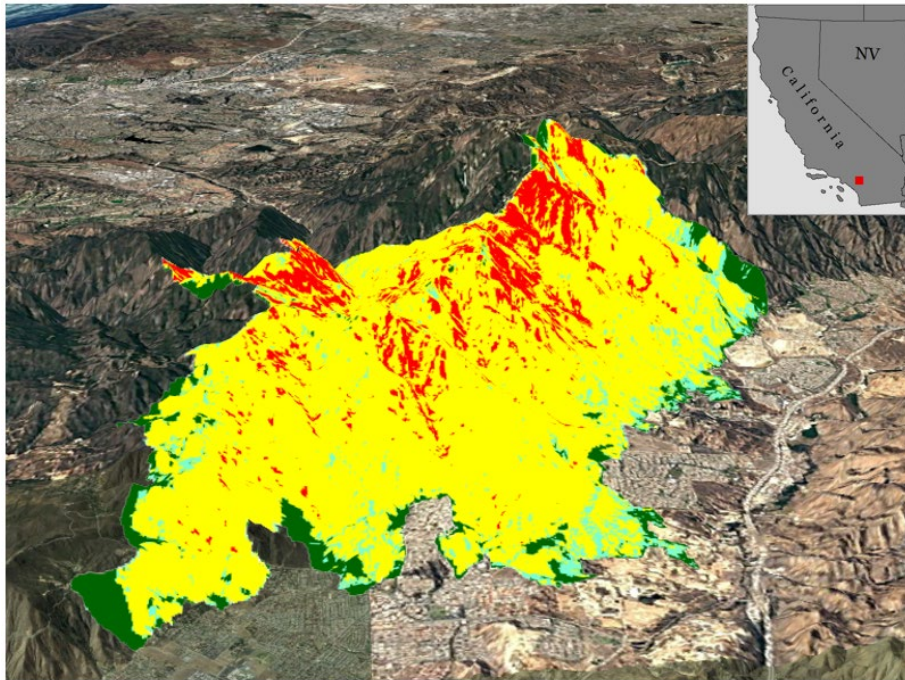


## Exercise 2: Editing the BARC



### Software Required

- ArcGIS 10.x with the Spatial Analyst extension

### Required Data

For these exercises we will use BARC 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\_bar4\_cm\_utm.tif (BARC4 cloud masked)
- ca3367611751620180806\_20180802\_20180812\_dnbr\_bar256\_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

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## Part 1: Create an ArcMap Project

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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**.

Let's get started by opening ArcMap, loading up the relevant data layers and creating a project.

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

### A. Create an ArcMap project (mxd)

1. Start ArcMap
2. Add the data layers for this exercise. That should be all **except** for **LandOwnership**
  - 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.
1. If you are unable to find these data files you may need to connect to the Training Data folder in ArcMap.
  - ◆ Click the Connect to Folder button.
  - ◆ Navigate to C:\Temp\BAER\_Workshop
  - ◆ Click **OK**. Now select the data sets from step 1.

### B. Enable the Spatial Analyst Extension

1. If necessary, enable the **Spatial Analyst** extension:
  - Click **Customize | Extensions...** from ArcMap's main menu.
  - Place a checkmark next to **Spatial Analyst** listed in the **Extensions** dialog.
  - Click Close to dismiss the **Extensions** dialog.

### C. Save your project now

1. Save as **Holy\_SBS\_training** to the BAER\_workshop folder.

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

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Now you are ready to proceed. First, let's look at our data. Compare the BARC4 and the BARC256 with our field observation data to decide if we need to do any editing at all. You can view the BARC data along with the pre and post-fire imagery as well, to help interpret the burned area.

### A. View and Symbolize layers

1. Let's view our data and symbolize to make things easier to interpret. Let's start by unchecking the field data layers. We will get back to those later. Make the fire perimeter hollow by clicking on the symbol (color) under this layer in the **Table of Contents**. Choose **Hollow** from the Symbol Selector, select **Black** (or another color) as your Outline Color and **2** for the Outline Width. Click **OK** to close.
2. Review the colors for the BARC4 and BARC256. The BARC4 only has four classes and should be color-coded as follows:
  - Value 1 = Unburned/Very Low (**Fir Green**)
  - Value 2 = Low (**Tourmaline Green**)
  - Value 3 = Moderate (**Solar Yellow**)
  - Value 4 = High (**Mars Red**)
  - i. The BARC25 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:
 

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  - ii. Notice the masked area along the northern edge of the burned area. Why do you think this area was masked out? \_\_\_\_\_
  - iii. We won't use the BARC4 any further in this example, so you can remove it from the map now.
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. 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 you double click the layer, open the **Symbology** tab and change the Stretch Type to **Standard Deviations**. Experiment with changing the numeric value for the degree of stretch. For this example, I chose a standard deviation of 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 let's review **the Sentinel 2 imagery**. This image includes 6 different bands, all at 20m resolution. ArcMap will display up to three bands simultaneously, one for each of the display channels (red, green, blue). Let's change the layer order to make the image look better. You do this by double-clicking the layer, clicking the **Symbology** tab and changing the band combination. Experiment with different combinations. You can also change the stretch to **Standard Deviation** like in the previous step. Let's use the combination **6,4,3** for this example (SWIR, NIR, red).
5. Now, let's symbolize our field data. Right click **Holy\_field\_pts.shp** and select **Properties...** from the pop-up menu.
6. Select the **Symbology** tab in the **Layer Properties** dialog. Then select **Categories** and **Unique Values** in the **Show** column.
7. In the **Value Field** select **Soil\_BS** from the drop-down menu.
8. Click the **Add All Values** button in the **Symbology** tab
9. Symbolize each of the points with colors to match the four Burn Severity classes used in the BARC. Make the symbols large enough to easily view in your map.
10. Click **Apply** and **OK** in the **Layer Properties** dialog when finished symbolizing **Holy\_field\_pts.shp**.

## B. Visually compare the BARC and the field data points

1. Using the **BARC256** layer, visually inspect the locations where the GPS points fall.
  - i. Zoom in and pan around where your GPS points are located to get a feel for how the BARC and the field observations compare to one another.
  - ii. 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.
  - iii. 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. In order to more accurately investigate the relationship of the BARC data to the field data points, let's extract the BARC values to those same points.
2. Open the **Extract Multi Values to Points** tool, either by searching for it, or opening it from the **Spatial Analyst/Extraction** toolset.
3. For the Input point features, use the **Holy\_field\_pts** layer and for the raster layer, use the **BARC256**.
4. Change the **Output field name** to '**BARC256**'.
5. Click **OK**. 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)

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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 **Properties** from the pop-up menu.
2. Select the **Symbolology** tab in the **Layer Properties** dialog. Then select **Unique Values** in the **Show** column.
3. Using the **<Value>** column, 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.
  - 78-122 = low.
  - 123-191 = moderate.
  - 192-255 = high.

4. 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 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.
5. Now let's change the colors of the BARC256 based on the breakpoints identified above. To change the symbol color, expand the full symbology of the BARC256 layer and right click on the value that you want to adjust. You can then select the color from the pop-up window. Alternatively, you can double click on the BARC256 layer to bring up the properties window.
  - 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 actually fall into very discrete classes without any outliers. That is not always the case, however.



**Why can't I just adjust the BARC4?** The BARC4 cannot be edited since the dnbr values have already been classified into four classes. As a result, we have to 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. Open **ArcToolbox** and expand the **Spatial Analyst Tools | Reclass** toolset.
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 **Break 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.
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.
  - i. At the bottom of the reclassify window, click the **Environments** tab. This will open the **Environments Settings** window. Now, open the **Raster analysis** tab. Under **Mask**, select **Holy\_perimeter.shp** and click ok.
11. Set the **Output Raster** to **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. Be sure to add the **'.tif'** extension to make the output a TIFF.
13. Click **Save** on the Output Raster dialog.
14. Leave the box **Change missing values to NoData** in the **Reclassify** dialog unchecked.
15. Click **OK** in the **Reclassify** dialog to reclassify your BARC.
16. 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 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 by GTAC when we created the BARC because there were still areas of active fire in the imagery and those areas tend to be misclassified as high severity when often they are not. We therefore assign a value of no-data to them, but for the final SBS, we want to fill them in. For this example, a polygon layer called **Holy\_field\_polys** will be used to provide the missing information for the largest holes. The other smaller holes we will fill in based on surrounding values. As with any GIS operation, there are multiple ways to accomplish the same task. We will show you just 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 **ArcToolbox** and expand 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.shp** and click **Save**.
6. **Uncheck** the **Simplify polygons** box (checking this box will distort the output more than is acceptable for this application).
7. Click **OK** 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 **Properties** in the pop-up.
2. Select the **Symbolology** tab in the **Layer Properties** dialog. Then select **Categories** and **Unique Values** in the **Show** column.
3. In the **Value Field** drop down select '**GRIDCODE**'.
4. Right-click on the symbol in the list and choose **Properties for All Symbols...** For the **Outline Color** choose '**No Color.**' Click **OK**. This step removes the border lines between severity classes.
5. Click the **Add All Values** button and adjust the colors to reflect the 4 severity classes.
6. Click **OK** to close the **Properties** window

## C. Add Vector edits from the field

1. Add the **Holy\_field\_polys** shapefile to your ArcMap document.
  - 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. Go to the Search toolbar and type **Update**. Update is a function available in the Analysis toolset of ArcToolbox as part of the Overlay functions.
  - Select the **Input Features** to update. This is the layer to which you want to add data (the SBS).
  - Now select the layer that contains the update features. These are our field edits.
  - Set the **Output Feature Class** to **Holy\_SBS\_poly\_filled.shp** and click **Save (don't uncheck the borders box)**.
3. Click **OK** to perform the Update. Open the new layer and view it. You should see that the polygon geometries from the mask\_fill layer were superimposed on top of the SBS layer. However, no attributes were assigned to the geometries, so we will do that in the next step.

## 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 SBS in the **Holy\_field\_polys** layer. Remember that you need to start an editing session first, then you can change the values of individual polygons.



3. 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).
  - Repeat for each of the remaining 0 values until they all have a burn severity assigned to them.
  - Once you have given all of the polygons a non-zero value, you are complete with this step. Stop the editing session and move to the next part of the exercise.

## Part 6: Create the Final SBS in Raster Format

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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 **ArcToolbox** and expand 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.shp**.
3. Set the **Value Field** to **GRIDCODE**.
4. Set the **Output Raster** to **Holy\_sbs\_final.tif** (be sure to use the extension). Be sure to set the output resolution to 20m since this was the resolution of our original imagery.
5. Click **OK** 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 your field edits integrated that represents field-validated soil burn severity. This is the product that should be used in all analyses and also 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

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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 Training\_Data folder (C:\Temp\BAER\_Workshop\Training\_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.txt. 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.
  - i. Provide the name of the fire and a short description of the product (make sure to include soil burn severity)
  - ii. Provide contact names (you can use made-up names for this section)
  - iii. Provide the updated SBS thresholds
  - iv. 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 a union to incorporate the edits shapefile.
  - v. 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.).
  - vi. 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. The BAER team would post the Soil Burn Severity and metadata to the T-drive for GTAC. You do not need to do this step 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 that the SBS has been posted to the T drive. You do not need to do that now, but for reference, you would email: [carl.albury@usda.gov](mailto:carl.albury@usda.gov) or [SM.FS.baerimagery@usda.gov](mailto:SM.FS.baerimagery@usda.gov)

**Congratulations!** You have successfully completed this exercise.