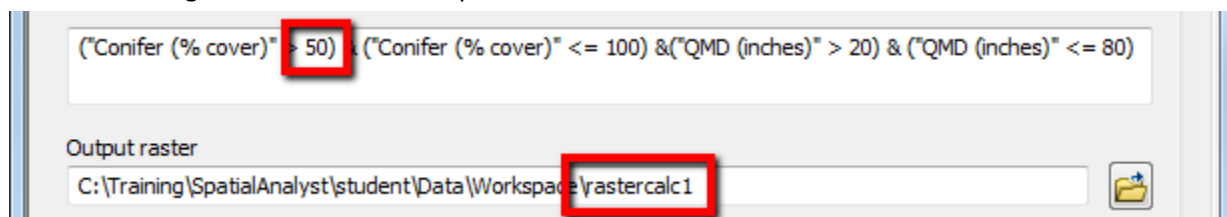
1. From ArcMap's *Main Menu...* navigate to the **Geoprocessing | Results**. The Results window opens. The one and only result listed should be the Raster Calculator you ran in this exercise (unless you entered it wrong and had to try more than one to get it to work). The most recent results are at the top of the list. If you expand the tool and Messages you can see the expression you entered.



2. Double-click **Raster Calculator** in the *Results* window. (Alternately, you can right click Raster Calculator and select Open).

Since the Raster Calculator opens with all of the information used before we only need to make a few minor edits to the expression.

3. Change the 70 to **50**.
4. Change the name of the output rastercalc to **rastercalc1**.



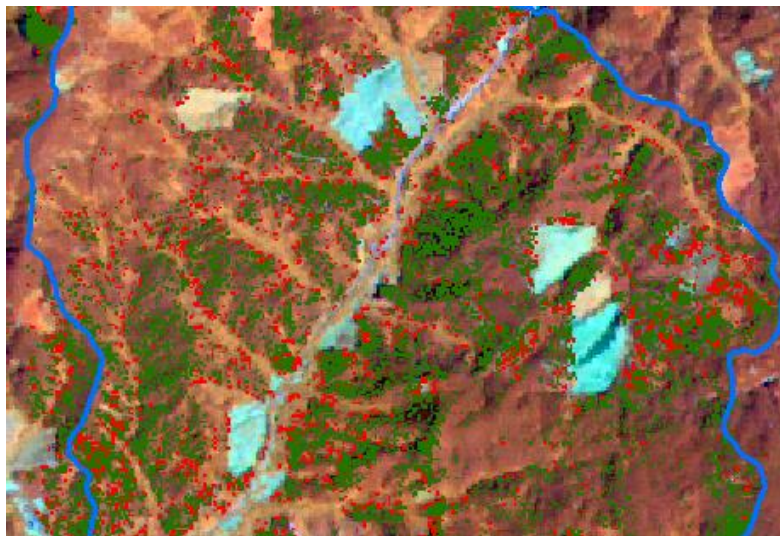
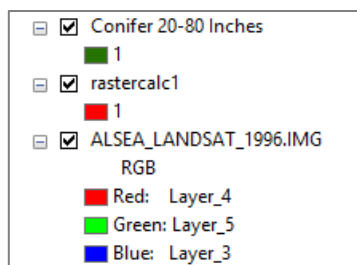
5. Click **OK** to rerun the raster calculation and then close the **Results** window.

E. Examine and alter properties of rastercalc1.

1. Open the layer properties of rastercalc1.
2. Highlight and **remove** the 0 value.
3. Change the color of the 1 value to **Mars Red**.

Symbol	<VALUE>	Label	Count
	<all other values>	<all other values>	
<Heading>			
	1	1	19824

4. Click **OK**.
5. Move rastercalc1 below Conifer 20-80 inches.

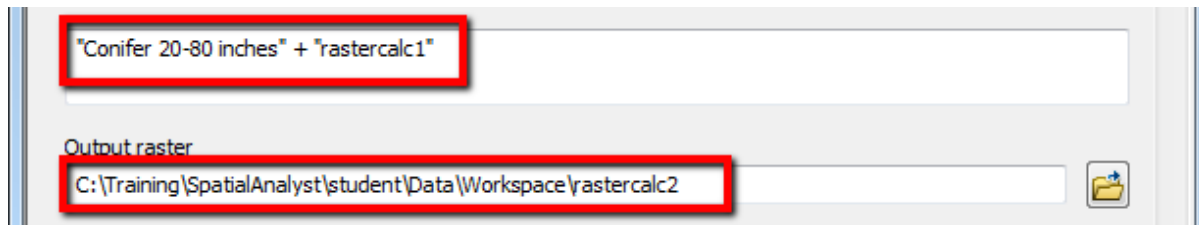


As expected more pixels are present in the new Calculation layer. The previous calculations were examples of Boolean (true/false) operations; however, it is also possible to add, subtract, multiply, and divide two raster datasets creating a new raster whose values are derived from the arithmetic operators used in the calculation. Next we will try adding the two raster layers together.

F. Add the two raster calculations together.

Combining the layers will result in a layer that shows both the areas that were based off of the original assumption of canopy cover as well as the new areas that better match the LandSat image.

1. Open the **Raster Calculator** and enter the following expression: "Conifer 20-80 inches" + "rastercalc1"
2. The output is automatically named: **rastercalc2**. Accept this default name and click **OK**.

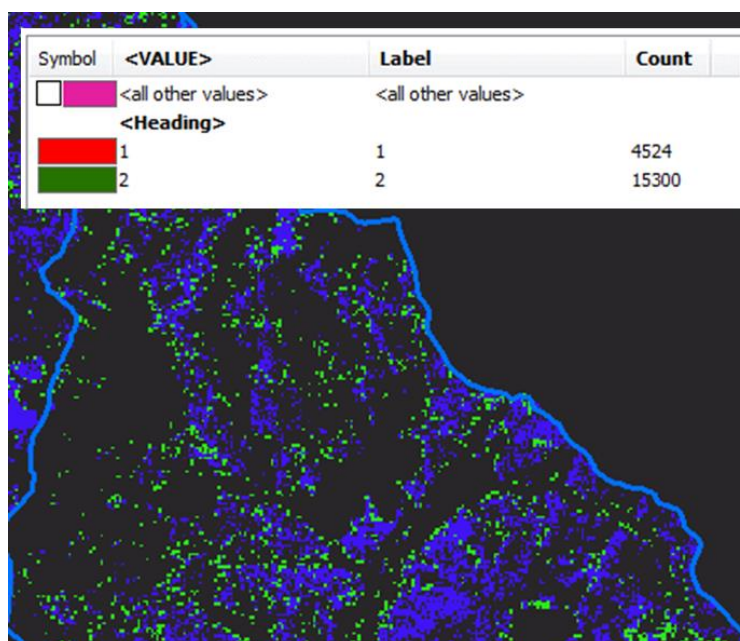


Note: If you get a Parsing Error, try adding the expression by double clicking on the listed layers to add them to the expression box.

An output raster called rastercalc2 is created. Notice, there are three values. Value 0 cells are where both input cells are zero ($0 + 0 = 0$). Value 1 cells are the 50% to 70% cover values from the "raster1" layer ($0 + 1 = 1$). Value 2 cells are the overlap of the >70% cover values from the "Conifer 20-80 inches" and the "raster1" layers ($1 + 1 = 2$).

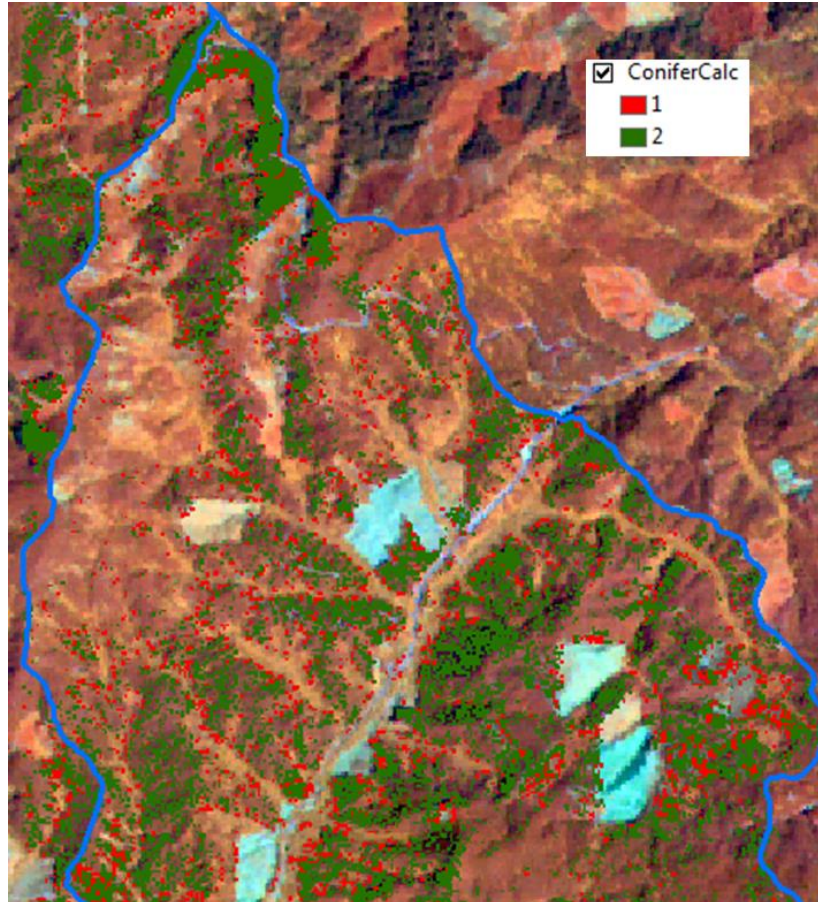
G. Open and examine the properties of the new calculation.

1. Open the properties of the **rastercalc2** layer. Update the following:
 - Name = ConiferCalc
 - Remove Value = 0
 - Value 1 color = Mars Red
 - Value 2 color = Fir Green



2. Click **OK** to accept the parameters and close the properties.

3. After comparing the new calculation to the Landsat image, remove **Conifer 20-80 inches** and **rastercalc1** from the table of contents. (Right click | Remove.)
4. **Save** the map document.

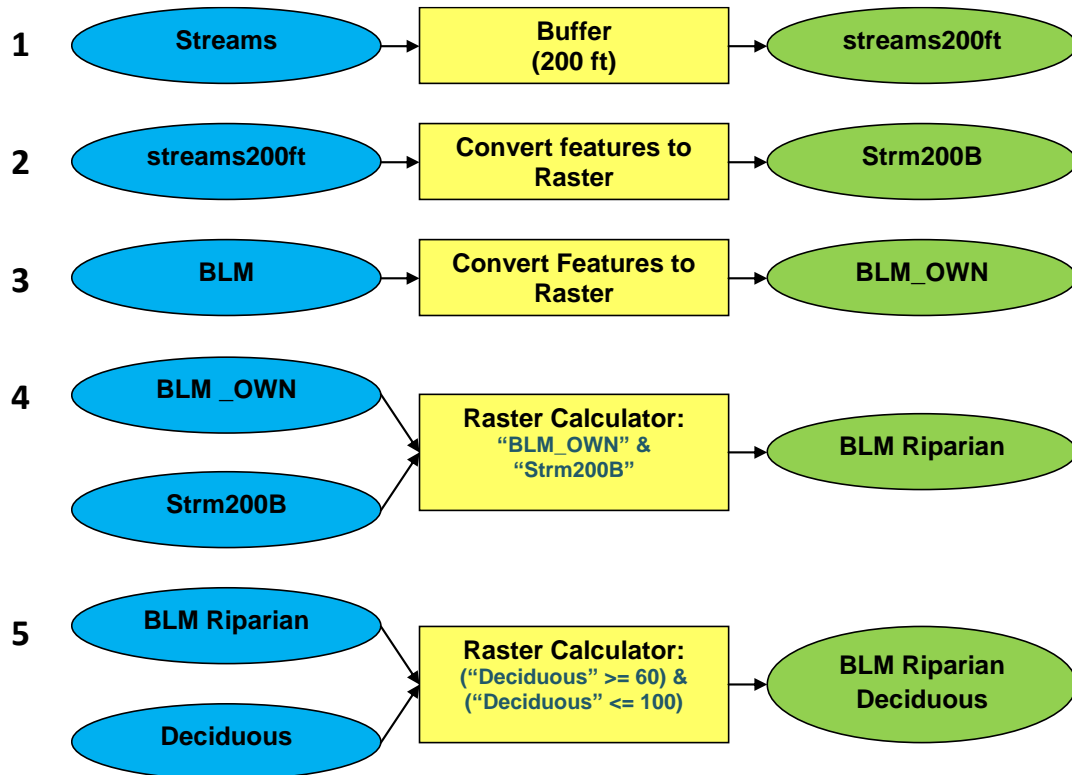


For the remainder of this exercise, we are going to make a map showing the distribution of deciduous (broadleaf) plants located in BLM-administered riparian corridors. In addition, we will limit the vegetation-crown cover to between 60% and 100%.

At first, the requirements of making such a map may seem a little intimidating. As you have seen in previous exercises, complex requests can be broken into a series of small steps that are best visualized by making a flow chart. The following flow chart can be used to complete the requested map. An extra copy of the chart, which you may remove for your convenience, has been placed at the end of this exercise.

After reviewing the steps outlined in the flow chart below, continue to step 6.

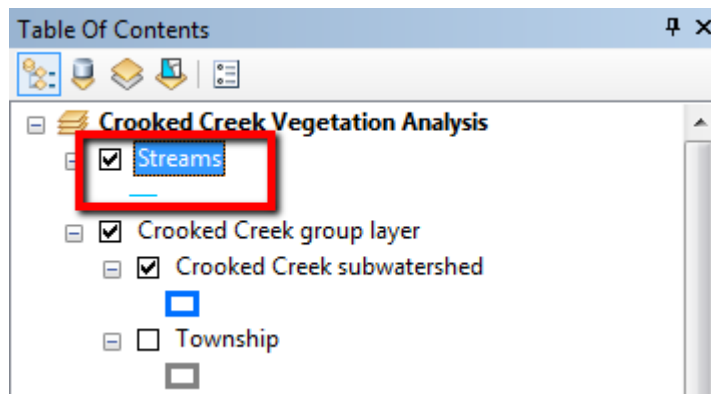
Part 6: Calculate the distribution of deciduous (broadleaf) plants located in BLM-administered riparian corridors



Good news! In the interest of time, the first item in the flow chart, buffering streams, has already been done for you. Let's take a look at the Streams layer, and then add the buffer layer to the map document.

A. Examine the Streams layer.

1. Expand the Crooked Creek group layer.
2. Move the **Streams** layer to the top of the table of contents (outside of the Crooked Creek group layer).

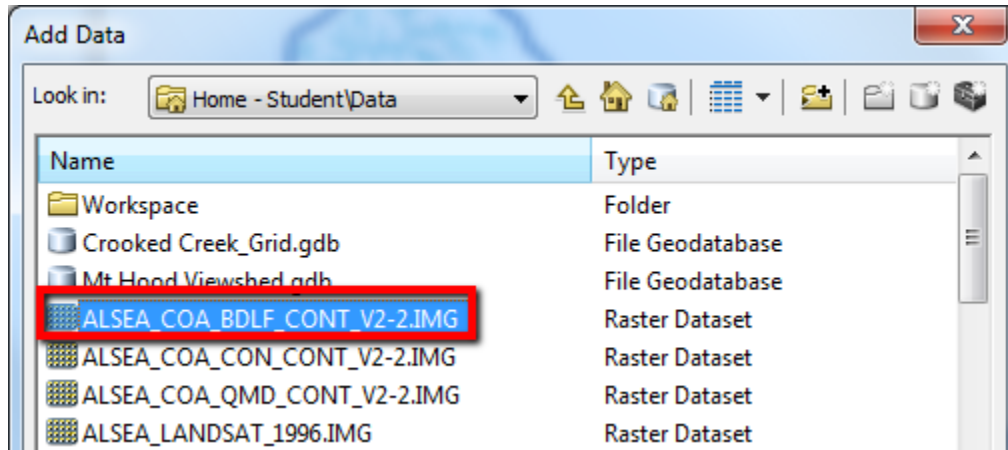


3. Collapse the Crooked Creek group layer.
4. Turn off the **ConiferCalc** layer.
5. Turn on the **Streams** layer.

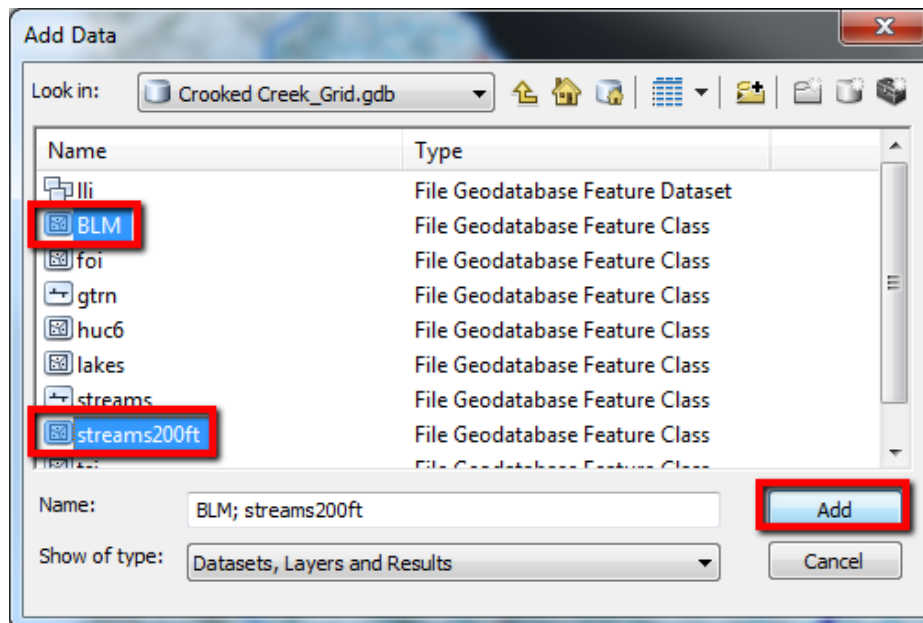
We need two final layers for the analysis: a vegetation map showing broadleaf distribution and a layer showing BLM ownership

B. Add a vegetation map layer and a BLM ownership layer.

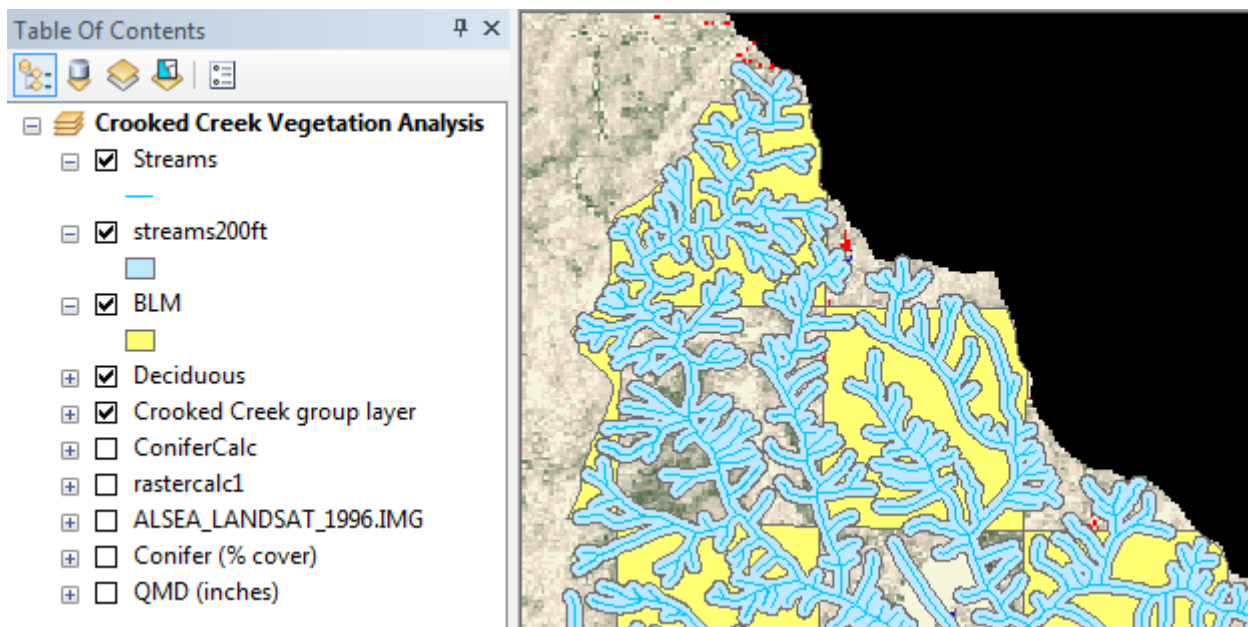
1. From the ...\\Data folder, add **ALSEA_COA_BDLF_CONT_V2-2.img** dataset. (NOTE: The graduated colors show the percent coverage of broadleaf/deciduous vegetation.)



2. Rename **ALSEA_COA_BDLF_CONT_V2-2** layer: **Deciduous**.
3. From the ...\\Data**Crooked Creek_Grid.gdb**, add the following layers:
 - BLM
 - Streams200ft



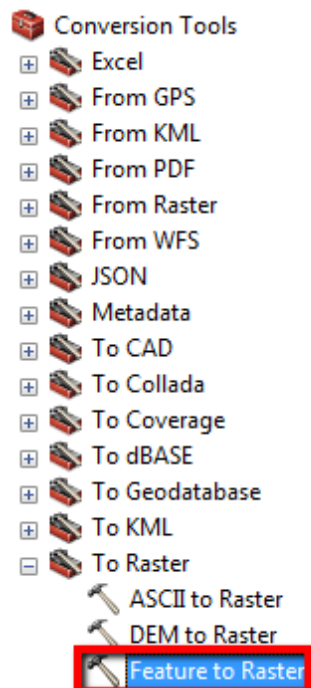
4. Move the **streams200ft** layer above the **BLM** layer.
5. Before moving on, compare your table of contents to the screenshot and make adjustments if needed.



Before we begin the analysis of locating deciduous vegetation on BLM-managed riparian corridors, the input layers used in the analysis must be the same format. In other words, the layers used in the analysis must either be all vector datasets or all raster datasets. Since this exercise deals with Spatial Analyst, we will opt for using raster datasets. This means both the BLM and streams200ft vector datasets must be converted into raster format.

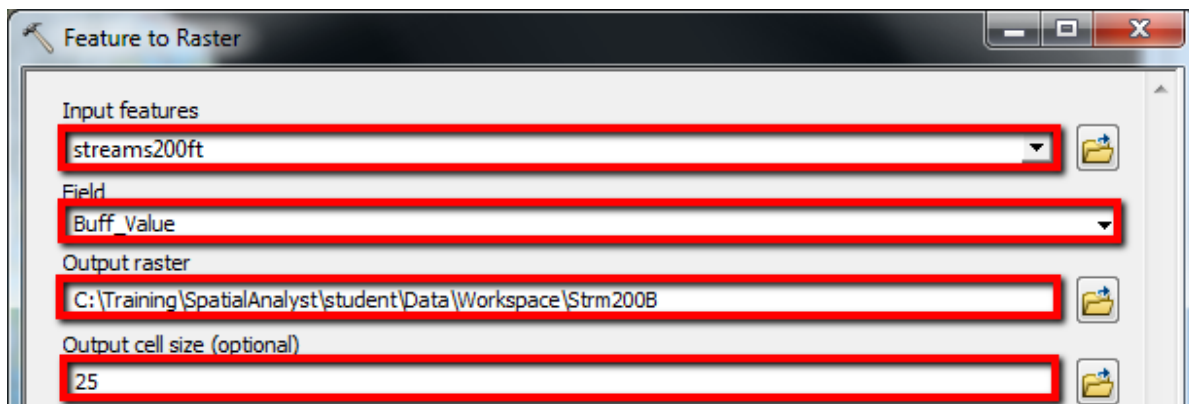
C. Use the Feature to Raster tool to convert all vector dataset used in this analysis to raster.

1. From the ArcToolbox, choose Conversion Tools | To Raster | Feature to Raster.



2. Use the following outline and item two of the flow chart to complete the conversion of the streams200ft layer:

- *Input features* = **Streams200ft**
- *Field* = **Buff_Value**
- *Output raster* = **Strm200B**
- *Output cell size* = **25**



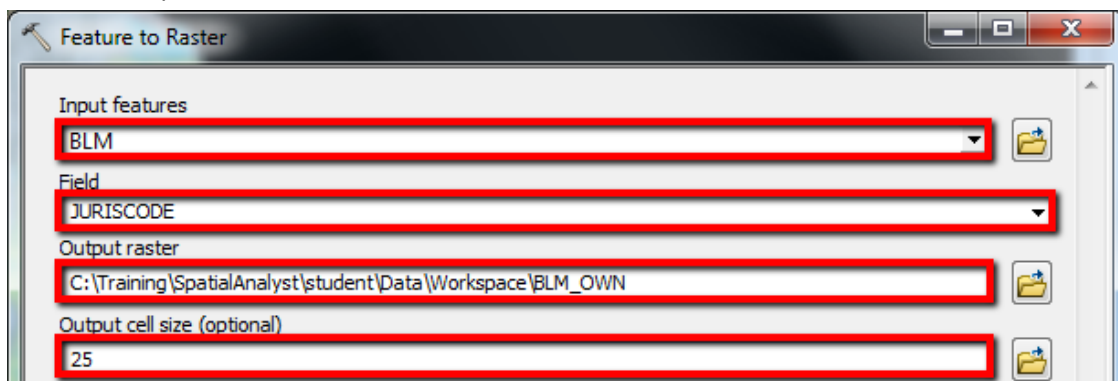
3. Click **OK**. The conversion process takes a minute or two to complete. When done, the new raster layer, **Strm200B** is added to the TOC.

QUESTION - What type of raster was created?

Unless you specify an extension for the output raster (e.g., strm200b.tif), an ESRI raster dataset is automatically created. Now, let's convert the BLM ownership layer to a raster dataset.

3. Use the following outline and item three of the flow chart to complete the conversion of the BLM layer:

- Input features = **BLM**
- Field = **JURISCODE**
- Output raster name = **BLM_OWN**
- Output cell size = **25**



4. Click **OK**. When the conversion process is complete, the new raster layer, “**BLM_OWN**”, is added to the TOC.

5. Turn off the following layers: Streams, streams200ft, BLM, BLM_OWN, and Strm200B.

COMMENTS ON CONVERTING VECTOR DATASETS TO RASTER DATASETS

Polygons, lines, and points from any type of source file can be converted to a raster.

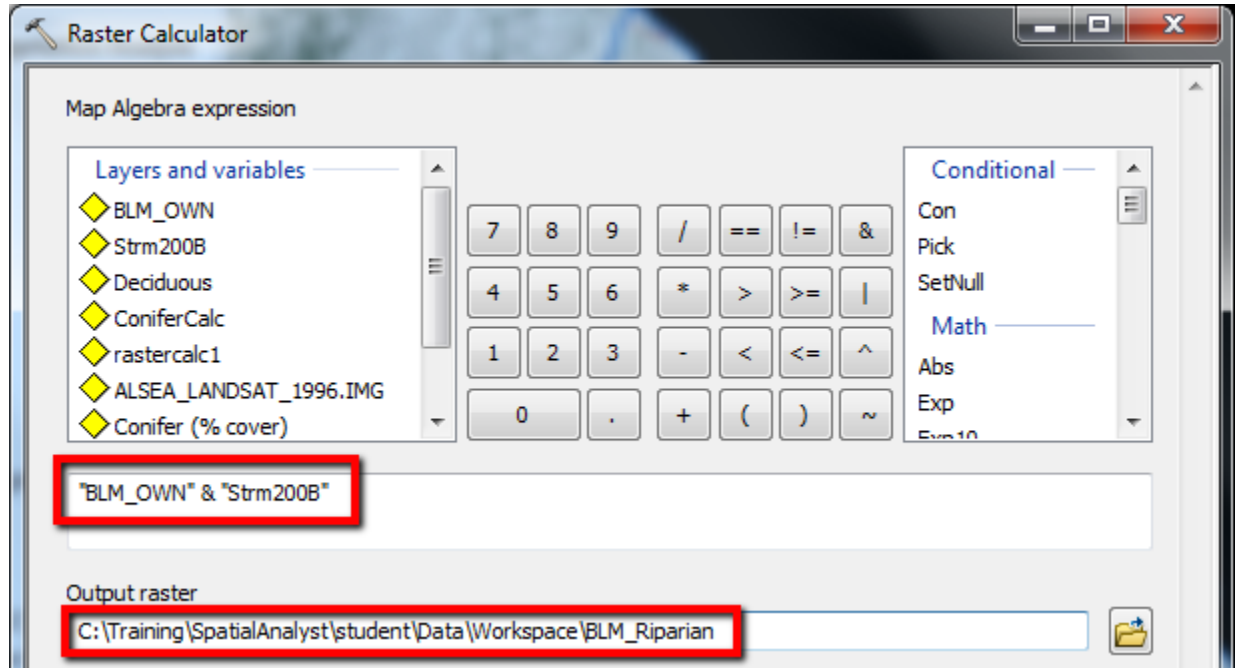
You can specify a cell size for the output raster. Remember, smaller cell sizes translate into larger file sizes, thus longer processing times. Also, smaller cell sizes do not necessarily translate into increased resolution.

You must select an attribute item to provide values for the cells. You can choose either a string or numeric field. If you use a string field, then each unique string value is assigned a unique number, which is then stored in the Value field in the output raster.

Now, let's perform a Boolean operation to determine where deciduous plants are located in BLM-riparian corridors.

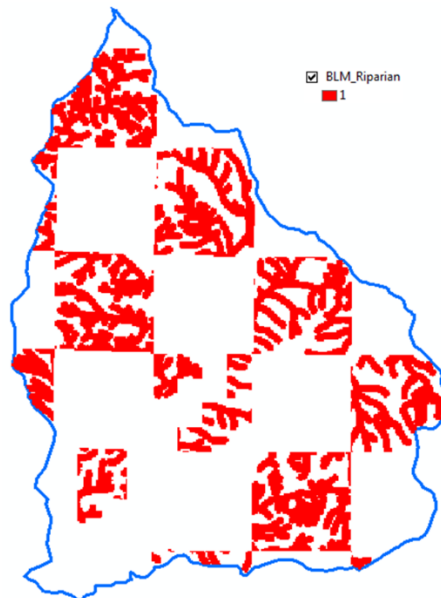
D. Use the raster calculator to perform Boolean operations.

1. Try to use the **Raster Calculator** (on your own) to complete item four of the flow chart. If you need a little help... refer to the screenshot (below).

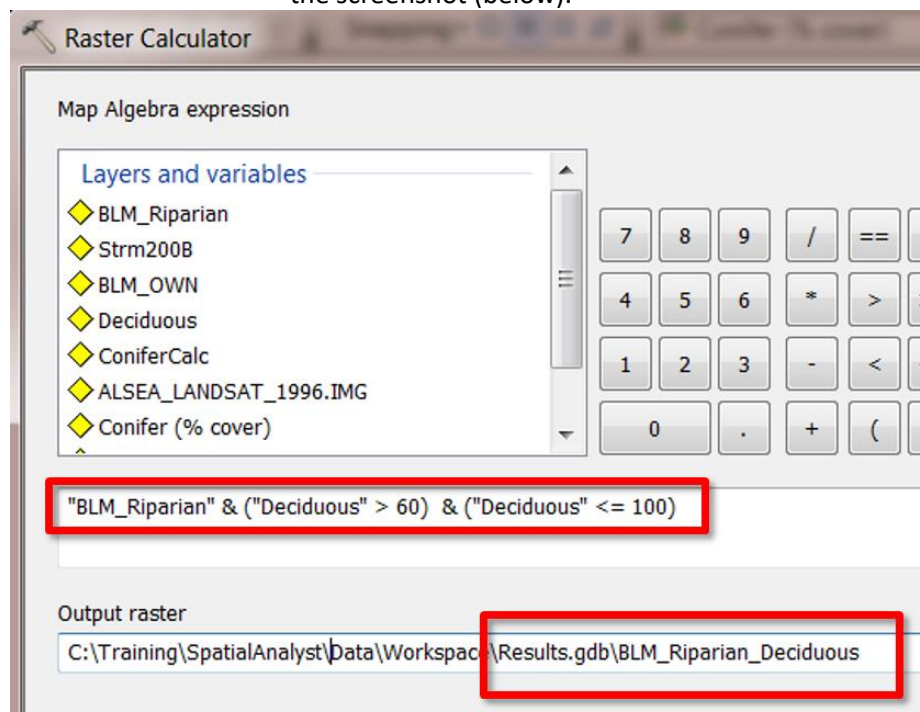


After you evaluate the expression, a new raster layer is added to the map document. The name of this new raster layer is either the default —raster# or what you named it when creating it. If you select your own name for the file keep it short – names over 13 characters will not work. Where cell values equal one, BLM-managed riparian areas exist.

2. Notice the output has values only in the areas where BOTH BLM_Own & Strm200b exist. If your results look different, please notify your instructor for assistance.



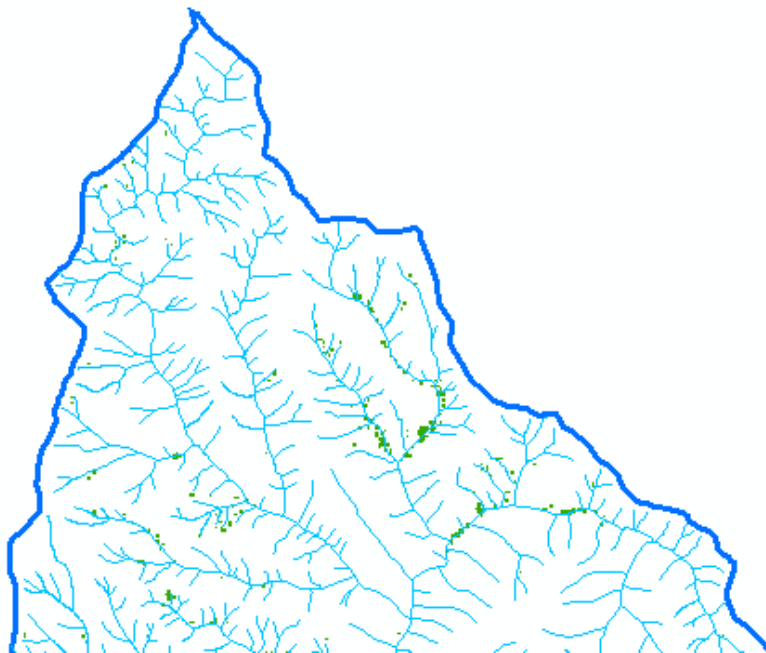
3. If needed, rename the new raster layer you just created BLM Riparian.
4. Now, let's find out where broadleaf plants reside in BLM Riparian corridors. On your own, use the Raster Calculator to complete item five of the flow chart. If you need a little help... refer to the screenshot (below).



5. "BLM_Riparian" & ("Deciduous" > 60) & ("Deciduous" <= 100)

Cells with a value equal to one (1) represent broadleaf vegetation with 60% or more coverage located on BLM-managed riparian areas.

6. Turn off both the **BLM Riparian** and **Deciduous** layers.
7. On your own, change the following properties for the new raster layer.
 - *Name* = BLM Riparian Deciduous
 - *Remove Value 0*
 - *Value 1 color* = Leaf Green
 - Save the map document.
8. Turn on the **Streams** layer.



Your map now shows the distribution of deciduous plants located in BLM administered, riparian corridors.

9. Close ArcMap.

Congratulations! You have completed Exercise 1.

E. For Reference on Part 6

