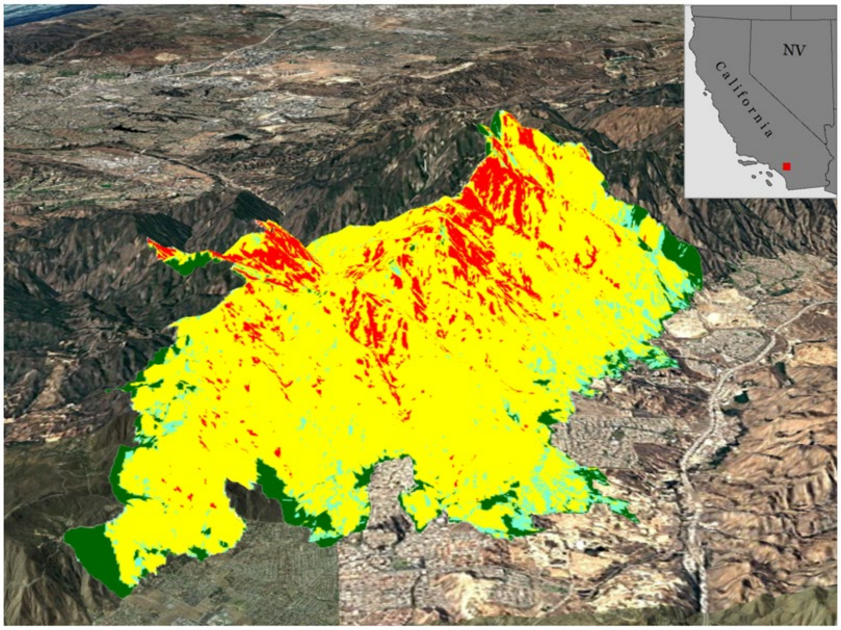
United States Department of Agriculture

Exercise 2: Editing the BARC



Software Required

- ArcGIS Pro 2.9.5 or newer

  Note: Although the specific steps in this exercise are written for ArcGIS Pro, the concepts are applicable to other GIS software platforms.

Required Data

For these exercises we will use the BARC and associated data from the **2018 Holy** fire that occurred on the Cleveland National Forest in southern California. We also have field data collected by the BAER team which we will use to modify the BARC. (Note: These data are not the actual BAER team field data. They were created for the purposes of this exercise.)

- ca3367611751620180806_20180802_s2b_refl_utm.tif (pre-fire Sentinel 2 image)
- ca3367611751620180806_20180812_s2b_refl_utm.tif (post-fire Sentinel 2 image)
- ca3367611751620180806_20180802_20180812_dnbr_barc4_cm_utm.tif (cloud-masked BARC4)
- ca3367611751620180806_20180802_20180812_dnbr_barc256_utm.tif (BARC256)
- ca3367611751620180806_20180802_20180812_dnbr_utm.tif (dNBR)
- Holy_perimeter.shp (fire perimeter)
- Holy_field_pts.shp (simulated field data collected by the BAER team, used to validate the BARC)
- Holy_field_polys.shp (simulated field data collected by the BAER team, used to fill missing data)

Overview of Major Steps

Part 1: Create an ArcGIS Pro Project

Let's get started by creating an ArcGIS Pro project and adding relevant data layers. Please make sure that the training data has been saved to your local machine. For consistency, create a folder called **BAER_workshop** on your C drive and put it in **C:\Temp**.

NOTE: *All of the exercises and data for this class should be downloaded and unzipped to C:\Temp\BAER_Workshop*

A. Create an ArcGIS Pro project (.aprx)

1. Start ArcGIS Pro.
2. Choose the "Blank Map" Template.
3. Tell ArcGIS Pro where you'd like to save your project file (.aprx).
4. Add the data layers for this exercise (all layers ***except*** for **LandOwnership, .PNG,** and the **.KMZ** files). The exercise data bundle includes more data than is listed in the required data section above. You may choose to add all the data or just those layers listed as required which will be referenced in the exercise.
   - Note that you can add multiple files simultaneously by holding down the **Control** key **(Ctrl)** while clicking on each file and selecting the ones you would like to add.

B. Enable the Spatial Analyst Extension

- If necessary, enable the **Spatial Analyst** extension:
  1. Click **Project** and then choose the **Licensing** page.
  2. Click **Configure your licensing options** (the window will take a moment to load).
  3. Place a checkmark next to Spatial Analyst listed in the Extensions dialog. (You may need to scroll to find Spatial Analyst in the list.)
  4. Click **OK** and wait for the license extension to initialize.
  5. Spatial Analyst is now enabled. Click the back button in the upper left to return to your project.

C. Save your project

1. Click the Save icon in the upper left corner of the ArcGIS Pro window.

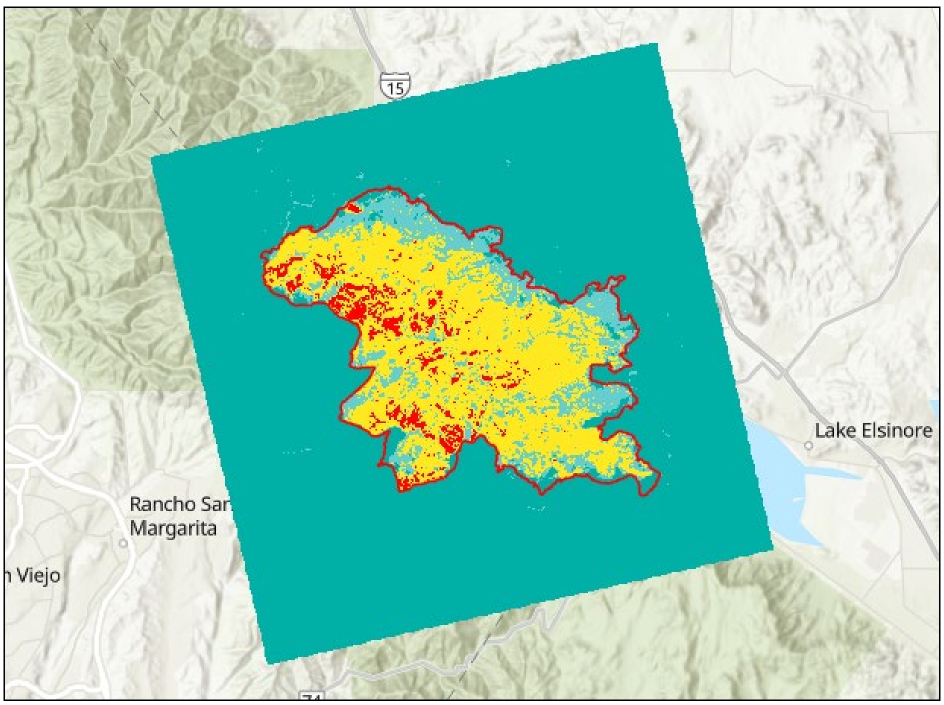
Part 2: View Data and Compare the BARC with your Burned Area Observations

Now you are ready to compare the BARC with our field observation data to decide if we need make any changes to the BARC. You can view the BARC data along with the pre- and post-fire imagery to help interpret the burned area.

A. View and symbolize layers

1. Let's change the symbology on some layers to make things easier to interpret. Let's start by unchecking the field data layers. We will get back to those later. Symbolize the fire perimeter (Holy_perimeter) as an outline by right clicking on the layer in the contents pane and choosing the **Symbology** option. Click the colored square next to **Symbol**, and then choose the **black outline** option from the **Gallery** tab of **Symbology** pane.

   (Optional) If desired, click on the **Properties** tab of the **Symbology** pane and modify the outline color and/or line thickness. When finished, click on the **Apply** button at the bottom of the **Symbology** pane to apply the changes.



2. Review the colors for the BARC4 and BARC256. As of the 2023 fire season, the color scheme has been modified to improve visibility for those with common color vision deficiencies ("colorblind"). The BARC4 has four severity classes, plus a "Mask" class, as shown and described in the following table:

Value	Class	Color Description	Color	RGB Triplet	Hex Color
1	Unburned/Very Low	Teal		0, 175, 166	00AFA6
2	Low	Light blue		102, 205, 205	66CDCD
3	Moderate	Dark yellow		255, 232, 32	FFE820
4	High	Red		255, 0, 0	FF0000
5	Mask	White		255, 255, 255	FFFFFF

- The BARC256 uses the same colors as the BARC4 but has 255 classes. We will modify the BARC256 by adjusting the breakpoints applied to each burn severity class. Toggle the BARC4 and BARC256 and observe the differences. Note the differences here:

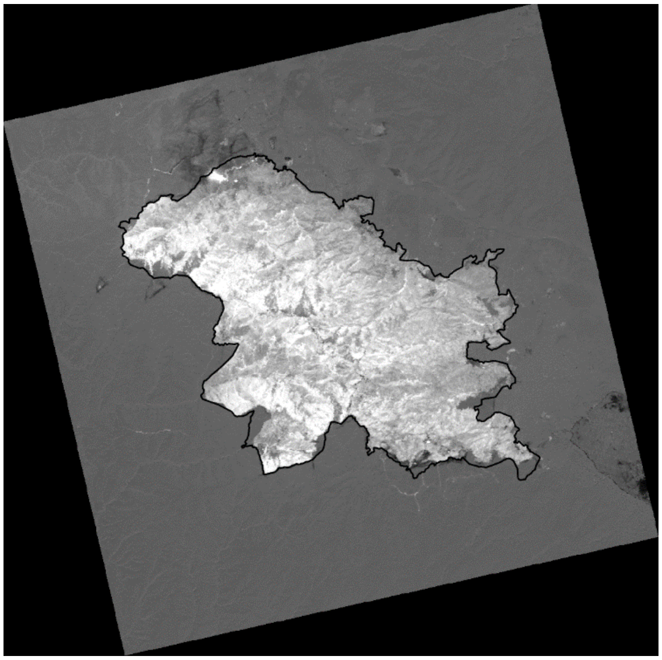
  ____

- Notice the masked area along the northern edge of the burned area. Why do you think this area was masked?

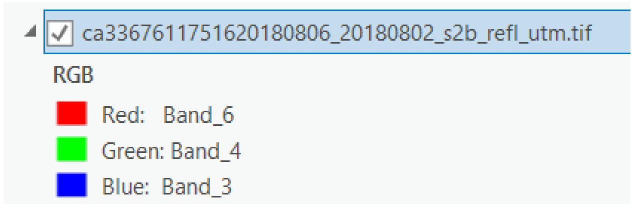
  ____

3. Now turn off the BARC layers and look at the **dNBR**. The dNBR is the difference between the pre-fire and post-fire Normalized Burn Ratio (NBR). The higher values represent higher burn severity. It may be difficult to interpret this image by default, so let's stretch it. To do this, right click on the layer and choose the **Symbology** option. On the **Symbology** pane, change the Stretch Type to **Standard Deviations**. Experiment with changing the numeric value for the degree of stretch (standard deviations). In the figure below, the number of standard deviations is 3. Can you see the areas with the highest burn severity? What range of values do they have?

   ____



4. Next, turn off the dNBR and review **the Sentinel-2 imagery**. This image includes 6 different bands, all at 20m resolution. ArcGIS Pro will display up to three bands simultaneously, one for each of the display channels (red, green, blue). You can change the layer order to improve the visualization. You can also select which bands of the image are displayed as **red, green, or blue** values in the contents pane underneath the layer. Experiment with different combinations. The true color band combination is Band 3 for red, Band 2 for green, Band 1 for blue. You can also change the stretch to **Standard Deviation** as in the previous step by selecting the image, navigating to the **Symbology tab**, clicking the drop-down menu for **Stretch Type**, and choosing the **Standard Deviation** option. For this exercise you should display **Band 6 for red, Band 4 for green, and band 3 for Blue** (SWIR, NIR, red).



5. Now, let's symbolize our field data. Right click **Holy_field_pts** and select **Symbology** from the pop-up menu.
6. Under **Primary Symbology**, select **Unique Values**.
7. Under **Field 1** select **Soil_BS** from the drop-down menu.
8. At the top of the **Classes** tab in the lower portion of the **Symobology** pane, click the **Add All Values** button. 
9. You may want to increase the size of the symbols so they are more visible on your map.
10. Symbolize each of the points with colors to roughly match the four Burn Severity classes used in the BARC. To match the exact colors, right-click on the symbol, choose **Color Properties…**, and set the RGB or hex values as shown in the table above. (If you have a layer with the desired colors visible (i.e. **BARC256** or **BARC4**), the **Eyedropper** is a convenient alternative.

    (*Recommended*) After setting each value, right-click on the symbol again. Choose **Color Properties…** to open the **Color Editor** window. With the correct color chosen, click **Save color to style…** to open the **Save Color As** window. Type a name for the color based on the soil burn severity class (i.e. Unburned/Low, Low, Moderate, High). Make sure the **Style** is set to **Favorites** and click **OK**. The color will now be available at the top of the color palette.

B. Visually compare the BARC and the field data points

1. Using the **BARC256** layer as the background, visually inspect the locations where the GPS points fall.
    - Zoom in and pan around your GPS points to get a feel for how the BARC and the field observations compare to one another.
    - Be sure to zoom in closer than 1:5000 so you can see the BARC256 values; this will help you develop a sense of where the break points are.

- Do all of the field samples match the BARC data? ____ yes _____ no. If they do, we can use the BARC as is and treat it as a field-validated Soil Burn Severity dataset. If not, we need to modify it as described in Part 3 below.

C. Extract BARC values to the field data points

1. To investigate the relationship of the BARC data to the field data points more accurately, let's extract the BARC values to those same points.
2. Under the Analysis tab, click Tools to open the GeoProcessing Tab.
3. Search for the **Extract Multi Values to Points** tool. Or open it from the **Spatial Analyst** toolbox under **Spatial Analyst Tools > Extraction > Extract Multi Values to Points**.
4. For the Input point features, use the **Holy_field_pts** layer and for the input raster, use the **BARC256**.
5. Change the **Output field name** to '*BARC256*'.
6. Click **Run**. The values will be added as a new field to the GPS data points.

Part 3: Adjust the BARC256 to Match Field Conditions (when/if necessary)

The **BARC256** has 256 classes with values of 0-255. We first create the BARC256 at GTAC and then create the BARC4 based on the analyst's expert opinion of where s/he thinks the breakpoints should occur. This is the first approximation of burn severity, but the BAER team will often modify the BARC based on their own field sampling and reconnaissance. This exercise shows you how to modify the BARC256 to create a final soil burn severity, based on field sampling data.

A. Adjust the BARC 256 to match field observations

1. Right-click the **BARC256** layer and select **Symbology** from the pop-up menu.
2. Scroll through the values and observe where the colors change. These represent the breakpoints or thresholds for the different burn severity classes. Find the **existing** breakpoints between classes and **write them down**. They should match the following:
   - 0-77 = unburned/very low (teal)
   - 78-122 = low (light blue)
   - 123-191 = moderate (yellow)
   - 192-255 = high (red)
3. The **Holy_field_pts** layer contains field-collected soil burn severity based on the BAER team's observations. It also now has the extracted BARC256 values at those points. Open the **Attribute table** and sort on the **BARC256** field. Now look at the **Soil_BS** field and compare it with the BARC values.
   - How well do the BARC values align with the field sampled observations? Note: Lower BARC values correspond to lower burn severity.
   - Try to identify natural breakpoints for where to set the new class threshold values. In some cases, there may be a range of breakpoints that you can choose. Just choose one that makes sense.

- Once you have identified the new breakpoints, write them down and go on to the next step.

4. Now let's change the colors of the BARC256 based on the breakpoints identified above. To change the symbol color, change the **Primary Symbology** of the BARC256 layer to **Unique Values** and click on the color swatch for the value that you want to adjust. You can then modify the value to display as the appropriate color. (*Optional*: To modify multiple values at the same time, click on the value and then hold the **Shift** key while clicking on a second value. With multiple values selected, **Right Click** on the color swatch for one of the selected values and choose **Format Symbol**.)

- The BARC256 colors should now match the colors of the field-collected GPS points. Review to see how well they match. In most cases, it will not be a perfect fit with all the GPS points**,** so the goal is to match as many as possible for the best possible fit based on the data. For this example, the data fall into very discrete classes without any outliers. However, that is not always the case.

Why can't I just adjust the BARC4? *The BARC4 cannot be edited since the dnbr values have already been classified into four classes. Instead, we use the BARC256 to make any adjustments.* Sometimes the BARC4 is ready to go as-is, without any further editing. This is more common in densely forested ecosystems since the ground fuels in such areas are sufficient that if the canopy is consumed and black sticks remain, usually the Soil Burn Severity is high as well.

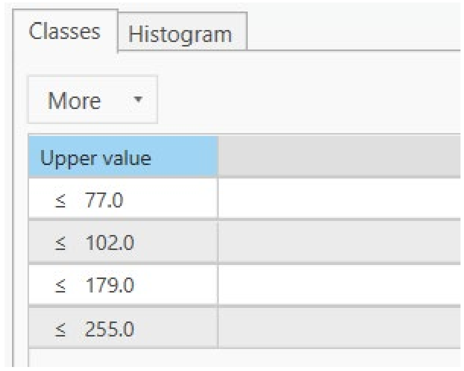
Part 4: Reclassify the adjusted BARC 256

Once you are satisfied with your new breakpoints in the BARC256 we need to create a new product that will represent the final soil burn severity of the fire.

A. Reclassify the adjusted BARC256 to a four-class Soil Burn Severity

1. Using the breakpoints that you identified in the previous step, we will now permanently modify the BARC256. We do this through a **reclass** of the BARC.
2. Check to confirm that your breakpoints are close to the ones identified below:
   - 0-77 = Unburned/Very low
   - 78-102 = Low
   - 103-179 = Moderate
   - 180-255 = High
3. Under Analysis, open the Geoprocessing Tools pane and find the **Reclass** toolset under **Spatial Analyst Tools**.
4. Open the **Reclassify** tool.
5. Set the **Input Raster** to the BARC256 layer.
6. Set the **Reclass Field** to **Value**.
7. Click the **Classify** button.
8. Set the Number of **Classes** to **4**. If this option is grayed out, set the method to **equal interval**.

9. Change the **Upper Values** to the BARC breakpoints you determined. You do this by clicking on the number and then modifying it. Keep 255 if it already exists. 255 should always be the highest value. Your **Classify** window should look like the screenshot at right, but with your custom breakpoints that you chose from the previous step. Click OK to close the pop-up window.



10. Let's also clip out the SBS based on the fire perimeter. To do this we go into the environment settings which are accessed via the reclassify tool.
    - At the top of the reclassify window, click the **Environments** tab in the Geoprocessing pane. This will open the **Environments Settings** window. Under the **Raster analysis** tab, select **Holy_perimeter** as the **Mask** input, and the **BARC256** as the **Snap Raster**.
11. Return to the **Parameters** tab, set the **Output Raster** to save to a folder outside of the project geodatabase, name it **holy_sbs_temp.tif**, and click **Save**. We are calling this "temp" because we know we have more editing to do and we will replace this layer at a later stage. If you don't have additional field edits to incorporate, you could use this as the final SBS.
12. Leave the box **Change missing values to NoData** in the **Reclassify** dialog unchecked.
13. Click **Run** to reclassify your BARC.
14. Before proceeding to the next step, open your newly reclassified raster layer and **symbolize** it with the standard color scheme to make sure that everything looks ok, and to confirm that the process was successful. Also, view the GPS points over this new layer. You should now see **better alignment** between the GPS field points and the SBS layer.

The above steps produce a new 4-class raster with your adjustments that represents Soil Burn Severity. The new grid is also clipped to the fire perimeter.

Part 5: Fill in Missing Data/Make Additional Field Edits

We now have a temporary Soil Burn Severity layer but we also need to fill in a few data gaps. These gaps were created in the BARC because there were areas of active fire in the imagery, which are often misclassified as high severity. The analyst therefore assigned a value of no-data to those areas, but we want to fill them in for the final SBS. For this example, a polygon layer called **Holy_field_polys** will be used to provide the missing information for the largest holes. We will fill in the smaller holes based on surrounding values. As with most GIS operations, there are multiple ways to accomplish the same task. We will show you one of those ways in this exercise.

A. Convert the SBS layer from raster to vector (polygons)

The first step before doing any further editing is to convert the raster data to vector format. It is much easier to edit in this format.

1. Open the **Geoprocessing Pane** and find the **Conversion Tools | From Raster** toolset.

2. Open the **Raster to Polygon** tool.
3. Set the **Input raster** to the temporary **SBS layer** you just created.
4. Set the **Field** to **Value**.
5. Set the **Output polygon features** to **Holy_SBS_poly**.
6. **Uncheck** the **Simplify polygons** box (checking this box will distort the output more than is acceptable for this application).
7. Click **Run** to perform the conversion (the new layer is automatically added to your map).

B. Symbolize the new vector layer

1. Right click on the new layer and go to **Symbology** in the pop-up.
2. In the Symbology pane, select **Unique Values** under the Primary Symbology menu.
3. In the **Field 1** dropdown, select **gridcode**.
4. Right-click on each class symbol in the list and choose the corresponding severity class color for each polygon class.
5. Turn off the outline color for all symbols at one time by opening the **More** menu at the top right of the **Classes** tab on the **Symobology** pane. Choose **Format all symbols**. Choose **Properties** at the top of the **Symbology** pane. Open the drop-down for the **Outline Color** and choose **No Color**. Click **Apply** at the bottom of the pane to apply the changes.

C. Add Vector edits from the field

1. Add the **Holy_field_polys** shapefile to your map.
   - This file represents field mapping done by BAER team members in areas of known missing data. Everything within a given polygon in this layer will be given the corresponding value in our modified SBS.
2. Under the Analysis Toolbox, look in the Overlay category, and choose the **Update** tool.
   - Select **Holy_SBS_Poly** as the **Input Features** to update. This is the layer to which you want to add data.
   - Choose the **Holy_field_polys** layer as the **Update Feature**. These are our field edits.
   - Set the **Output Feature Class** to **Holy_SBS_poly_filled** and don't uncheck the borders box**.**
3. Click **Run** to perform the Update. The new layer should be automatically added to the map. You may see that the new layer is added with the same symbology set for the original **Holy_SBS_Poly** layer.
4. You should see that the polygon geometries from the field-based layer (**Holy_field_polys**) were superimposed on top of the SBS layer. However, no attributes were assigned to the geometries. The new polygons may be displayed with the color set as **<all other values>** by default.

D. Update the attribute fields to reflect the appropriate severity

1. Open the attribute table of **Holy_SBS_poly_filled.shp** and examine it. You should see a **GRIDCODE** field with all the original burn severity values. Sort on this field. You will now see several records with a value of 0. These are all areas that had no data assigned to them. We can now manually enter the correct burn severity class in that field.

2. Update the **GRIDCODE** field to properly reflect the field edits. You can do this in several ways. For those areas where we have field data, use the value in the **SBS** field in the **Holy_field_polys** layer.
3. Turn on labels for the **SBS** field on the **Holy_field_polys** layer by selecting the layer in the **Contents** pane, and click the **Labeling** menu on the ribbon menu. Make sure the **SBS** field is selected for the **Field** in the **Label Class** section of the **Labeling** menu in the ribbon. Then click the **Label** button on the far left side of the ribbon to enable labeling.
4. We do not have field data for all of the missing data holes. Therefore, manually visit each of these polygons and enter the burn severity class based on the surrounding values. To do this:
   - In the attribute table, right click on each GRIDCODE = 0 value and click Zoom to selected.
   - View the data gap and the surrounding polygons. Manually change the value of 0 to the appropriate class based on the majority value of the surrounding polygons (1, 2, 3, or 4).
   - Once you have given all the 0 gridcode polygons a severity classification value, this step is complete. Go to the Edit tab and click the Save button to finalize these edits. If prompted to Save all edits?, choose Yes.
5. Be sure to clear any selected polygons before proceeding with the next section. In the **Edit** menu in the ribbon, press the **Clear** button in the **Selection** section on the ribbon.

Part 6: Create the Final SBS in Raster Format

You now have an SBS layer with all of the holes filled in. You can certainly use the data in this format, but for archiving and distribution we prefer to have a TIFF format, so let's convert it to back to a raster.

A. Convert the final Soil Burn Severity layer to a Raster

1. Open the **Geoprocessing Pane** and find the **Conversion Tools | To Raster** toolset or search for **Feature to Raster** in the search tab.
2. Set the **Input Features** to **Holy_SBS_poly_filled** feature.
3. Set the **Value Field to** GRIDCODE.
4. Set the **Output Raster** to **Holy_sbs_final.tif**
5. Set the output resolution to match the Holy_SBS_Temp raster that you already created. This is 20m, which is the resolution of our original imagery. (Note: This information is available in the layer properties in the **Raster Information** section under the **Source** property.)
6. Under the **Environments** tab, set the **Snap Raster** to any of the original BARC raster layers in your map. This will ensure the output aligns with the original data.
7. Click **Run** to perform the conversion. **Open** your raster layer, **symbolize** it with the same colors that we've been using and make sure that it looks correct. You are now finished with the SBS layer! Next, we will create simple metadata for it and then it will be ready to **send to GTAC for archiving and distribution.**

The above steps produce a final 4-class raster with all of the field edits integrated. This is the field-validated soil burn severity that should be used in all analyses and that will be shared with the public. It is therefore important that it gets submitted to GTAC for distribution.

Part 7: Create Metadata and Make the SBS Data Available to Others

The final step is to provide the SBS data back to GTAC for distribution and archiving. To do that, first we will document some basic details about how we modified the BARC256 to create the SBS.

A. Create Soil Burn Severity Metadata

1. Using Windows Explorer, navigate to the **data** folder in the training resources. (C:\Temp\BAER_Workshop\data)
2. Notice there are two metadata docs in the data folder. One is for the BARC and other products that were created for the BAER team. This file is called ca3367611751620180806_20180812_20180812_metadata_utm.xml. There is also a second metadata file with **SBS** in the name. This is the file that the BAER team will fill out and return to GTAC with the SBS.
3. Open the text file **ca3367611751620180806_20180802_20180812_SBS_metadata.txt** with a text editor.
4. Review the fields to see what information is requested. Populate the fields that are applicable to this exercise.
   - Provide the name of the fire and a short description of the product (make sure to include soil burn severity).
   - Provide contact names (you can use made-up names for this section).
   - Provide the updated SBS thresholds.
   - Indicate if systematic or manual edits, or both, were applied. Systematic edits refers to adjusting the threshold values for the entire fire. Manual edits refers to modifying portions of the SBS only, such as when we performed the update features geoprocessing tool to incorporate the edits shapefile.
   - Provide a brief narrative describing how the thresholds were adjusted. Include info on how the data were collected, if possible (with a GPS, a phone, etc.).
   - Add additional comments if desired. This might reference some caveats with the data such as “snow was present when the field work was completed”, or “limited areas were field validated due to inaccessible terrain.“
5. For an actual BAER assessment, the BAER team would post the final Soil Burn Severity dataset and metadata to the T-drive for GTAC. Please don’t do this step for this exercise, but the location is provided for your reference:
   - T:\FS\NFS\WOEngineering\GMO-RSAC\RDAS\BAER_FINAL_SoilBurnSeverity
6. The final step would be to notify GTAC by email (SM.FS.baerimagery@usda.gov) that the SBS has been posted to the T drive.

Congratulations! You have successfully completed this exercise.