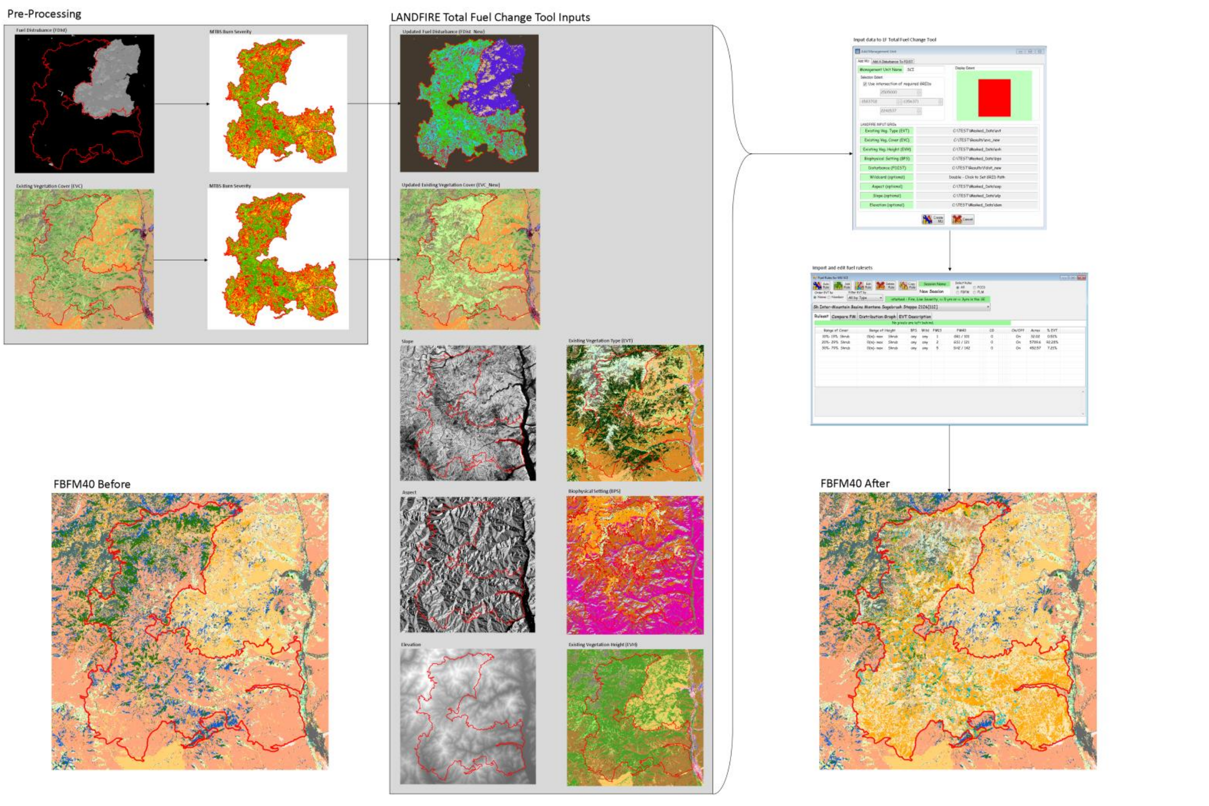
# Updating LANDFIRE Fuels Data

# For Recent Wildfires

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## Introduction

This document is intended to outline a process for updating LANDFIRE fuels geospatial data after wildfire. LANDFIRE delivers updated products every few years, but users sometimes need to update the products more frequently due to landscape change. The example we document here shows the process we used for updating LANDFIRE fire behavior fuel model (Scott and Burgan) and the associated canopy fuel rasters (forest canopy cover, forest canopy height, forest crown bulk density, forest canopy base height) for recent wildfires on the Sawtooth National Forest in Idaho.

The process we used for updating the fuel rasters is as follows:

1. Update the fuel disturbance raster for time-since-disturbance.
2. Update the fuel disturbance raster for recent wildfires.
3. Adjust the existing vegetation cover within fire perimeters based on fire severity.
4. Use the updated fuel disturbance and vegetation cover rasters, along with other required rasters, in the LANDFIRE Total Fuel Change Tool (LFTFCT) to create new fire behavior fuel model and canopy fuel rasters.

LANDFIRE assigns fire behavior fuel models based on the existing vegetation type (EVT), cover (EVC), height (EVH), biophysical setting (BpS) and fuel disturbance (FDist). The FDist raster depicts disturbance event locations, and includes attributes for disturbance type, disturbance severity and time-since-disturbance. This information is used to assign post-disturbance fuel attributes based on rule sets in the LFTFCT.

The goal of the Sawtooth project was to update LANDFIRE 2012 data to a circa 2015 condition by making appropriate changes to the fuel rasters based on four fires -- Beaver Creek, Kelley, Little Queens, and McCann-- that occurred within the analysis area in 2013. We updated the LANDFIRE FDist and EVC rasters within the fire perimeters using ArcGIS. For all other required data sets, we used unmodified LANDFIRE 2012 data. We assumed that the EVT and BpS did not change. We did not have any information on post-fire vegetation height so we also assumed that EVH did not change.

Readers of this document should note that:

- This process is technical and requires strong spatial analysis skills to complete the data preparation work. This document should be used along with existing LANDFIRE, LFTFCT and ArcGIS User Guides, Tutorials, and help references.
- This document shows the specific processing steps we used for updating the Sawtooth data to a circa 2015 condition. Users following our method will need to make minor adjustments to the steps we outline based on their update period. In particular, the annual fuel disturbance rasters

and the composite fuel disturbance raster will vary based on the update period (see the Note below for more information on disturbance rasters).

- Step 6 discusses joining raster attributes. Attributes can be joined as needed before Step 6 or after all the pre-processing steps are complete.
- We provide an overview of the processing steps we used in the LFTFCT. Detailed information about the use of the tool can be found in the LFTFCT User's Guide and Tutorial on the LANDFIRE Tools and User Documents webpage.
- Appendix 1 provides information about checking the rasters created in each data processing step to be sure they are accurate. We recommend that users check their data throughout the analysis.

***NOTE:*** *LANDFIRE creates annual disturbance rasters and a composite fuel disturbance raster that combine the annual disturbance rasters. Both are used in this process.*

## Data Requirements, Processing Environments and Arc Tools

We used the rasters shown in Table 1 below for our analysis.

*Table 1. Rasters used in the update process.*

| DATA | SOURCE | NOTES |
|---|---|---|
| Fire Severity | MTBS or RAVG | Need data showing location, severity and date of fire |
| Biophysical Settings (BpS) | LANDFIRE | Required input to LFTFCT |
| Existing Vegetation Type (EVT) | LANDFIRE | Required input to LFTFCT |
| Existing Vegetation Cover (EVC) | LANDFIRE | Required input to LFTFCT |
| Existing Vegetation Height (EVH) | LANDFIRE | Required input to LFTFCT |
| Fuel Disturbance (FDist) | LANDFIRE | Required input to LFTFCT |
| Annual Disturbance | LANDFIRE | Used to create new fuel disturbance raster; the annual disturbance rasters needed for this analysis will depend on the update period. |

For this analysis, all spatial data must have the same extent, projected coordinate system (see the Note below for considerations about coordinate systems) and cell size. We used the Extent, Snap Raster and Mask functions, set in the Geoprocessing → Environments, to maintain our desired analysis extent and to keep all rasters aligned. This is most applicable in Step 2 and will be discussed further there.

***NOTE:*** *Data processing can be done in any projected coordinate system as long as it is the same for all rasters, but final rasters should be in a local coordinate system. LANDFIRE geospatial data are delivered in Alber's Equal Area, a coordinate system that preserves area but distorts shapes and direction. Direction distortion is important to consider because fire behavior modeling systems assume grid north is true north when modeling wind. This distortion can be minimized by choosing a local projected coordinate system.*

The examples and workflows shown in this document use several ArcGIS tools that require the Spatial Analyst Extension. The applicable tool paths from ArcToolbox are:

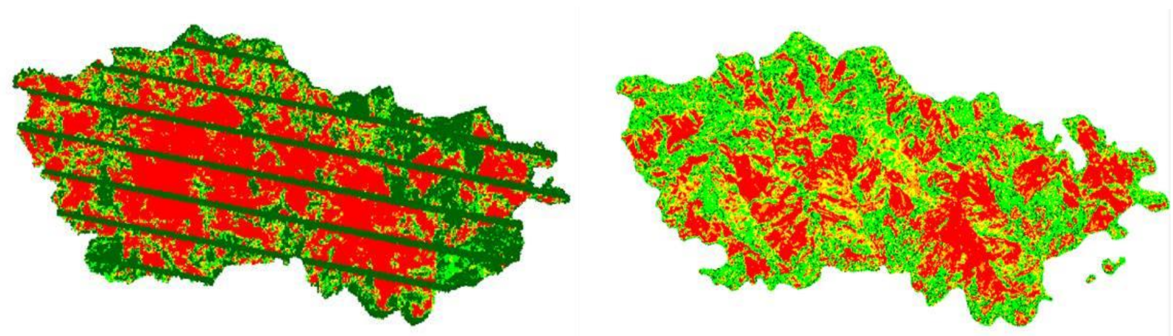
**Combine:** Spatial Analyst Tools → Local → Combine
**Polygon to Raster:** Conversion Tools → To Raster → Polygon to Raster
**Extract by Mask:** Spatial Analyst Tools → Extraction → Extract by Mask
**Join Field:** Data Management Tools → Joins → Join Field
**Mosaic to New Raster:** Data Management Tools → Raster → Raster Dataset → Mosaic to New Raster
**Reclassify:** Spatial Analyst Tools → Reclass → Reclassify
**Raster Calculator:** Spatial Analyst Tools → Map Algebra → Raster Calculator

## Step 1: Choose and Pre-process Fire Severity Data

The Modeling Trends in Burn Severity (MTBS) and Rapid Assessment of Vegetation Condition after Wildfire (RAVG) programs provide fire severity data that are suitable for this analysis. RAVG data are available for fires that burn more than 1,000 acres of forested National Forest System land. MTBS provides data for fires greater than 1,000 acres in the west and 500 acres in the east.

We chose MTBS data for our analysis because:

1. There were scan lines in the RAVG rasters (Figure 1); and
2. One of the four fires of concern (McCann Fire) did not meet the criteria for inclusion in the RAVG assessment (>1,000 acres burned on Forest Service land).



**RAVG rdnbr_cc5** **MTBS rdnbr_cc5**

Figure 1: Comparison of RAVG (left) and MTBS (right) rasters for the Kelley Fire. The RAVG raster scan lines were likely the result of the available Landsat imagery within the RAVG data acquisition time frame (45 days post containment). Later scenes may have been cloudy or affected by snow (personal communication, Craig Baker, Remote Sensing Applications Center). The MTBS raster would have used the best available scene near the following peak of green, allowing a year for recovery or delayed mortality.

The fire perimeters differ slightly between the two rasters. The MTBS perimeter was likely delineated independently and is therefore more likely to exclude very low severity areas (personal communication, Craig Baker). Note: in this figure, we show the classified rasters (rdnbr_cc5) for visualization, rather than the non-classified rdnbr rasters that we used in the processing steps.

- Users of RAVG data can download the canopy cover reduction raster (**…rdnbr_cc.tif**) from the RAVG Data Access and Summaries webpage, re-project it if necessary, and skip to Step 1C below.

- Users of MTBS data can continue to Step 1A below to create a canopy cover reduction/mortality raster.

**Step 1A: Download MTBS data**

Download the relevant individual fire-level geospatial data from MTBS (Figure 2) and re-project it if needed so that all data have the same projected coordinate system (see the Note below).

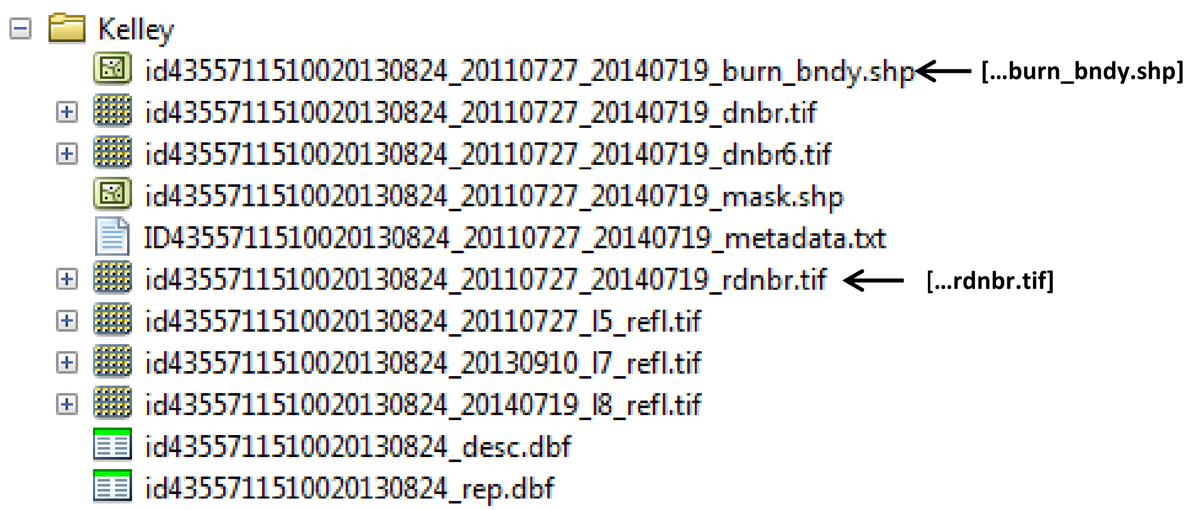



Figure 2. Individual MTBS fire-level data for the Kelley Fire shown in ArcCatalog. We used the fire perimeter shapefile, **[…burn_bndy.shp]**, and the relative differenced normalized burn ratio raster, **[…rdnbr.tif]**, to create a scaled canopy cover change raster (Step 1B).

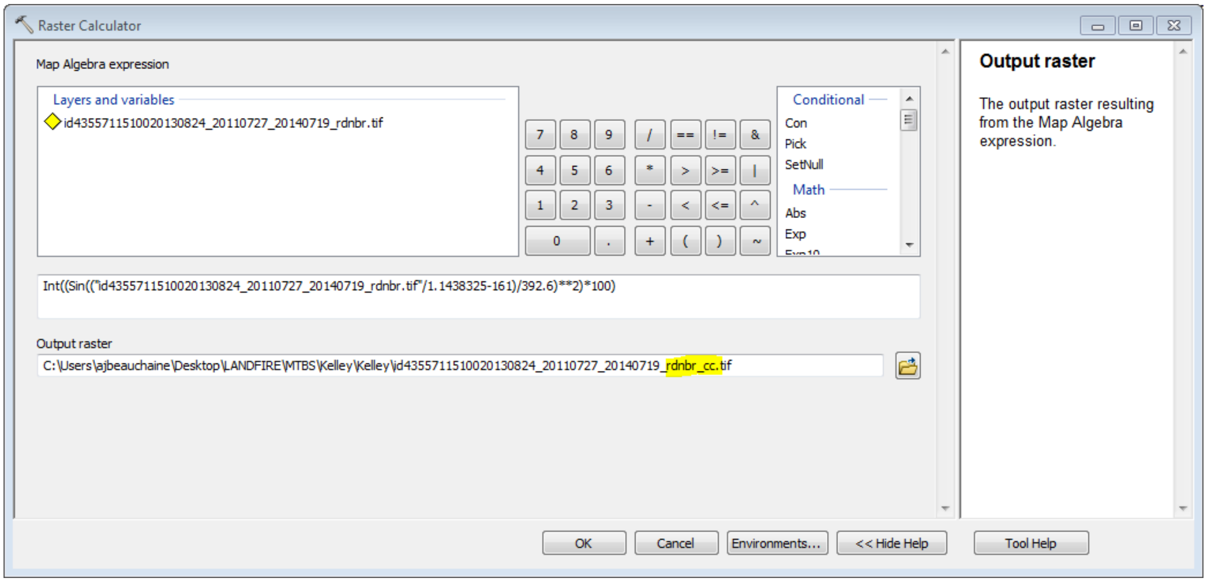
***NOTE:*** *MTBS and LANDFIRE rasters share a native "NAD_1983_Albers" projected coordinate system. This projection is also referred to as "USA_Contiguous_Albers_Equal_Area_Conic_USGS_Version." These projections have the same datum and spatial reference parameters and should align without issue.*

**Step 1B: Create scaled percent change in canopy cover raster […rdnbr_cc.tif]**

Because MTBS does not deliver a continuous canopy cover reduction raster, it needs to be created using the following formula (found in RAVG metadata and updated by Craig Baker, Remote Sensing Specialist, Remote Sensing Applications Center):

Int((Sin(("**[…rdnbr.tif]**"/1.1438325-161)/392.6)**2)*100)

Add the MTBS raster ending in **[…rdnbr.tif]** to the ArcMap project and use the Raster Calculator tool with the formula above to create the output raster **[…rdnbr_cc.tif]**. At the same time, use the Mask setting to mask the output to the fire perimeter. Go to the Environments → Raster Analysis setting. Set the Mask as the fire perimeter polygon **[…burn_bndy.shp]**.




The output raster, **[…rdnbr_cc.tif]**, is a scaled percent change in canopy cover from 0-100% masked to the fire perimeter (Figure 3). This reflects the post-fire reduction (mortality) in canopy cover. *Note* that this is *canopy reduction* and not the post-fire *canopy cover*. If you are analyzing multiple fires, repeat Step 1B for all the fires to create individual **[…rdnbr_cc.tif]** rasters for each fire.

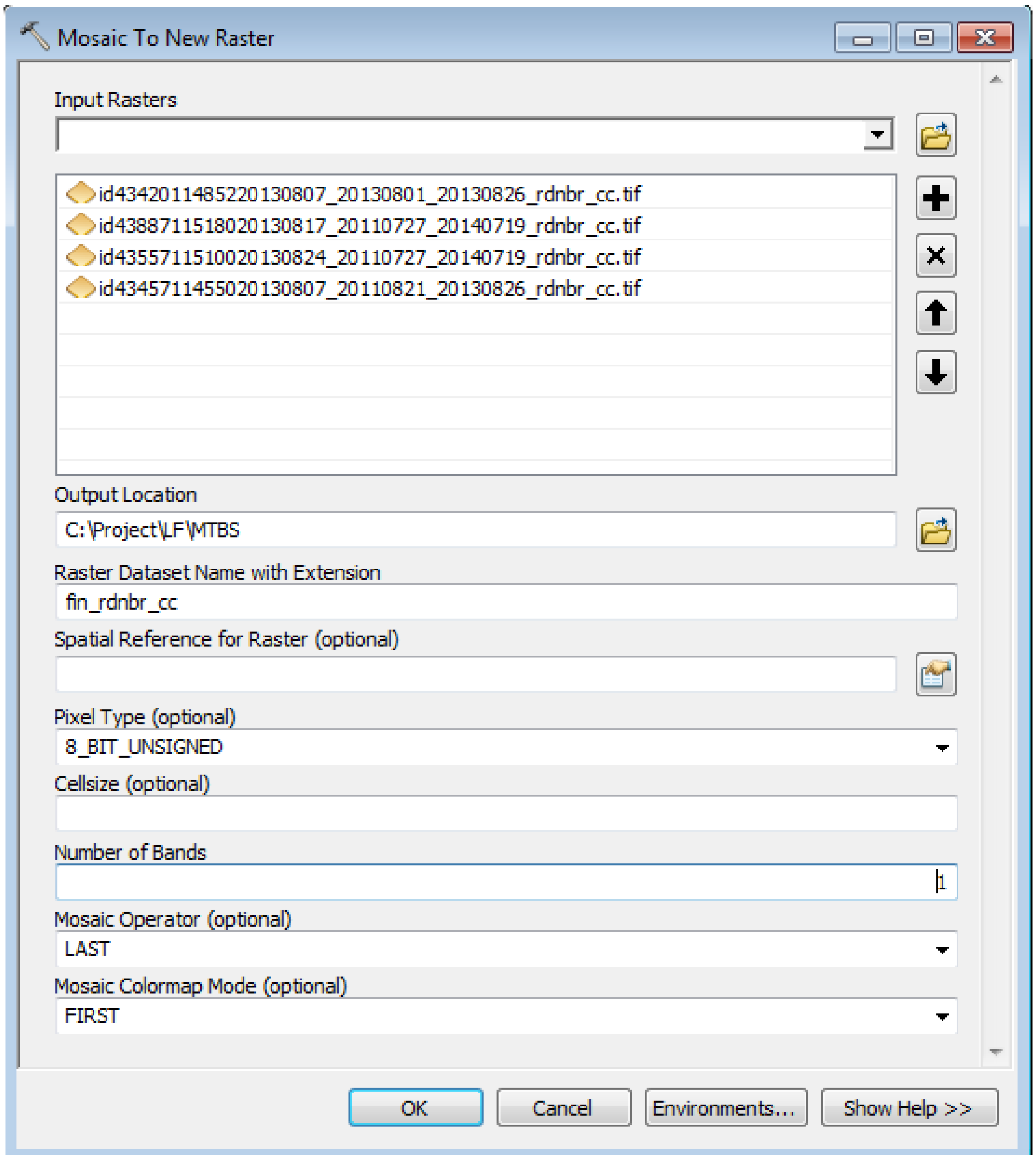
**[…rdnbr.tif]** **[…burn_bndy.shp]** **[…rdnbr_cc.tif]**

Figure 3. Processing steps to create the post-fire canopy reduction raster **[…rdnbr_cc.tif]**.

**Step 1C: Mosaic canopy cover reduction grids into one**

If you are analyzing multiple fires, use the Mosaic to New Raster tool to “merge” the rasters into one final output raster **[fin_rdnbr_cc]** which will be used in later steps. Set the parameters as shown below in the Mosaic to New Raster dialogue box. Note: for this operation, we’re not concerned with the input order since none of the fires overlap. In subsequent steps, we will be concerned with the order. Also, for users of RAVG data, the pixel type will be float rather than integer as shown in the dialogue box below.

The canopy cover reduction raster **[fin_rdnbr_cc]** is now ready to be used in the later steps -- update the FDist and EVC rasters and prepare them for input into the LFTFCT.

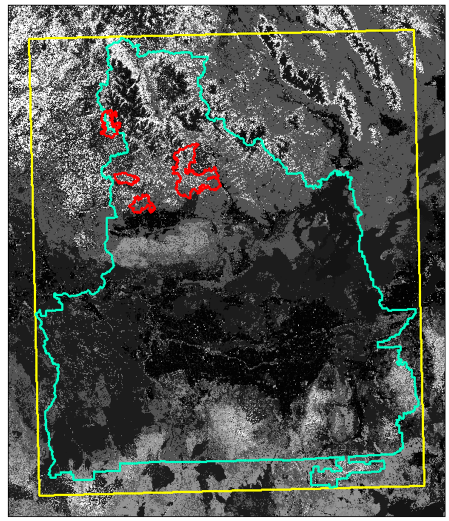


## Step 2: Pre-process LANDFIRE Data

### Step 2A: Create an analysis area raster

Before downloading the LANDFIRE data, create an analysis area raster. This raster will be used to mask, or “clip,” the downloaded data to the area of interest and will reduce the file size and processing time. For the Sawtooth project we created the **[analysis_area]** raster by first drawing a rectangle with the Draw Tools around the Fire Planning Unit (FPU) and the recent fires, converting the rectangle to a shapefile (Draw toolbar → Drawing → Convert Graphics to Feature) and converting the shapefile to a raster using the Polygon to Raster tool (Figure 4). The **[analysis_area]** raster should have the same projection and cell size as the other analysis rasters.

Figure 4. All LANDFIRE data used in the Sawtooth project were masked to the Analysis Area (shown as a polygon for display purposes) to reduce file size and processing time.




### Step 2B: Download LANDFIRE data

Download the required LANDFIRE rasters (Table 1) from the [LANDFIRE Data Distribution Site]() or using the [LANDFIRE Data Access Tool]() (LFDAT) within ArcMap making sure that they cover the entire analysis area. The required annual disturbance rasters will depend on the update period. See the background information provided in Step 3 and 3A to help determine which annual rasters are needed.

***TIP:*** *Create a file management system to keep the data organized. Consider creating a “Raw_Data” folder to store the original rasters downloaded from LANDFIRE and a “Masked_Data” folder to store the masked rasters.*

### Step 2C: Set Geoprocessing Environments

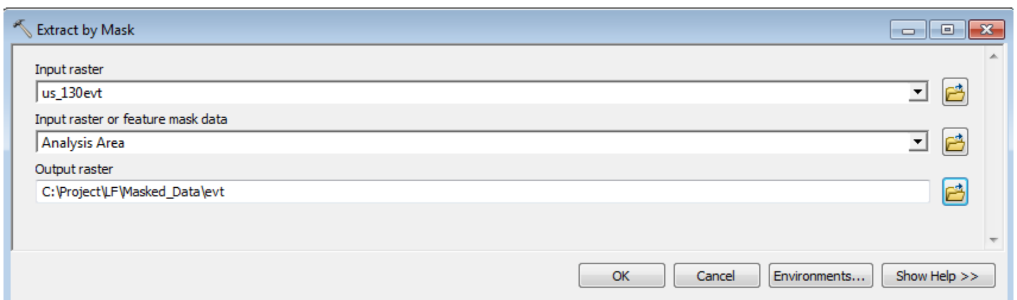
At this point it’s important to use the Geoprocessing → Environments to set the Mask, Extent and Snap Raster. This can be set within the tool dialogue box each time a processing step is performed, or set for all tools in the map document.

To set the Mask and Snap Raster for all tools used in the map document:

- From the Geoprocessing dropdown, select Environments.
- Under Processing Extent, use the Extent dropdown to set the extent to the analysis area raster. Then, from the Snap Raster dropdown, select one of the downloaded raw LANDFIRE rasters as the Snap Raster. This ensures that all grid cells align by snapping output rasters created with any of the tools to the Snap Raster.
- Under Raster Analysis, set the Mask to the analysis area raster. This will ensure that all masked outputs retain the same cell counts and spatial extent. When using the Extract by Mask tool in the next step this will become redundant, but will not cause any issues. This is more important for future steps.
- Under Raster Storage, uncheck “Build Pyramids” to reduce processing time and improve performance.

**Step 2D: Mask raw data to the analysis area**

Use the Extract by Mask tool to “trim” or “clip” the raw rasters to the **[analysis_area]** raster. Repeat for all downloaded raw rasters, or run the tool in batch mode to process multiple rasters at once (see Tip below), and save all outputs (Figure 5).



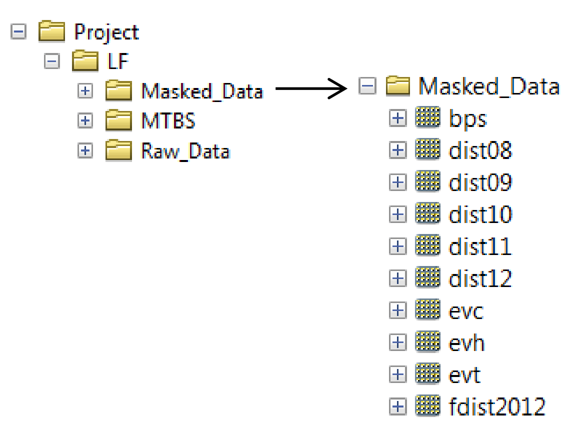




Figure 5. Example file management structure for the Sawtooth project. The masked data file names were abbreviated during the extract by mask step (e.g. us_130evt → evt).

***TIP:** To run a geoprocessing tool in batch mode, right click on it and select Batch.*

## Step 3: Update LANDFIRE Fuel Disturbance Data

The LANDFIRE FDist raster depicts the location, type, severity, and age of disturbances that occurred over the ten-year period prior to the data currency date. For example, the 2012 FDist raster would include disturbances that occurred in 2003 through 2012. A three-digit code is assigned to the pixels where disturbances have occurred to categorize the disturbance type, severity and age (Table 2).

*Table 2: LANDFIRE fuel disturbance (FDist) three-digit coding system. Each disturbance in the FDist raster is assigned a value that reflects its type (first digit), severity (second digit) and time-since-disturbance (TSD) relative to the LANDFIRE currency date (third digit). For example, a TSD value of 122 represents a fire (1), of moderate severity (2) that occurred 2-5 years ago (2).*

| **First Digit**<br>**Type** | **Second Digit**<br>**Severity** | **Third Digit**<br>**Time-Since-Disturbance** |
|---|---|---|
| 1: Fire<br>2: Mechanical Add<br>3: Mechanical Remove<br>4: Wind<br>5: Insects | 1: Low (<25% above-ground biomass removed)<br>2: Moderate: (25-75% above-ground biomass removed)<br>3: High: (>75% above-ground biomass removed) | 1: Less than 1 year TSD<br>2: 2 to 5 years TSD<br>3: 6 – 10 years |

LANDFIRE provides updated versions of its data in two-year increments. However, due to the effort involved in the update process, the data are typically not available until two-to-three years past their currency date. This means the time-since-disturbance (TSD) attribute in the FDist raster needs to be updated to reflect disturbances that have occurred after the currency date of the LANDFIRE data.

### Step 3A: Determine for which years a disturbance would have moved to a different TSD class

The years for which the TSD class will change is dependent on the update period. Figure 6 shows the shift in TSD from a 2012 LANDFIRE product to the desired 2015 condition for the Sawtooth project. Use this as a guide to determine where the TSD attribute needs to change (Steps 3B and later) and which annual disturbance rasters need to be downloaded from LANDFIRE (Step 2B). *Steps 3B, C, and D refer specifically to the updates made for the Sawtooth project and will need to be translated for a different update period.*

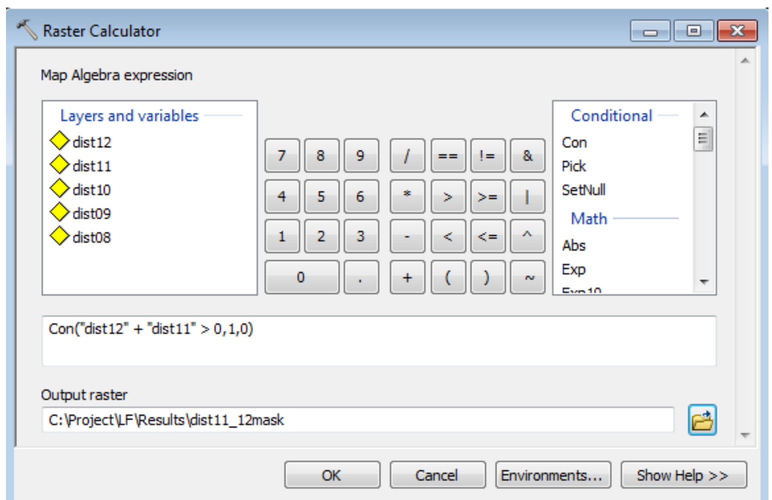
| Year: | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| LANDFIRE 2012 TSD: | N/A | N/A | N/A | 1 | 2 | 3 | 4 | 5 | 6 |
| 2015 TSD: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| | |
|---|---|
| (green) | 1 Year TSD |
| (blue) | 2-5 Years TSD |
| (orange) | 6-10 Years TSD |

Figure 6. For the Sawtooth project, LANDFIRE 2012 data were updated to 2015. To create a 2015 FDist raster, disturbances that occurred in 2008, 2009, and 2010 needed to be classified as 6-10 year TSD, and disturbances in 2012 needed to be classified as 2-5 year TSD. Disturbances in 2011 and prior to 2008 were already in the desired TSD category and therefore did not require a change.

**Step 3B: Create two spatial masks, one for 2008-2010 (6-10 year TSD) disturbances and one for 2011-2012 (2-5 year TSD) disturbances**

Create a new “Results” folder to store the outputs of the following steps. Use the Raster Calculator tool to enter the following conditional (con) statements in the expression box as shown in the example to the right (an example is shown only for the 2011-2012 mask). The result of the Con statements is 1 if a disturbance occurred in the selected years, or zero if no disturbance occurred.

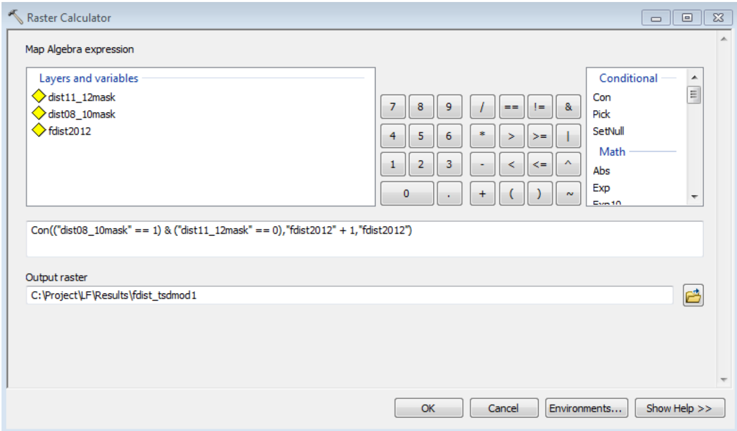



Con("dist2012" + "dist2011"  > 0,1,0) → Output is **[dist11_12mask]**
Con("dist2010" + "dist2009" + "dist2008"  > 0,1,0) → Output is **[dist08_10mask]**

**Step 3C: Update FDist if a disturbance occurred in 2008-2010 that was not followed by another disturbance in 2011-2012**

In the Raster Raster Calculator, enter the following Con statement in the expression box as shown in the example below. This Con statement is interpreted as: if there was a disturbance in 2008-2010 that was not followed by another disturbance in 2011-2012, then add 1 to the TSD value of fdist2012; if not, leave fdist2012 as is.

Con(("dist08_10mask" == 1) & ("dist11_12mask" == 0),"fdist2012" + 1,"fdist2012")→Output is **[fdist_tsdmod1]**

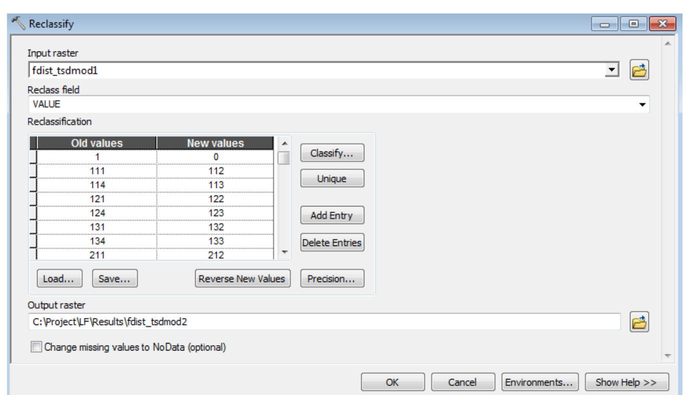



**Step 3D: Update FDist TSD values**

Use the Reclassify tool to edit TSD values. Use **[fdist_tsdmod1]** as the input raster and click the *Unique* button.

- Highlight the rows of values that will not be changed (0 and values that end in a 2 or 3) and click the *Delete Entries* button. Zero values reflect no disturbance, and values that end with a 2 or 3 are the updated values that we want to keep. For reclassification purposes, ignore them by deleting them from the process in this step.
- A pixel value of 1 indicates that there was a disturbance in one of the annual disturbance rasters that was filtered out of the final FDist raster by LANDFIRE during a quality control process. These need to be updated to a value of 0 to indicate that No Disturbance occurred.
- Values that end in 1 need to be updated to end in 2. These are 2012 disturbances that still need to be updated to the 2-5 year TSD category.
- Values ending in 4 indicate that a fire occurred prior to 2008, followed by a non-fire disturbance in 2008, 2009 or 2010. They met the criteria in our Con Statement—a disturbance occurred during the period of 2008-2010 and no disturbance occurred in 2011-2012. Following LANDFIRE's methods, fires take precedence over non-fire disturbances in the final FDist assignment so the FDist value for these pixels needs to reflect the pre-2008 fire event. Therefore, disturbance codes ending in 4 should be changed to end in a 3 indicating a 6-10 year TSD.

Reclassify values as shown to the right and save the output raster **[fdist_tsdmod2]** to the Results folder.

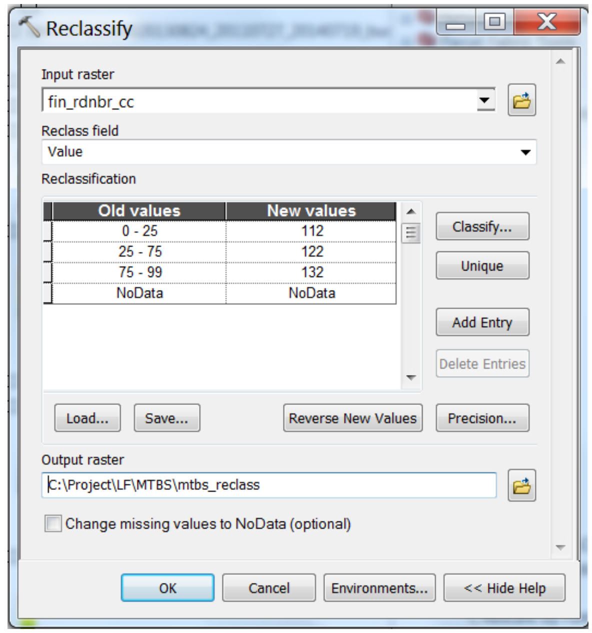


## Step 4: Update Fuel Disturbance Raster for New Fire Disturbances

### Step 4A: Reclassify the canopy cover reduction raster to FDist values

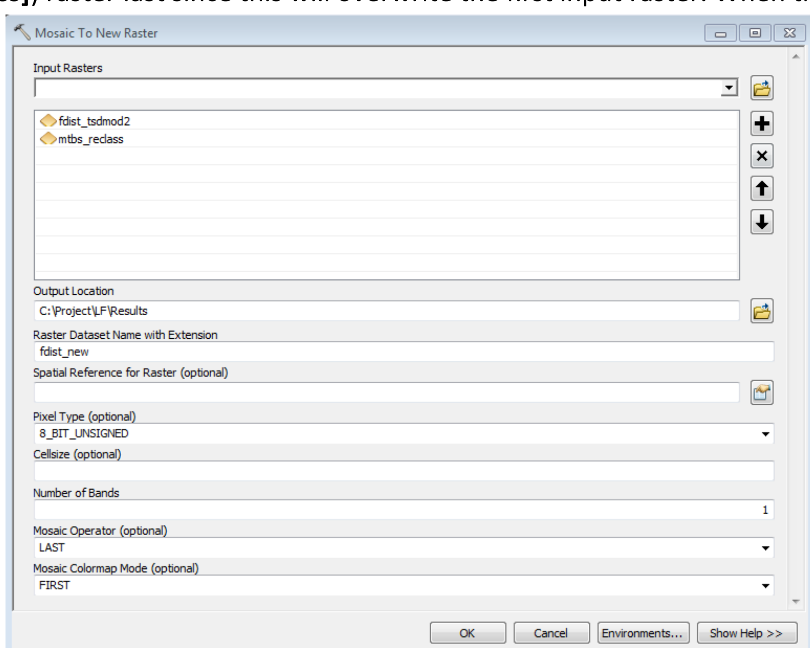
In this step the canopy cover reduction raster, **[fin_rdnbr_cc]** obtained in Step 1, is used to update the FDist raster based on fire severity. The canopy cover reduction values will translate into FDist values (112, 122 and 132). Remember that these three values are for fire disturbances (first digit = 1), of varying severity (second digit = 1, 2 or 3), that occurred between 2-5 years ago (third digit = 2).

Reclassify so that **[fin_rdnbr_cc]** values of 0-24 reflect Low severity fire, values of 25-74 reflect Moderate severity fire and values of 75-99 reflect High severity fire. Save output as **[mtbs_reclass]** (or **[ravg_reclass]**).




### Step 4B: Mosaic the reclassified canopy cover reduction raster with the [fdist_tsdmod2] raster

Use the Mosaic to New Raster tool to "stamp" the reclassified **[mtbs_reclass]** (or **[ravg_reclass]**) values onto the **[fdist_tsdmod2]**. In this step, we *are* concerned with the order that the rasters are input. Add the **[mtbs_reclass]** (or **[ravg_reclass]**) raster last since this will overwrite the first input raster. When the two rasters are mosaicked, the overlapping values from the last raster are used in the output mosaic. Set parameters as shown below specifying '1' for the Number of Bands and using the default Mosaic Operator 'LAST.' Save the output as **[fdist_new]**. This updated FDist raster is ready for use in the LFTFCT.



## Step 5: Update Existing Vegetation Cover for Post-Fire Effects

Since the fire disturbances ultimately reduced some of the tree canopy cover based on the fire severity, we'll need to modify the EVC raster to reflect those changes. This document does not cover adjusting EVH to reflect a post-fire condition because there were no post-fire height data available for the Sawtooth project.

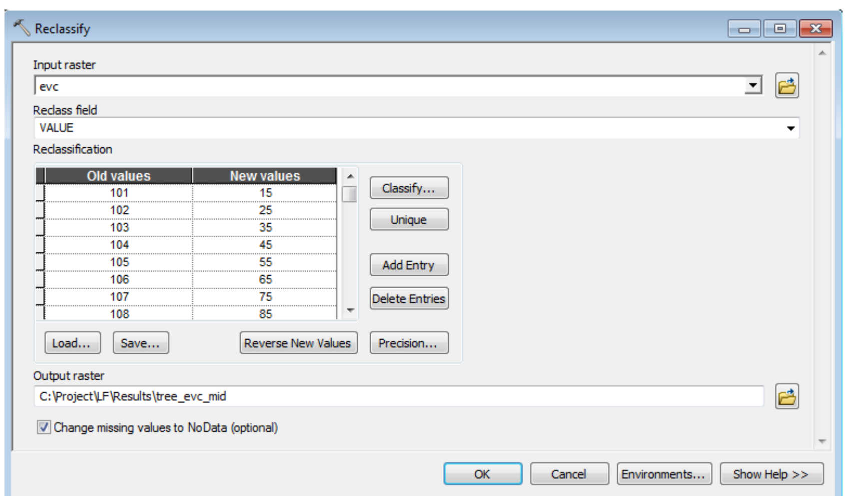
### Step 5A: Reclassify EVC classes to mid-point canopy cover values

It is important to note in this step that only the tree lifeforms need to be reduced because canopy fuel attributes are not assigned to shrub and herbaceous lifeforms. Canopy cover values in the EVC value attribute table for tree lifeforms range from 101-109 with each value representing a 10% range of cover. This step assigns a midpoint cover value for each cover class (Table 3).

*Table 3. The LANDFIRE EVC raster is classified in 10% cover increments. Class midpoint values are used to reduce the EVC based on the post-fire canopy cover reduction raster.*

| LANDFIRE EVC Value | Class name | Midpoint |
|---|---|---|
| 100 | Sparse Vegetation Canopy | |
| 101 | Tree Cover >= 10 and < 20% | 15 |
| 102 | Tree Cover >= 20 and < 30% | 25 |
| 103 | Tree Cover >= 30 and < 40% | 35 |
| 104 | Tree Cover >= 40 and < 50% | 45 |
| 105 | Tree Cover >= 50 and < 60% | 55 |
| 106 | Tree Cover >= 60 and < 70% | 65 |
| 107 | Tree Cover >= 70 and < 80% | 75 |
| 108 | Tree Cover >= 80 and < 90% | 85 |
| 109 | Tree Cover >= 90 and <= 100% | 95 |

Open the Reclassify tool, select the input raster **[evc]**, select Value as the Reclass field (if needed) and click the *Unique* button. Remove values <=100 and >109 by highlighting the rows and clicking *Delete Entries* (these are non-vegetated or non-tree lifeform values). Enter the mid-point canopy cover values as shown below, and check the "Change missing values to NoData" box. Save the output raster as **[tree_evc_mid]** to the Results folder.



**Step 5B: Reduce the mid-point canopy cover values by the canopy reduction values**

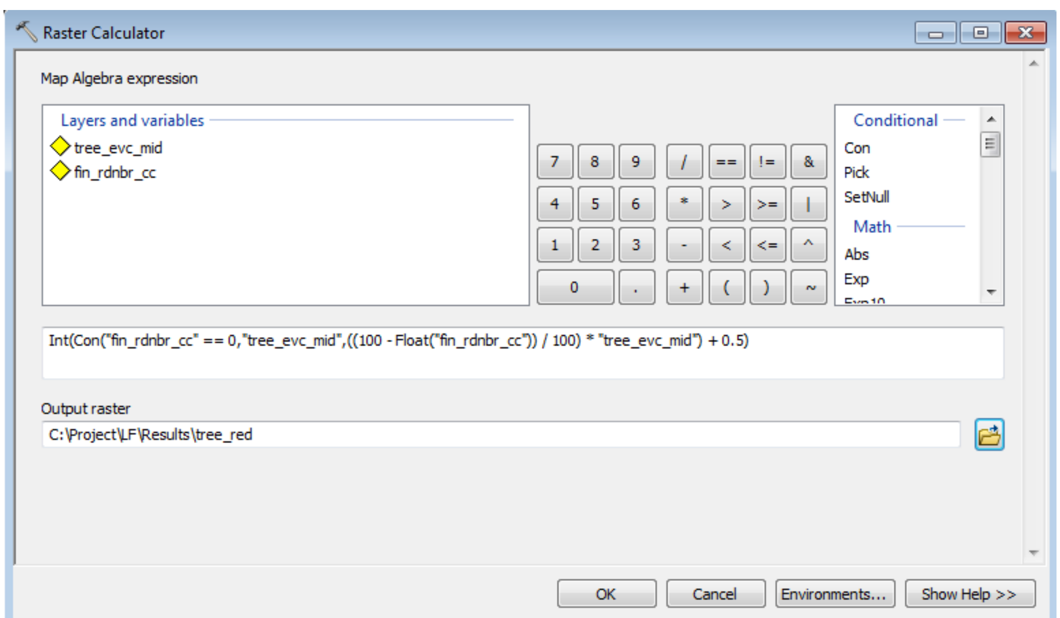
In this step, we're going to reduce the mid-point canopy cover values that we created in Step 5A, using the canopy cover reduction raster **[fin_rdnbr_cc]** and a Con statement. The canopy cover reduction raster may have an integer or a floating point data type (see Note below), and the Con statement syntax will need to account for this. The canopy cover reduction raster (**[fin_rdnbr_cc]**) created in Steps 1B and C from MTBS data was integer. The equivalent RAVG raster is floating point.

Use the Raster Calculator to enter the correct Con statement in the expression box:

For integer data:
Int(Con("fin_rdnbr_cc" == 0,"tree_evc_mid",((100 - Float("fin_rdnbr_cc")) / 100) * "tree_evc_mid") + 0.5)

For floating data:
Int(Con("fin_rdnbr_cc"==0, "tree_evc_mid",((100-"fin_rdnbr_cc") / 100)*"tree_evc_mid")+0.5)

This Con statement means that if the continuous canopy cover reduction raster **[fin_rdnbr_cc]** equals 0, then the output will equal the value of the EVC mid-point raster **[tree_evc_mid]**; else, the output will be the result of the equation rounded to the nearest whole number. The Integer (Int) and Floating (Float) functions are used in this statement to control the raster's data type. Save the output **[tree_red]** to the Results folder.



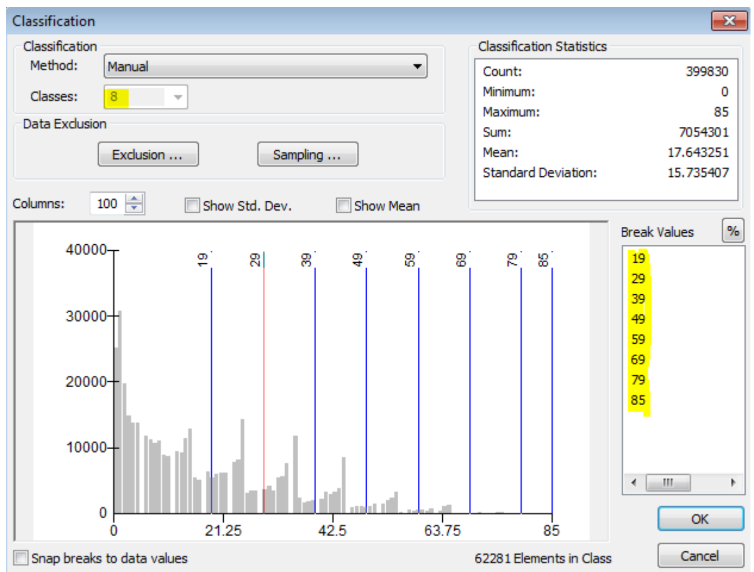
*__Note:__ Raster values can be stored as [Integer (int) or Floating (float)](). In Step 5B, Int is used to specify that the output raster's data type should be integer. Used alone, Int will truncate the decimals from a value. Adding 0.5 to the raster value before "integerizing" it, rounds the value to the nearest integer (as in Step 5B).*

*The Float function within the statement is only necessary if the continuous canopy cover reduction raster is an integer. In this case, Float converts the canopy cover reduction raster to floating point. Without the Float function the equation ((100 - Float("fin_rdnbr_cc")) / 100) would evaluate as zero when converted to an integer. Using the Float function ensures results between 0.01 and 0.99.*

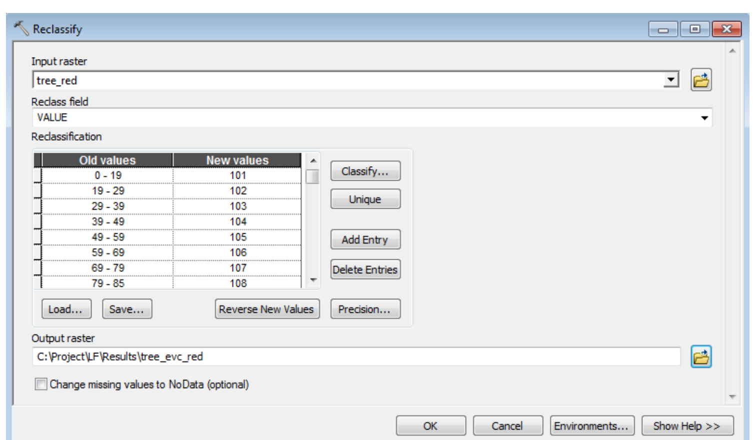
**Step 5C: Reclassify reduced canopy cover values back to EVC classes**

Now that we have the reduced canopy cover values, we'll need to convert them back to EVC classes with values between 101 and 109 (Table 3).

Open the Reclassify tool and add the **[tree_red]** raster as the Input Raster. Click the *Classify* button and enter the number of classes needed. Enter the break values as shown to the right. LANDFIRE EVC classes are greater-than-or-equal-to the first value in the range (Table 3). In the ArcGIS Reclassify tool, the first value in a range is *exclusive* and the second value is *inclusive*, therefore, the reclassified value of 101 in the figure below would include a value of 19. A reclassified value of 102 would include values >= 20 and <=29.

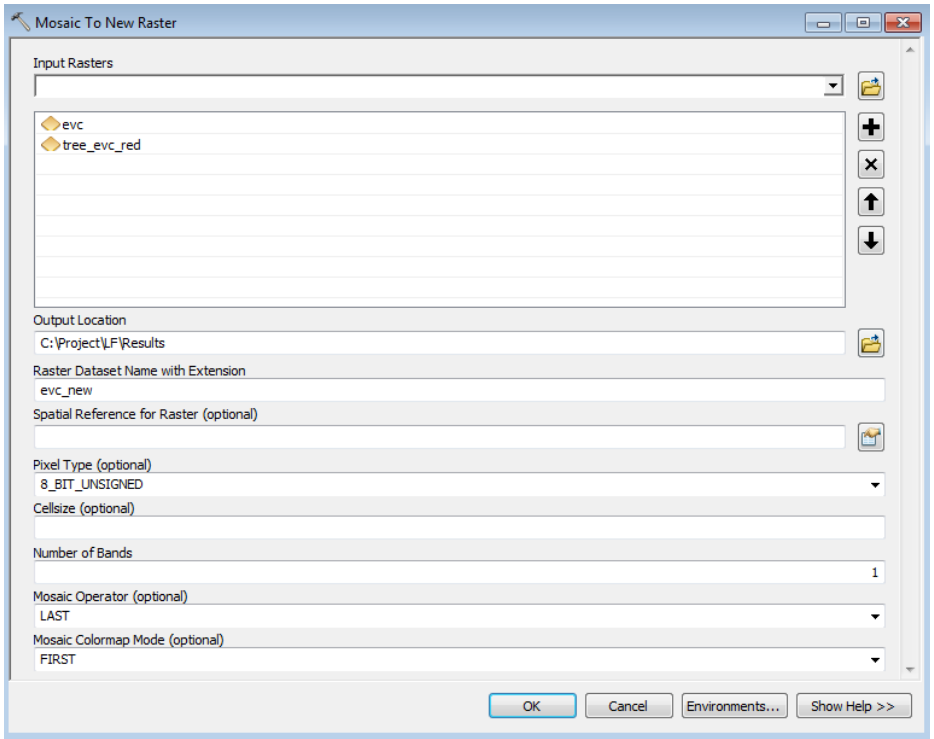



Update the new values to reflect the reduced canopy cover classes as to the right. Notice that since the highest value in the Sawtooth project was for **[tree_red]** was 85, we only needed to create 8 classes to reflect EVC values of 101-108. This means that no pixels within the fire disturbance areas had a final canopy cover higher than 85% and therefore no resulting EVC value of 109.



**Step 5D: Mosaic reduced EVC with original**

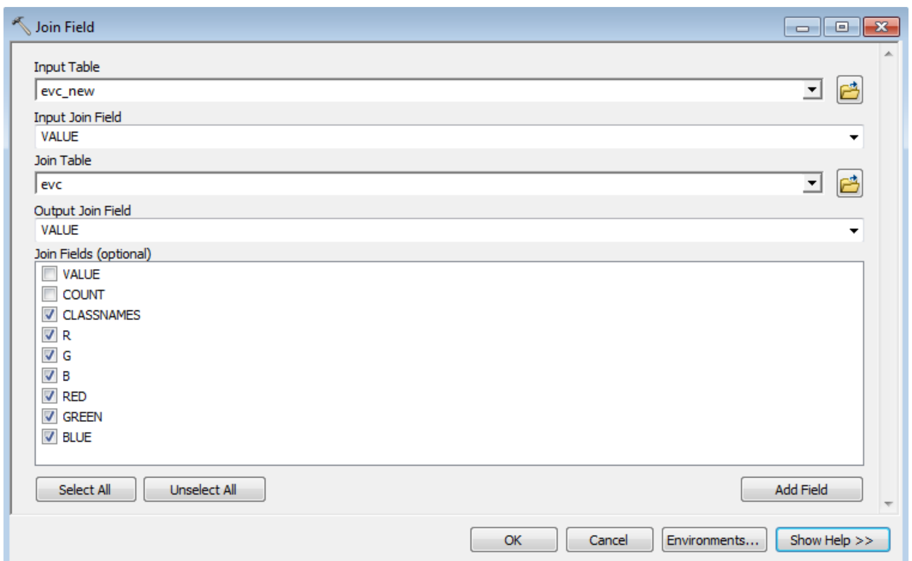
Use the Mosaic to New Raster tool to "stamp" the reclassified **[tree_evc_red]** values onto the **[evc]**. Again, we *are* concerned with the order that the rasters are input. Add the **[tree_evc_red]** raster last since this will overwrite the first input raster. Set parameters as shown below and save the output as **[evc_new]**. This is the updated EVC for use in the LFTFCT.



## Step 6: Join Value Attribute Tables to Processed Rasters

Since ArcGIS "drops" the Value Attribute Tables (VAT) when completing most processing steps on raster data (including Reclassify and using the Raster Calculator), it is useful to join those attributes once the rasters are processed. This step isn't really necessary to complete the pre-processing, but it is very useful for visual comparisons of the data and validation of the operations conducted throughout the pre-processing. Symbolizing the data using existing LANDFIRE colormaps can help to visualize changes in EVC and FDist.

Attributes can be joined from the raw or the masked LANDFIRE rasters. Below we show how the Join Field tool was used to join the attributes from **[evc]** to **[evc_new]**. In this case, we included all the join fields from **[evc]** except *VALUE* and *COUNT*, since these fields already existed in and were accurate for **[evc_new]**. Repeat this process as needed for other rasters.




***TIP:*** *This is a good time to check the pre-processing output rasters. See Appendix 1.*

## Step 7: Create New Fuel Rasters with the LANDFIRE Total Fuel Change Tool

Once the pre-processing steps are complete, the LANDFIRE Total Fuel Change Tool is used to create new fuel rasters based on the updated EVC and FDist information. The required LFTFCT inputs are:

- **[fdist_new]**
- **[evc_new]**
- **[evt]**
- **[evh]**
- **[bps]**

For the Sawtooth project we followed the steps outlined in the LFTFCT Tutorial to:

- Define the management unit;
- Import fuel rules for the map zones in the analysis area starting with the rules from the zone that covered the largest extent of the analysis area;
- Edit the existing rules based on local information and create rules as needed to cover all data combinations; and
- Create output surface and canopy fuel rasters.

***TIP:*** *The LANDFIRE Total Fuel Change Tool provides an interface for updating fuels rules and producing new rasters. A tutorial and user guide for the tool are available from the LANDFIRE Tools and User Document webpage.*

## Appendix 1: Checking the Data as You Go

We used the Combine tool to check our results after several key processing steps:

- Creating the FDist modification 1 **[fdist_tsdmod1]** (Step 3C) and 2 **[fdist_tsdmod2]** (Step 3D) rasters.
- Creating the tree reduction raster **[tree_red]** (Step 5B).

We used the following steps to check the data:

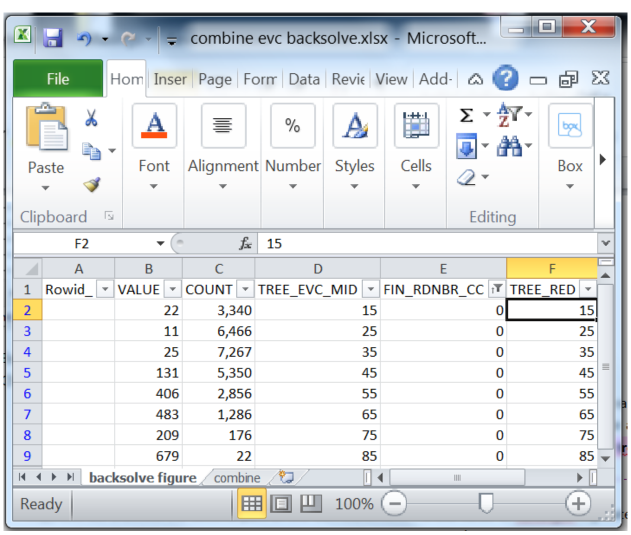
- Combine the key input rasters and the output raster(s), and join the attributes to the combined raster (if needed).
- Export the VAT as a .dbf file and open it in Excel.
- Check that the processing steps are accurate in the results.

**Example: Checking the tree reduction raster (Step 5b)**

1. Combine **[tree_evc_mid]**, **[fin_rdnbr_cc]** and **[tree_red]** (in that order). In this case, we did not join the attributes because the value fields in the combine contained the information we needed. Users of RAVG data will need to convert their **[fin_rdnbr_cc]** grid from float to integer before performing this combine.

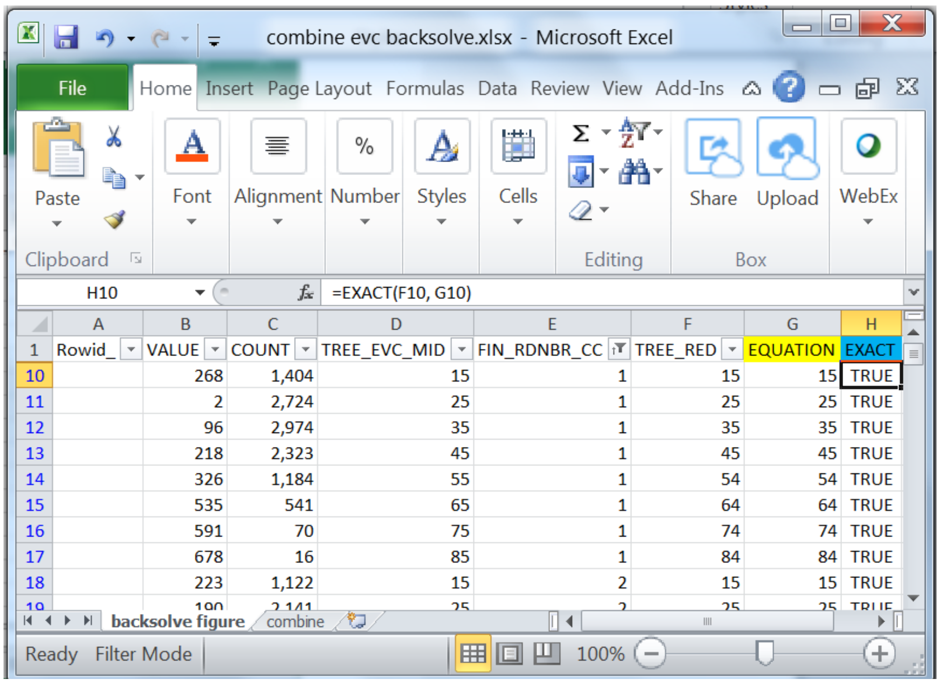
2. Export the table to a text file and open it in Excel.

3. Check the data in Excel:
   a. First we checked part one of the Con statement (see Step 5B) – if the canopy reduction raster **fin_rdnbr_cc**, equals 0 then assign the **tree_evc_mid** value. We used a filter to eliminate all rows with a **fin_rdnbr_cc** value greater than 0. Then we confirmed that for the remaining rows, the **tree_evc_mid** value was equal to the **tree_red** value.




| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Rowid_ | VALUE | COUNT | TREE_EVC_MID | FIN_RDNBR_CC | TREE_RED |
| 2 | | 22 | 3,340 | 15 | 0 | 15 |
| 3 | | 11 | 6,466 | 25 | 0 | 25 |
| 4 | | 25 | 7,267 | 35 | 0 | 35 |
| 5 | | 131 | 5,350 | 45 | 0 | 45 |
| 6 | | 406 | 2,856 | 55 | 0 | 55 |
| 7 | | 483 | 1,286 | 65 | 0 | 65 |
| 8 | | 209 | 176 | 75 | 0 | 75 |
| 9 | | 679 | 22 | 85 | 0 | 85 |

b. Next we checked the second part of the Con statement – if the value of **fin_rdnbr_cc** is greater than 0 then perform the following equation: (((100 - Float("**fin_rdnbr_cc**")) / 100) * "**tree_evc_mid**") + 0.5). We filtered to eliminate all rows with a **fin_rdnbr_cc** value of 0. Then in an empty column we added the equation in a format that would work in Excel: =INT((((100-**E10**)/100)***D10**)+0.5) (In this case E10 = **fin_rdnbr_cc** and D10 = **tree_evc_mid**). The results of the equation (column G in the screen grab below) will match the **tree_red** value (column F) if the tree reduction raster is accurate. To compare values from many cells, use the [Exact function](#) (shown in column H). Resulting values should all be TRUE; if not, recheck your work.




| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | Rowid_ | VALUE | COUNT | TREE_EVC_MID | FIN_RDNBR_CC | TREE_RED | EQUATION | EXACT |
| 10 | | 268 | 1,404 | 15 | 1 | 15 | 15 | TRUE |
| 11 | | 2 | 2,724 | 25 | 1 | 25 | 25 | TRUE |
| 12 | | 96 | 2,974 | 35 | 1 | 35 | 35 | TRUE |
| 13 | | 218 | 2,323 | 45 | 1 | 45 | 45 | TRUE |
| 14 | | 326 | 1,184 | 55 | 1 | 54 | 54 | TRUE |
| 15 | | 535 | 541 | 65 | 1 | 64 | 64 | TRUE |
| 16 | | 591 | 70 | 75 | 1 | 74 | 74 | TRUE |
| 17 | | 678 | 16 | 85 | 1 | 84 | 84 | TRUE |
| 18 | | 223 | 1,122 | 15 | 2 | 15 | 15 | TRUE |
| 19 | | 190 | 2,141 | 25 | 2 | 25 | 25 | TRUE |