Lab 7– Postfire Mapping and Analysis

Your Mission: As part of your analysis of the Pioneer fire, you have been asked to create an initial BARC map of burn severity. This information will be used to determine if management actions should be taken to prevent erosion or decrease the spread of invasive species among other things. In this lab, you will learn how to acquire Landsat imagery and convert that into a severity map known as dNBR and adjust the values to create a classified BARC map that can be ground-validated by the BAER team. You will also compare what you create to a BARC map created by RSAC and use this BARC map to see if there are fire severity trends when compared with existing vegetation type.

7.1. Optional - Download Landsat Imagery (data is available, but this step will be useful if you plan on using post-fire data in your final project)

a. Create an account
    a. Go to https://earthexplorer.usgs.gov
    b. Click **Register** and create a username and password (read the password directions, it is really picky). Answer the registration questions. Note that *Fire science/management* is one of the secondary usage options. If you are unsure of your organization, you can enter the University of Idaho.

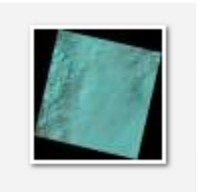
The fire we are interested in, burned from July 3, 2016, to September 26, 2016, in the Boise National Forest. To calculate dNBR, we need both a pre-fire and post-fire image that are not obstructed by clouds. When the USFS creates burn severity maps, they also try to find scenes that are anniversary dates, meaning that they were acquired on or as close to the same date as possible in successive years. For fires that burned over a short period, it may be acceptable to compare a pre-fire image to a post-fire image in the same year since the general vegetation has not changed much. For longer duration fires the difference between pre-fire and post-fire vegetation have an impact on the dNBR values since seasonal changes in the vegetation may be interpreted as changes caused by the fire. In this case, it may be better to look for a pre-fire image from a previous year at around the same date. Several pre-fire and post-fire comparisons may need to be made depending on the length of the fire. Determining which Landsat scenes to use for burn severity mapping is often the most time-consuming part of the process. For this lab, we are keeping it simple by just selecting the best cloud-free day before the fire and after the fire.

Landsat scenes are spatially located by path and row on the WRS-2 grid. The path/row location for this fire will be path 41 and row 29. The highest quality cloud free pre-fire and post-fire images were acquired on June 22, 2016, and September 26, 2016, respectively.

b. Enter search criteria. – There are several ways you can select an area within which to search for data. The same functions used to scroll up and down on a

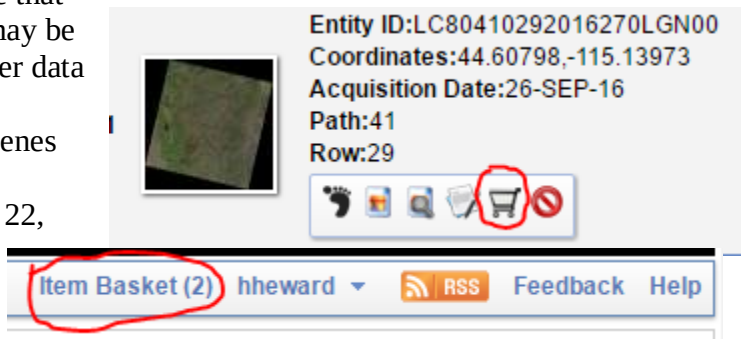
page allow you to zoom in and out on the map: up and down arrows, plus and minus keys, and sliding two fingers on your mouse pad.

a. Select *Path/Row* – If you know your Latitude and Longitude, you can look up your path and row (https://landsat.usgs.gov/wrs-2-pathrow-latitudelongitude-converter). By selecting the data this way, you get one entire scene. Fires frequently overlap two different scenes, in which case you need to download both.
   i. *Path* – **41**
   ii. *Row* - **29**
   iii. Select **Show** - this will zoom into the area where the fire burned in central Idaho



b. *Date Range* – From **06/22/2016** To **09/26/2016** – these have been determined to be the most cloud-free days before and after the fire
c. Click **Data Sets**

c. Click on *Landsat >Landsat Collection 1 Level 1* > **Landsat 8 OLI/TIRS Level 1**. These data have already been calibrated and atmospherically corrected, and therefore are ready for use in ArcMap. More information about the Landsat Level 1 product can be found: https://landsat.usgs.gov/landsat-level-1-standard-data-products
d. Click **Additional Criteria** – notice here that you can set levels of cloud cover, this may be useful if you are going to download other data from this site.
e. Click **Results**- Notice that it pulls all scenes available for the time period specified.
f. Click on the shopping cart for and June 22, 2016, and Sept. 26, 2016
g. Click on your **Item Basket** in the upper right.
h. Click **Proceed to Checkout** and **Submit Order.**



You will receive an e-mail notifying you that your order has been placed. Another e-mail will come when USGS begins processing the order, and finally the third e-mail when the order has been processed. The third e-mail will come when your order is ready with a link to access your data for downloading. ***Note***: depending on how much data USGS is serving up or if their servers are down for maintenance (often this is the case on weekends), it can take several hours or more to receive your data download link.

START HERE – if you did not download the data

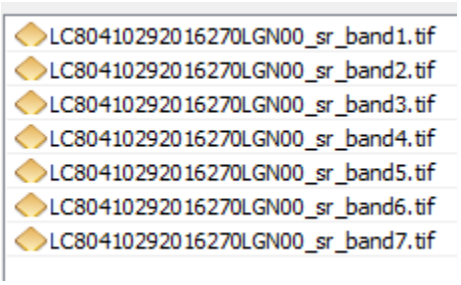
a. In your Lesson_7 folder create a folder for **Prefire_Imagery** and **Postfire_Imagery**
b. Download the three data files from Bblearn or USGS and save them in their respective folders.

    a. Prefire - Ex. LC80410292016**174**-SC20170303150622.tar.gz – 174 is the Julian day, the characters following the Julian day may be different for you. You can find the Julian day on this site https://landweb.modaps.eosdis.nasa.gov/browse/calendar.html
    b. Postfire – Ex. LC80410292016**270**-SC20170303145953.tar.gz
    c. Rapid fire perimeter can go in the main Lesson_7 folder
c. Both .tar.gz files will need to be unzipped twice (.tar.gz -> .tar -> files to use in ArcMap).
    a. For unzipping files, I recommend using 7zip http://www.7-zip.org/download.html. *I find that downloading WinZip installs many unwanted programs and hijacks my computer settings.*
    b. To extract, right click on the .tar.gz file >> 7-zip >> Extract Here
    c. Repeat with the .tar file.

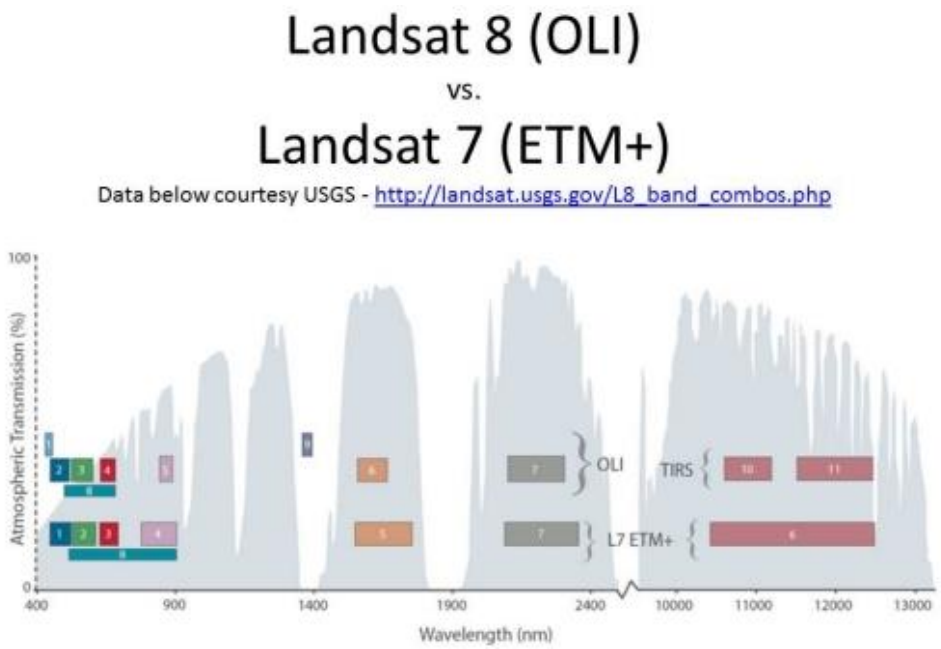
After unzipping the data, the pre and post-fire folders should contain ten .tif image files each. These individual bands each represent the wavelengths for a portion of the electromagnetic spectrum; most are light that is reflected off the Earth surface, and the thermal bands are essentially heat energy emitted from the Earth surface. Various combinations of these bands will show us different things. The reflectance bands we will be using for this exercise are the images in the near infrared and shortwave infrared bands (labeled sr_band5 and sr_band7). The data are packaged as 16-bit signed integers with valid pixel values ranging between 0 and 10000 (it is perfectly ok if you do not fully understand this, but feel free to read up more on Landsat if you are interested).

7.2.Creating a multi-band GeoTIFF from individual files

The individual files will be used for the calculation of dNBR, but it is also important to be able to manipulate the way the combination of bands is displayed so that you can get a better idea of what each of the bands represents.

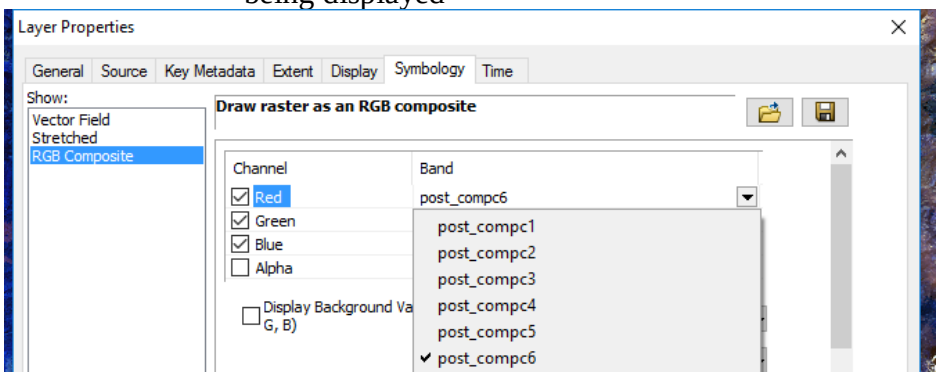


a. Add all seven **post-fire** bands
b. In ArcToolbox go to *Data Management Tools >>Raster>>Raster Processing>>***Composite Bands**
c. Select all 7 bands for prefire – **They must be entered in order as shown**. If not you will not be able to get the right color combinations.
d. Name the output file post_comp (must be shorter than 13 characters)
e. Running ArcGIS 10.4 or higher? When you save the composite image, type ".tif" at the end of the composite file name. Ex. post_comp.tif.
f. Click **OK**



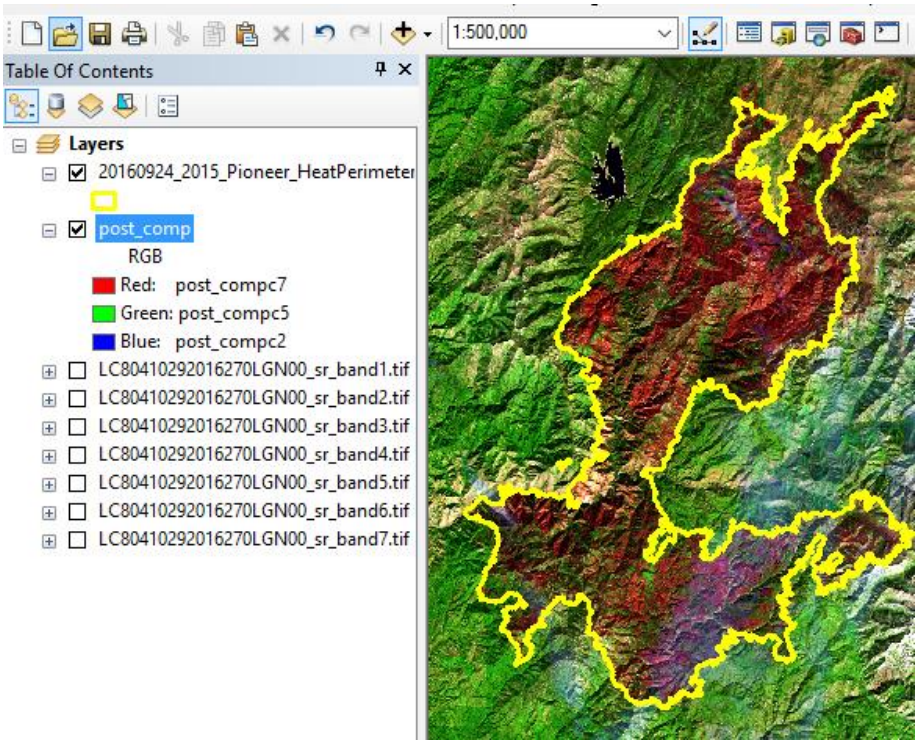
Referencing the figure above for Landsat 8 (OLI) we want to display band 4, 3, 2 to view what we would normally see on the landscape. Display 7, 5, 2 for false color that is especially good for viewing burned areas. There are many other band combinations, each suited to exemplify different land features.

a. Click on *Properties* and select *Symbology*
b. Use the dropdown arrow next to the Band to select a different band being displayed



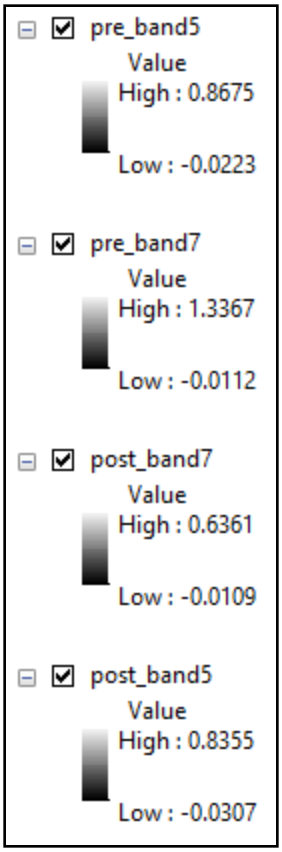
c. Add the final fire perimeter (9/24/2016) from the Lab_7_data for the Pioneer fire and change the symbology so it is hollow and a visible color
d. Zoom into the fire area and take a screen capture
e. Running 10.4? If your image does not look like the example below just take a screen capture of what you have

Question 1: Submit a screen capture of the display for bands 7,5,2 including the final fire perimeter of the Pioneer fire and the table of contents.



7.3.Convert Landsat image floating point and apply scaling factor

a. Add the pre-fire bands
b. Go to *Spatial Analyst >> Map Algebra >>***Raster Calculator**
c. Convert and apply scaling factor to Band 5 and 7 for pre and post-fire
    a. Double click on the band ex. "LC80410292016174LGN00_sr_band7.tif"
    b. Click "*"
    c. Enter 0.0001
    d. Save in the lesson 7 folder, named ex. **pre_band7**
    e. Repeat with pre-fire band 5 and then post-fire band 5 and 7. Distribution should roughly match those to the right →



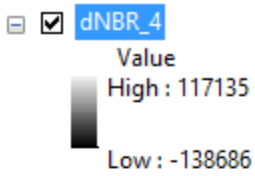
7.4.Calculate dNBR

The differenced Normalized Burn Ratio (dNBR) is a measure of the *change* between NBR pre-fire and NBR post-fire. This measure of change works better in some vegetation types than others. If you are going to be using this as a tool for other analysis, it is recommended that you do a little more reading in the literature to understand the applications and limitations of this process. In the equation below NIR = Near Infrared and SWIR = Shortwave Infrared.

VERY IMPORTANT: For Landsat 8 this corresponds to band 5 and band 7, respectively. As you can see from the figure above showing the location of the bands, there has been a change in the number and location of bands with Landsat 8 from prior Landsat sensors. Much of the literature that talks about NBR refers to using bands 4 and 7, but that referred to the prior configuration of bands and wavelengths on Landsat 4, 5, and 7. It is important to use the correct bands if you will be doing this type of analysis on other fires.

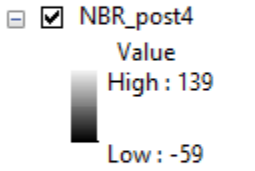
$$NBR = \frac{\rho_{NIR} - \rho_{SWIR2.1}}{\rho_{NIR} + \rho_{SWIR2.1}}$$

a. Open Raster Calculator
b. Enter the following equation (don't copy and paste, double click on layer names) and label the output **NBR_pre** (Distribution should roughly match those to the right, disregard the #4 →)



NBRpre

```
(("pre_band5" - "pre_band7") / ("pre_band5" + "pre_band7"))
```



c. Repeat for **NBR_post**

NBRpost

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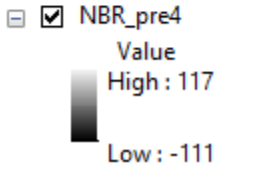
(("post_band5" - "post_band7") / ("post_band5" + "post_band7"))
```



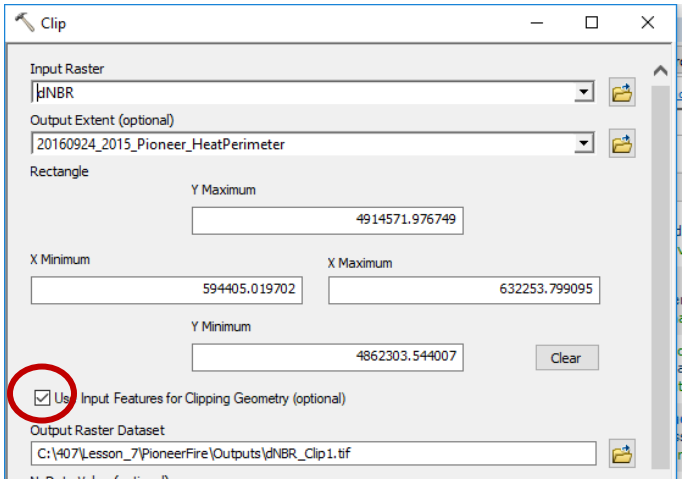
d. Enter the following equation for dNBR and name the output **dNBR**

dNBR

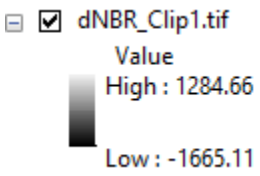
1000 * (NBRpre – NBRpost)

Make sure to get the parentheses in the correct places when using these formulas.

Use the *Clip (Data Management)* tool to clip the dNBR polygon using the final Pioneer fire perimeter (don't forget to check the box to "use input features for clipping geometry").

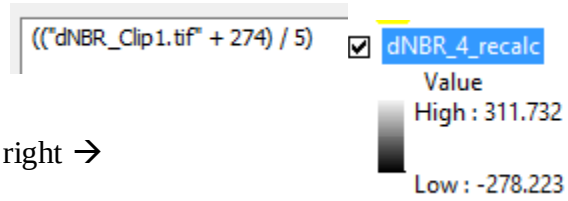


7.5.Reclassify dNBR



We first need to adjust the values of the dNBR file. This calculation was recommended by the group that creates the BARC maps to improve the distribution of values.

a. In raster calculator enter the following equation ("dNBR_clip" + 275) / 5and name the output **dnbr_recalc**

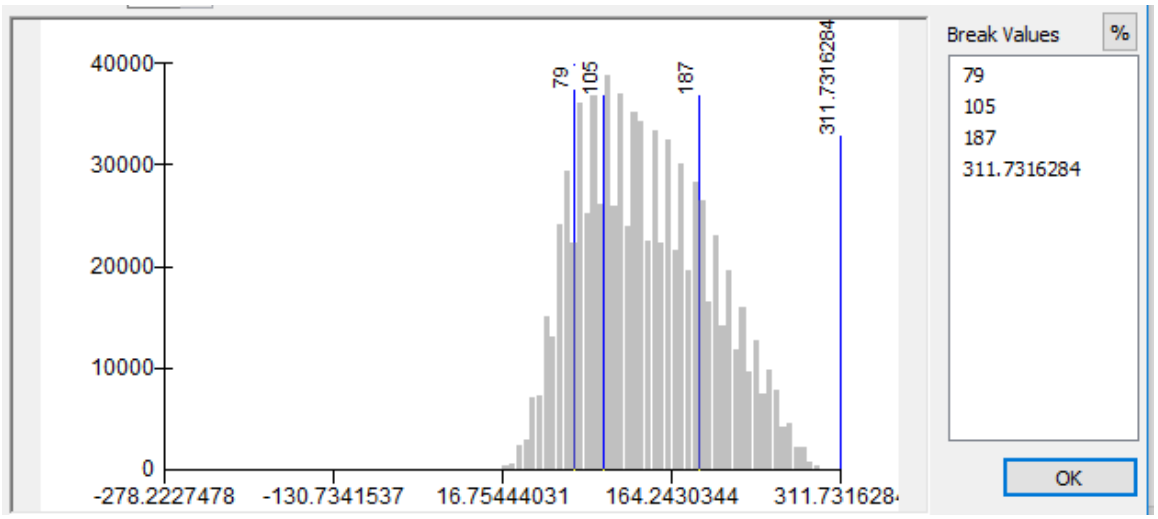


Distribution should roughly match those to the right →

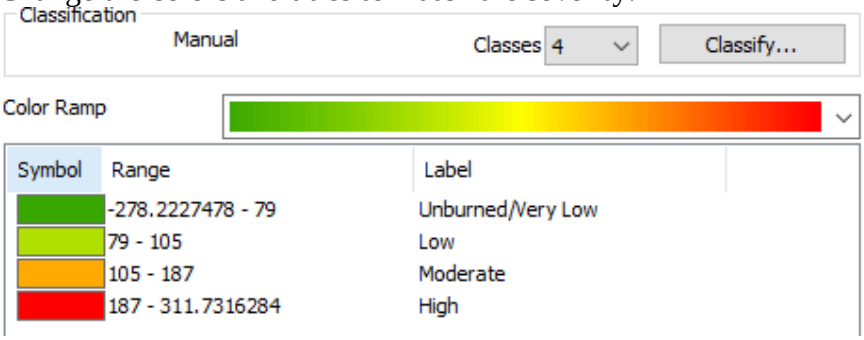
b. Under *Properties* >> *Symbology* tab select **Classified** and **Yes** when asked about creating a histogram.

c. Change to 4 classes and click **Classify** and change to the following break points (leave the last one at its original number). These are standard break points. For the best results, ground-truthing should take place to confirm severity on the ground as is done by BAER teams. (this is important to remember when answering question #3)

Severity Level	dNBR range
Unburned/ Very Low	≤ **79**
Low Severity	80 to **105**
Moderate Severity	106 to **187**
High Severity	>187



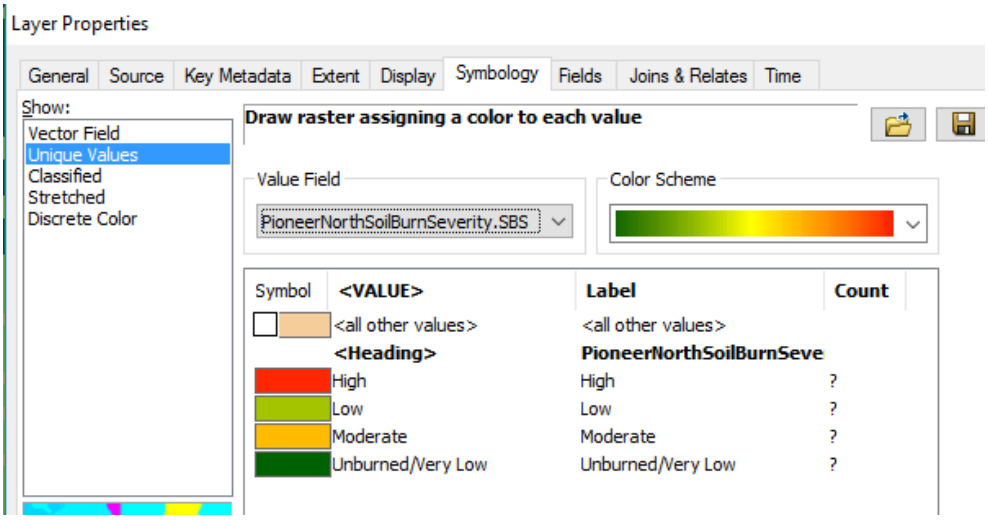
d. Change the colors and titles to match the severity.



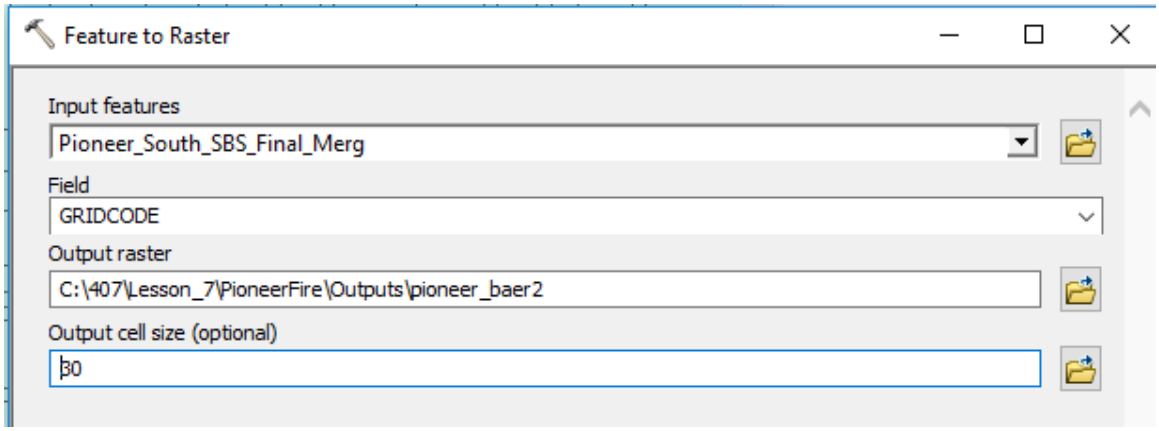
7.6.Displaying BARC data from RSAC

a. Download the **soil burn severity** layer from https://fsapps.nwcg.gov/afm/baer/download.php. Make sure to select 2016 as the year and use ctrl+F to quickly find the Pioneer fire
b. Unzip and save the folders for both *pioneernorth* and *pioneersouth*
c. Add burn severity shapefiles to your ArcMap project - In the *PioneerNorth>>SoilBurnSeverity.gbd* add the PioneerNorthSoilBurnSeverity shapefile. Do the same for South

The creation of this BARC map was particularly difficult for the team at RSAC because of the duration of the fire and the number of scenes with clouds. Several pre-fire scenes were used to create a more accurate dNBR map and then ground-truthed points were used to determine the best break points for the severity classes to creates the most accurate BARC map possible.



d. Merge the two shapefiles (search for the *Merge* tool) – you can keep the default file name since you will be making another adjustment.
e. Convert the new shapefile (feature) to raster (search for *feature to raster* tool)
    a. *Field* – **GRIDCODE**
    b. *Output raster* – **pioneer_barc**
    c. *Output cell size* – **30**

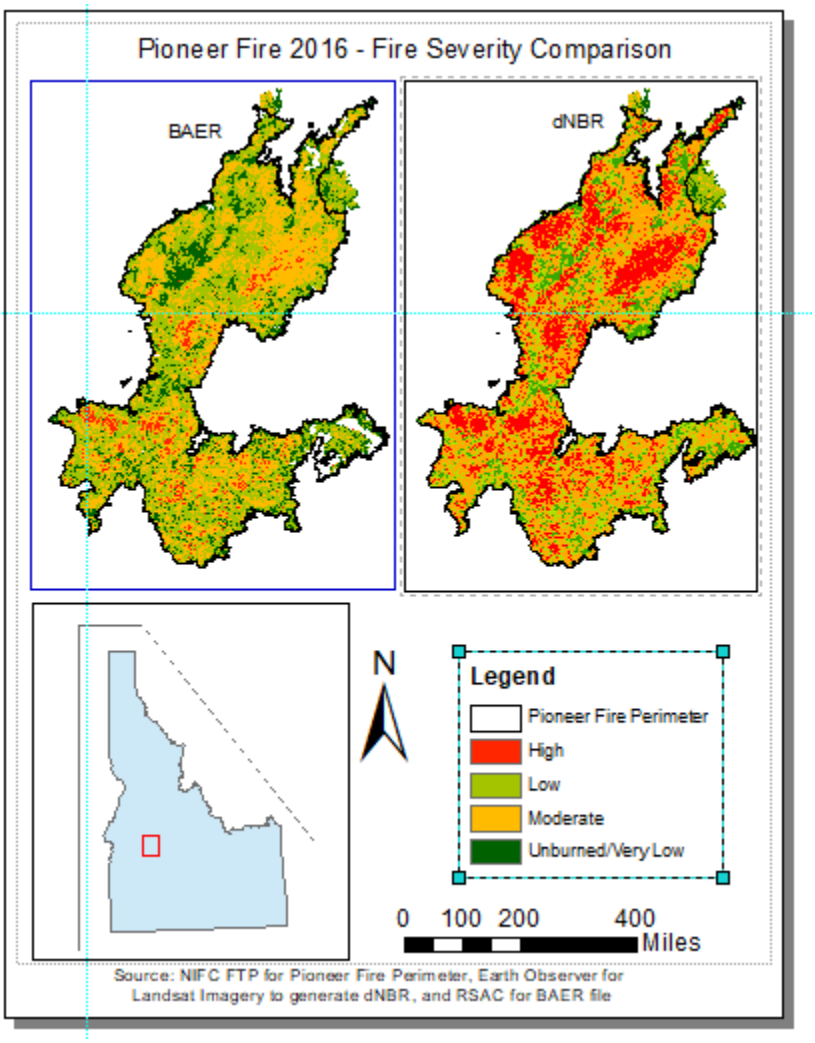


f. We now want to add the fire severity names to the BARC raster. The fire severity names are located in *PioneerNorthSoilBurnSeverity*. Look at the attributes tables for both layers to determine which columns to join. (HINT: the columns have different names but the same values).
g. Change the symbology of the BARC layer to show the severity names and logical colors.
h. Flip back and forth between the reclassified dNBR that you created and the BARC map created by RSAC. Zoom into specific areas to see the change more closely.
i. Create a visual comparison in the Layout view by adding a new data frame for the BAER map and for the state of Idaho for reference. Take time to add all the features included in the map below. Remember to reference the *How-*

to:create an organized map for specific directions, like making the two data frames the same extent.

Question 2: Submit the visual comparison of the reclassified dNBR and the BARC map

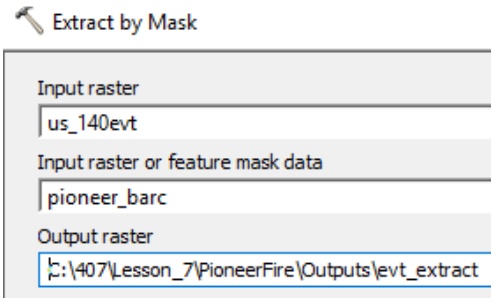
Question 3: Describe the difference between the reclassified dNBR that you created and the BARC map created by RSAC. Discuss why these two maps are different. (HINT: think about the pre-fire images used and then breakpoint used for the severity classes).



7.7.Compare BARC to EVT

a. Add the Existing Vegetation Type layer you downloaded in Lab 6.

b. Use the *Extract by Mask* function to trim the evt layer to the extent of the BARC layer. Name it **evt_extract**. *If you get an error in processing, try again in a blank ArcMap project.*



You will now be joining the two grids so you can see which vegetation types had the highest soil burn severity. The same procedure could be used with any other LANDFIRE layers to try and determine if the vegetation is a predictor of soil burn severity.

c. Using the same process using in lab 3 and 5, combine evt_extract and the pioneer_barc using the *Combine* tool. Label the combined layer **evt_barc.** Use the *Join field tool* to add the **EVT_PHYS** to the table.

Question 4: Describe patterns you observe in the comparison between the soil burn severity and the existing vegetation type.

If you want to know more about BARC and MTBS you can download the webinar and practice data on the following sites. These webinars and labs may provide insight into potential final projects for this class.

- Understanding and Using MTBS data - http://www.mtbs.gov/tech_transfer/techtransfer.html
- Using BARC for BAER support - https://www.fs.fed.us/eng/rsac/baer/training.html