# Determining Success of Conservation Efforts in the Big Bend National Park

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**Project Scope**

Big Bend National Park (BBNP) is located in southwest Texas and encompasses 1,252 square miles of land. Approximately 200 miles of the Rio Grande River forms the entire southern boundary of the park as well as the international boundary between the United States and Mexico. The park was first established as a state park in 1933, authorized as a National Park in 1935, and formally established on June 12, 1944. Since it's inception, a primary mission of the park has been to preserve and protect the national resources of the park, such as the Chihuahuan Desert ecosystem and the Rio Grande River. Unfortunately, the park faces significant threats to this mission, with heavy use and sedimentation of the Rio Grande river and channel, habitat loss due to climate change and nonnative species, and man-made influence through recreation such as hiking and camping (Big Bend 2019).

In 2010, then-President Barack Obama launched the America's Great Outdoors Initiative with the goal of conserving outdoor spaces (Council n.d.). The Big Bend Conservation Cooperative (BBCC), a group of government agencies such as the National Park Service (NPS) and U.S. Geological Survey (USGS) and over 30 state and local agencies, initiated several projects in the park aimed at restoring grassland, riparian, and wetland habitats. The BBCC reported in 2015 that their efforts had led to the restoration of over 6,800 acres of grassland habitats, 500 acres of riparian habitats, and 70 acres of wetland habitats (Roberson 2015).

The purpose of this project is to examine the change in landcover from the start of the America's Great Outdoors Initiative in 2010 to the conclusion of the BBCC's projects in 2015. The goal is to identify the location and amount of landcover change to surmise the relative success of the conservation efforts. Criteria for success is a net increase in landcover as well as noticeable landcover increases near water sources, as this also helps curb erosion and river sedimentation, thus improving the quality of the Rio Grande River.

## **Data Sources**

BBNP General Information

- National Park Service

BBNP General Data

- Department of the Interior datasets (Shapefiles)

Digital Elevation Models (DEMs)

- USGS National Map

Landcover data

- Landfire.gov

## **Data Processing**

*Note: All data files used were projected into NAD_1983_Albers coordinate system using the project tool.*

The first step taken was to create a hillshade for the entire park. Once landcover data is laid on top, it will be a good indication of landcover growth on slopes in the park. Low vegetation on slopes would increase the amount of sediment that could find its way to the Rio Grande through runoff. Three DEMs cover the entirety of the park, 29N/30N 104W and 30N 103W, as seen in Figure 1.

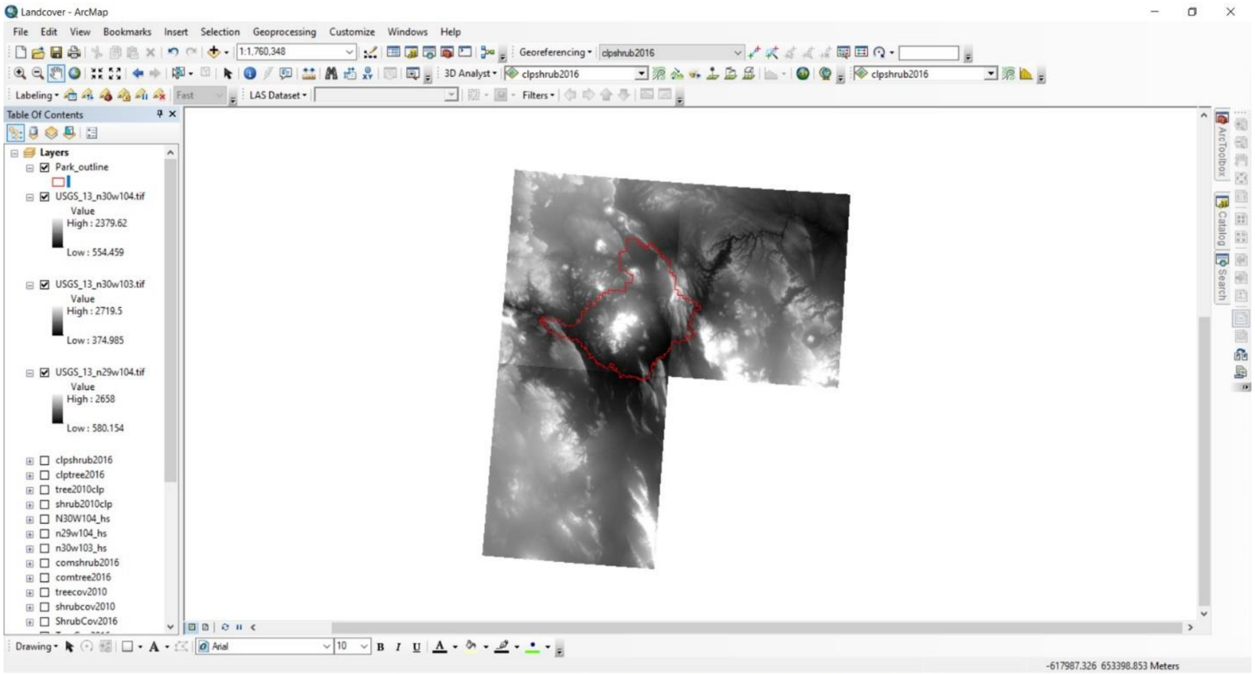



**Figure 1**. *Digital Elevation Models (DEMs) for Big Bend National Park*

The Raster Clip tool (Data Management > Raster > Raster processing > Clip) was used to create DEM rasters bounded by the BBNP park boundaries. The input raster was each of the DEMs and the output extent was the park outline. The "Use Input Features for Clipping Geometry" box was checked in all cases to avoid any DEM overhangs (Figure 2).

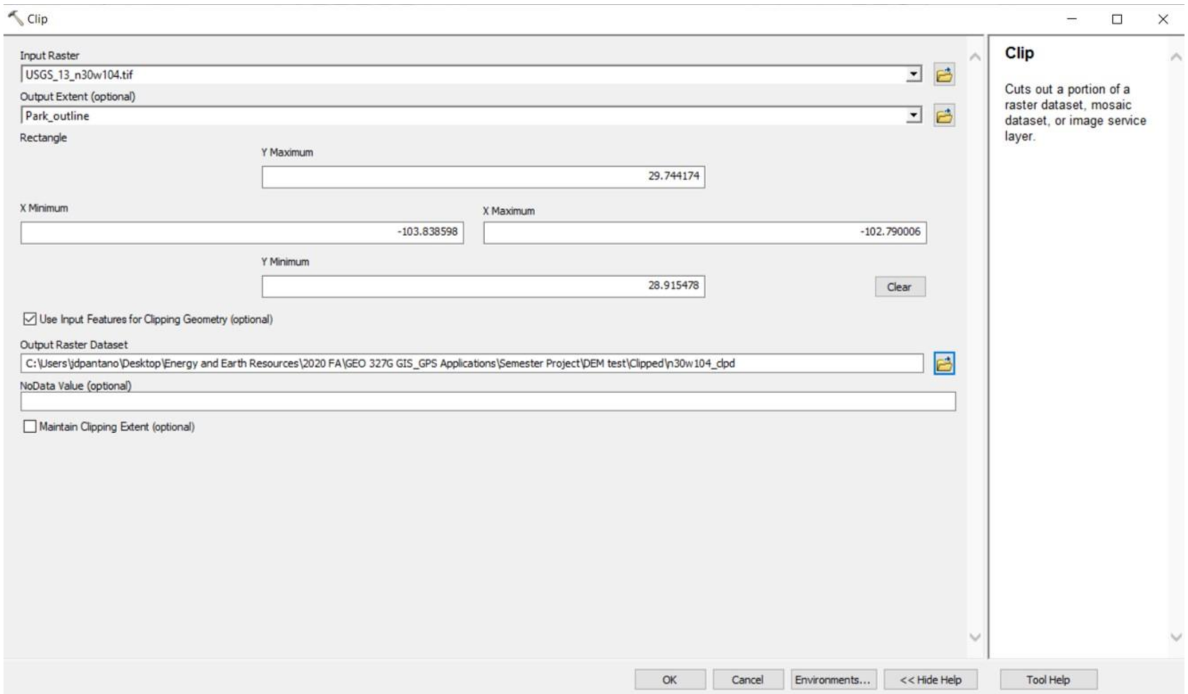



**Figure 2**. *Raster Clip tool for DEMs*

Once complete, the three DEMs lined up completely with the park boundaries, however they were still in three separate files (Figure 3).

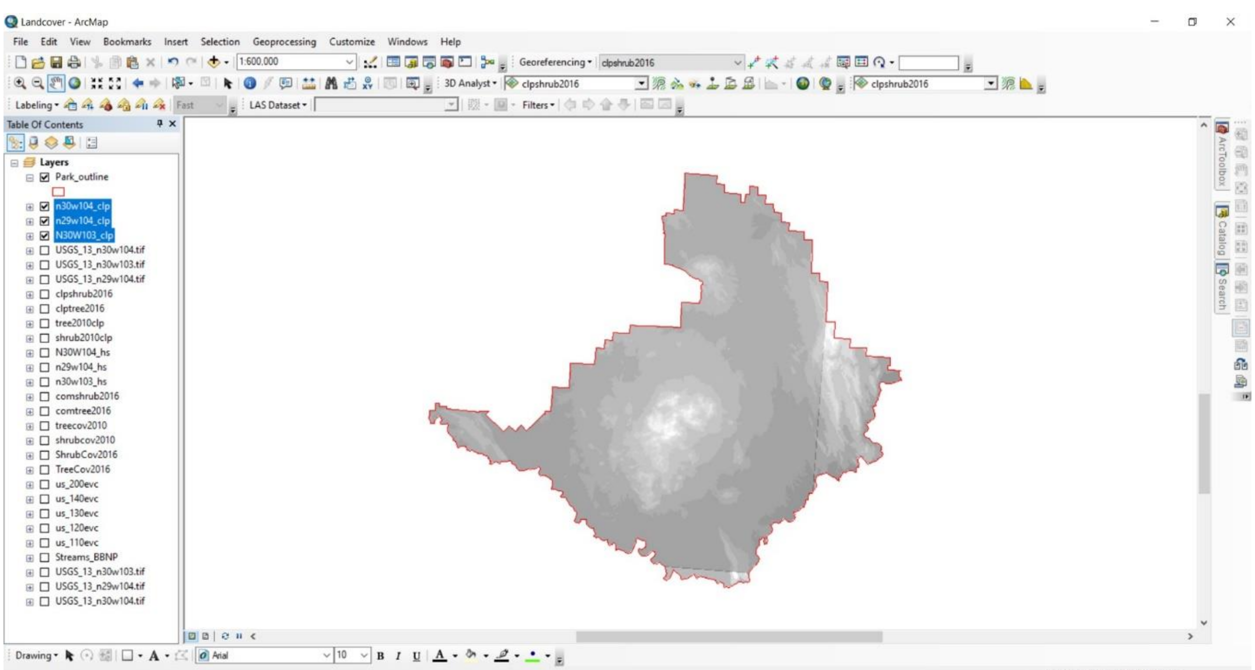



**Figure 3**. *Separate clipped DEMs for BBNP*

In order to make it easier to work with the data, the three DEMs were combined using the Mosaic to New Raster tool (Data Management > Raster > Raster Dataset > Mosaic to New Raster). The three DEMs were used as the input raster and the number of bands and spatial reference were set. No other environments were changed (Figure 4).

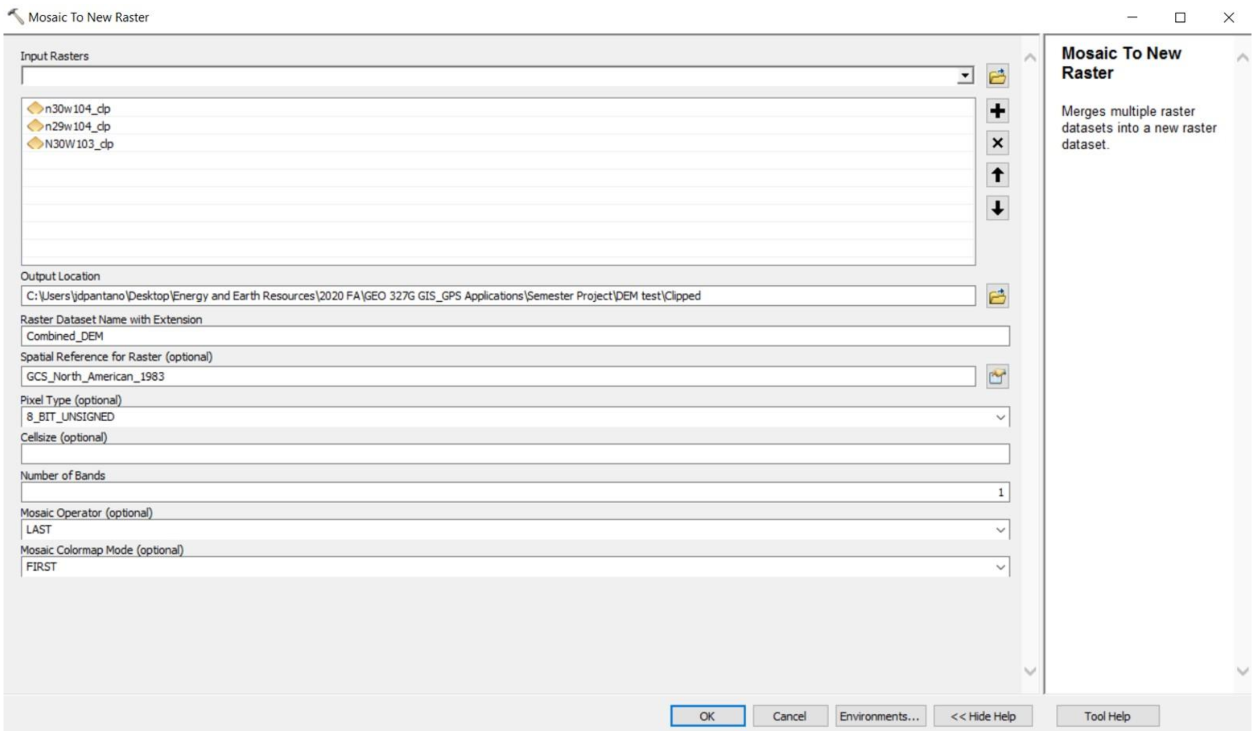



**Figure 4**. *Mosaic to New Raster inputs*

The resulting DEM was a combination of the three. The DEM was classified with elevation intervals of 200m (Figure 5) and symbolized with the Elevation #2 color wheel (Figure 6), resulting in the combined, symbolized DEM seen in Figure 7.

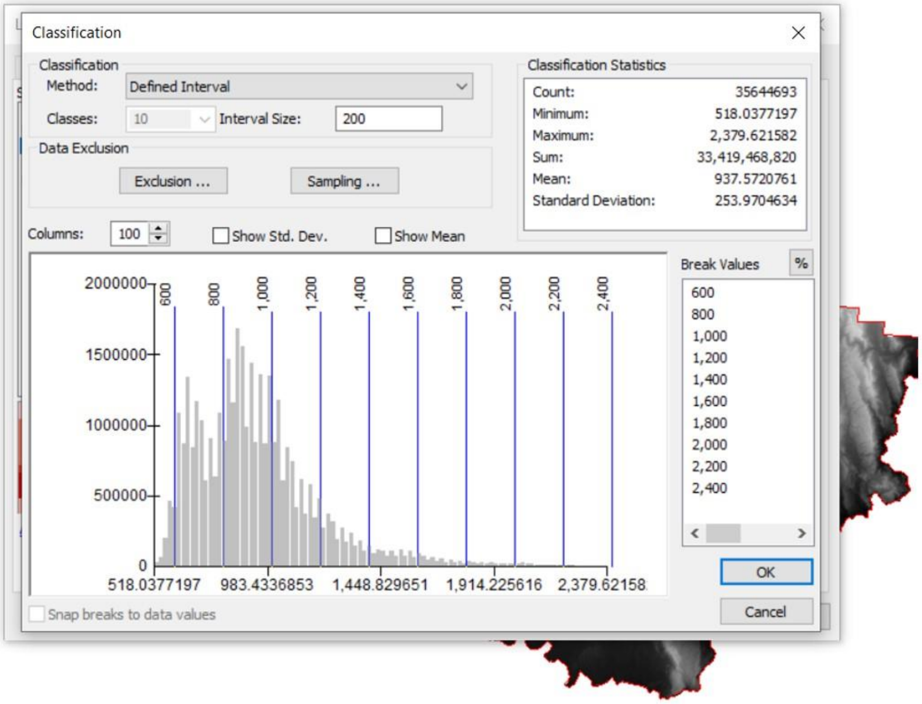



**Figure 5**. *Classification of DEM*

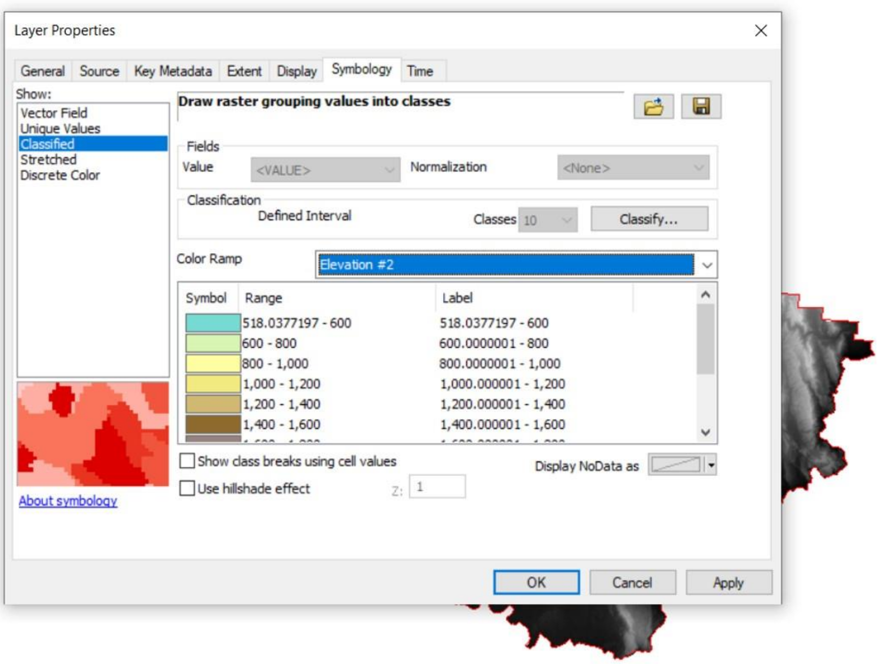



**Figure 6**. *DEM symbology*

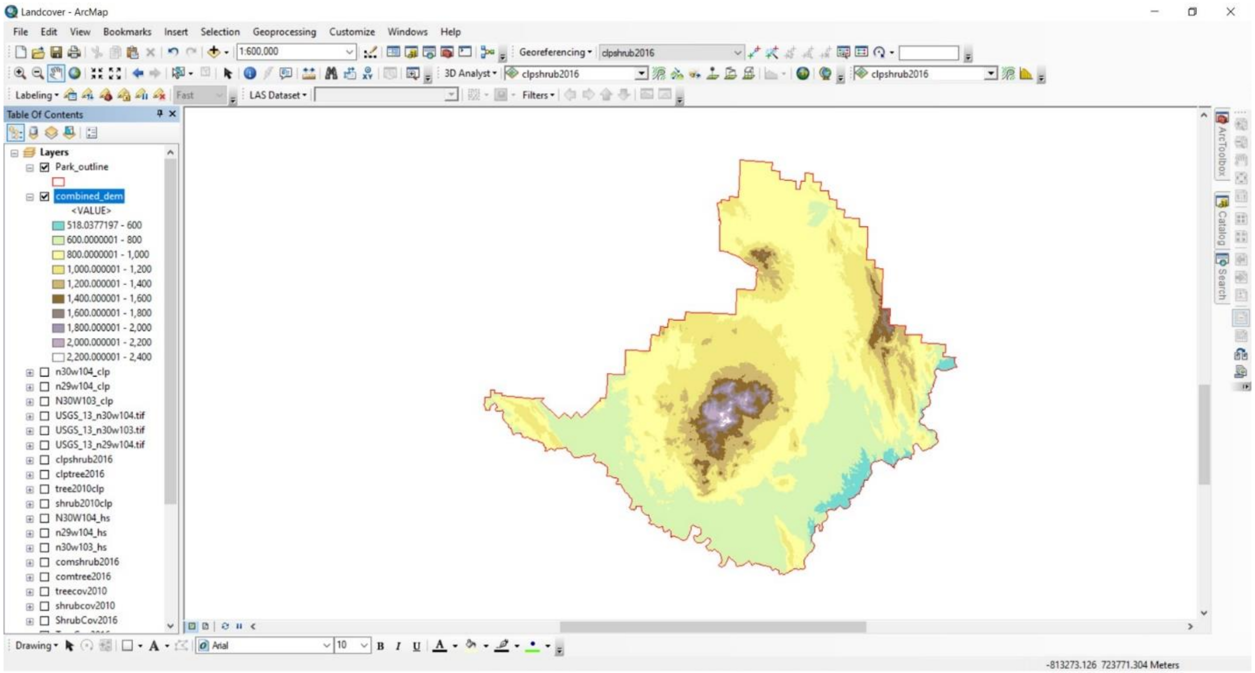



**Figure 7**. *Combined and symbolized DEM*

To create a hillshade, the Hillshade tool (Spatial Analyst > Surface > Hillshade) was used. The input raster was the combined DEM, and the optional Z factor was given a default value of 1 (Figure 8).

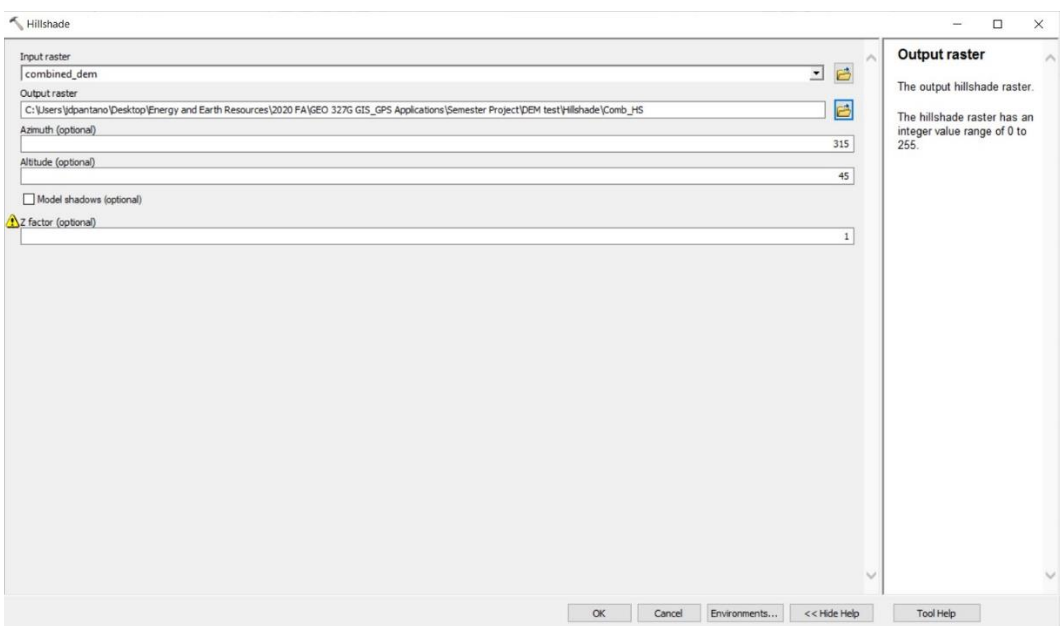



**Figure 8**. *Hillshade inputs*

The resulting hillshade was then stretched with standard deviations of 2. The combined DEM was set to a transparency of 50% and overlaid on the hillshade by putting it above in the table of contents (TOC) (Figure 9). This was the last step for the DEM processing.

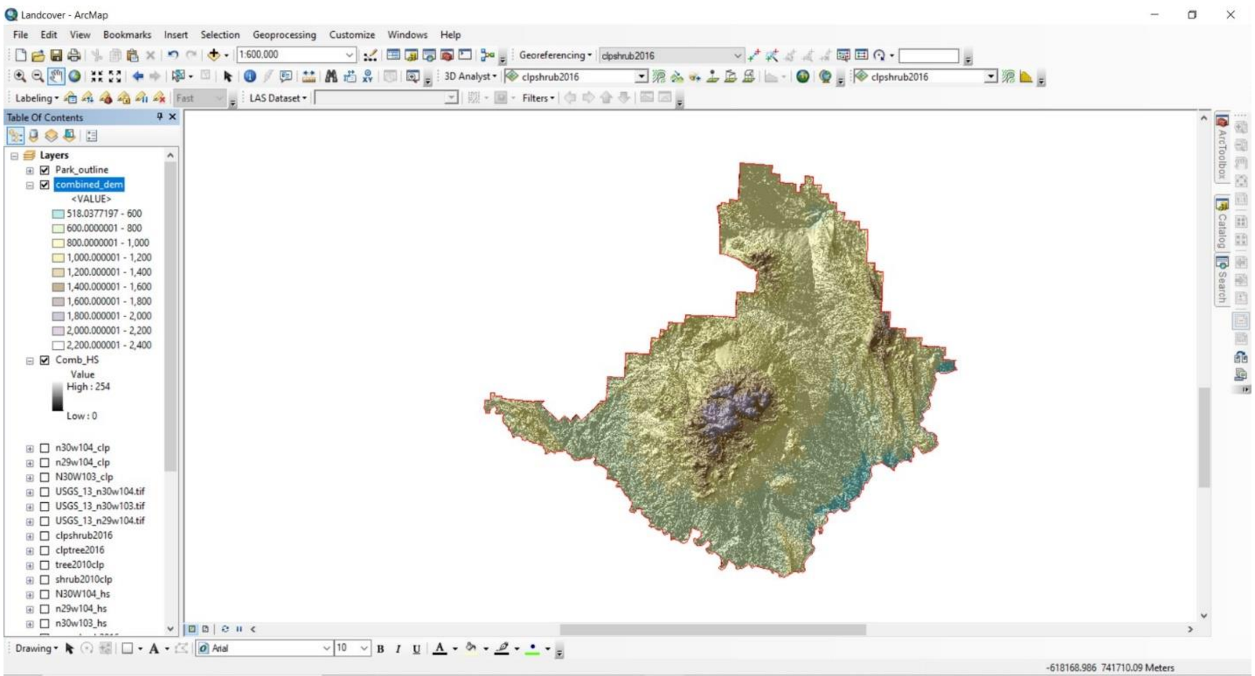



**Figure 9**. *Hillshade with DEM overlay*

Next, the landcover data had to be processed. Two sets of data were retrieved in GeoTIFF format, existing landcover for 2010 and existing landcover for 2016. Both sets of data were processed the same, apart from the data sorting that needed to be done to only the 2016 data. Retrieving the data from LANDFIRE.gov involved zooming in to the area of interest (AoI) on an interactive map and using a rectangle tool to select the desired data. As such, the data was much larger than the project's AoI (Figure 10) and was clipped in the same way as the DEM raster, using the Raster Clip tool.

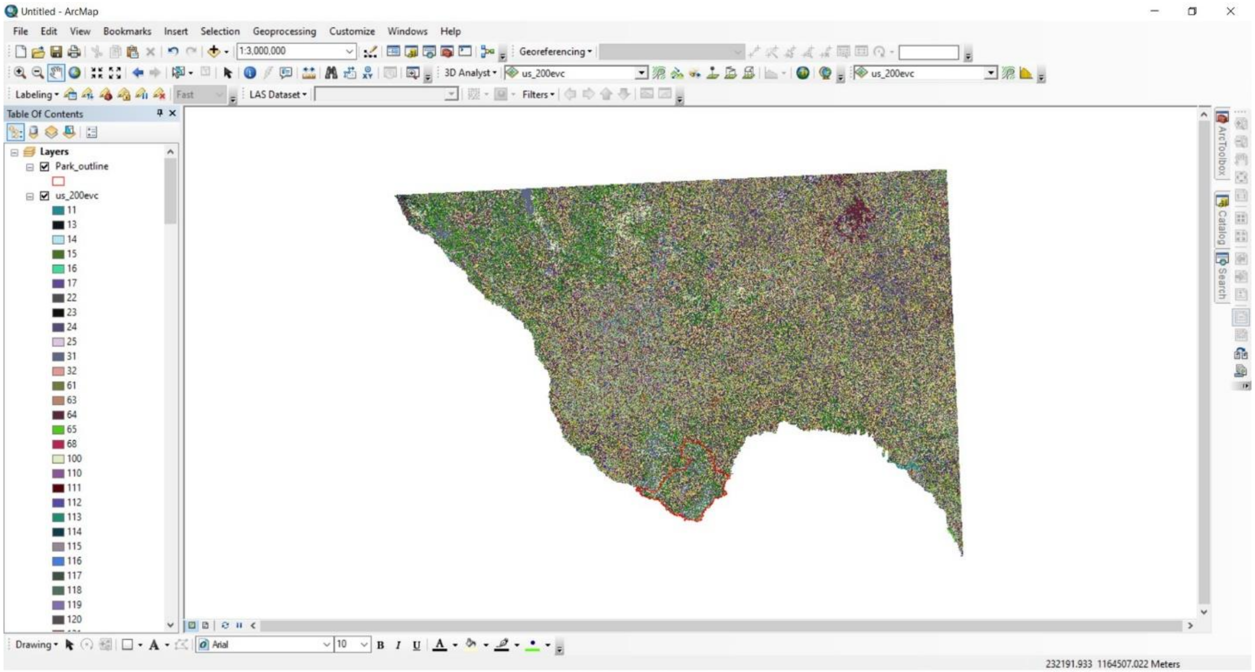



**Figure 10**. *Raw landcover data*

Additionally, the 2016 data included over 300 values that corresponded to various types of landcover. Because this project is only concerned with vegetation, the data needed to be filtered to include only tree cover and shrub cover. This was accomplished by using a conditional statement in map algebra that looked at values between specific ranges and creating a raster with only those values. Both landcover rasters were put through the raster calculator with similar expressions seen in Figure 11. The tree cover values for 2016 were 110-199 and shrub cover was 210-299. For 2010, the values were different (will be shown in a future step) but the data was processed using similar expressions.

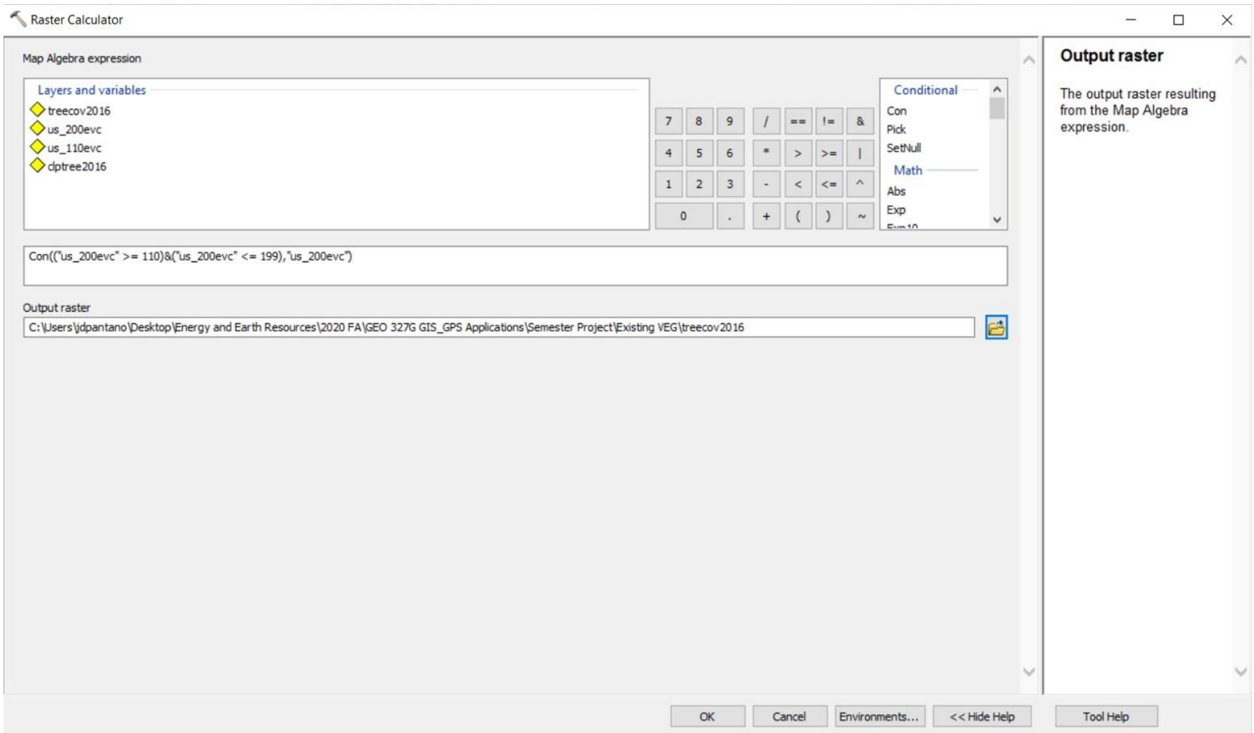



**Figure 11**. *Creating a raster with only tree cover data*

This map algebra resulted in four separate rasters, two showing tree and shrub cover in 2016 and two showing tree and shrub cover in 2010 (Figure 12).

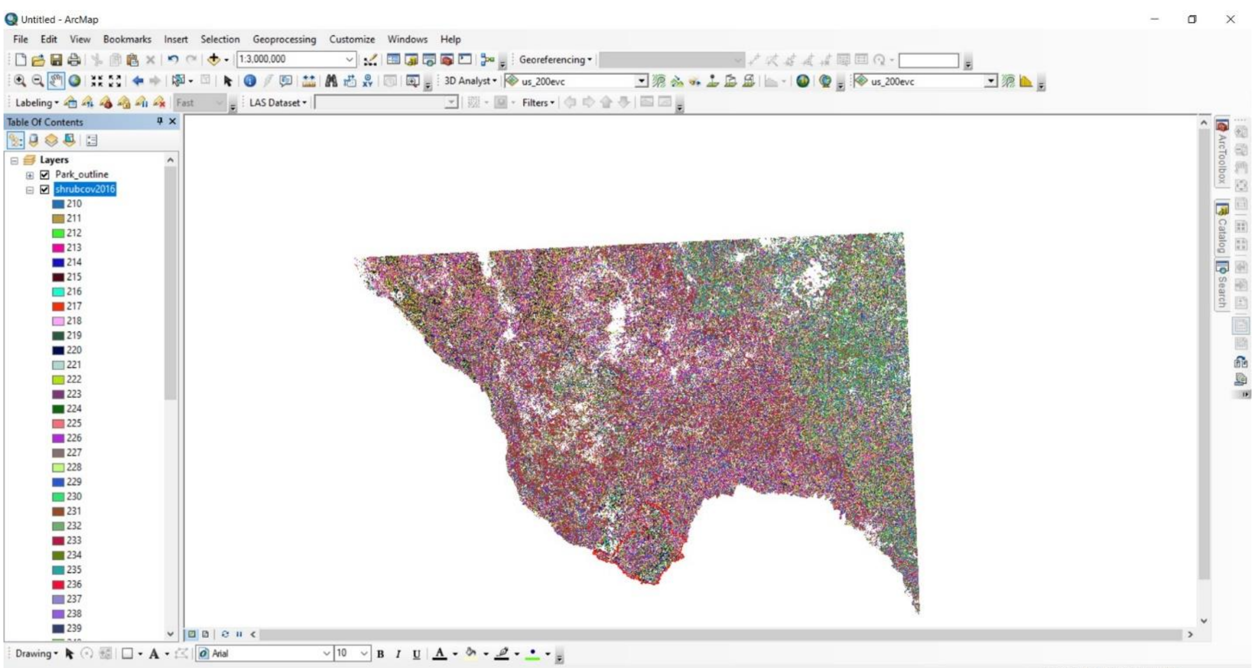



**Figure 12**. *Example raster showing only shrub cover after map algebra*

The data for 2016 was much more exact than for earlier years. For instance, the value for 15% tree cover was 115 in 2016, however earlier years had more of a range, for instance 20-29% tree cover had a value of 102 (Figure 13).

**2014 and earlier attribute details**

| | |
|---|---|
| 102 | Tree Cover >= 20 and < 30% |
| 103 | Tree Cover >= 30 and < 40% |
| 104 | Tree Cover >= 40 and < 50% |
| 105 | Tree Cover >= 50 and < 60% |
| 106 | Tree Cover >= 60 and < 70% |
| 107 | Tree Cover >= 70 and < 80% |
| 108 | Tree Cover >= 80 and < 90% |
| 109 | Tree Cover >= 90 and <= 100% |
| 111 | Shrub Cover >= 10 and < 20% |
| 112 | Shrub Cover >= 20 and < 30% |
| 113 | Shrub Cover >= 30 and < 40% |
| 114 | Shrub Cover >= 40 and < 50% |
| 115 | Shrub Cover >= 50 and < 60% |
| 116 | Shrub Cover >= 60 and < 70% |

**2016 attribute details**

| | |
|---|---|
| 110 | Tree Cover = 10% |
| 111 | Tree Cover = 11% |
| 112 | Tree Cover = 12% |
| 113 | Tree Cover = 13% |
| 114 | Tree Cover = 14% |
| 115 | Tree Cover = 15% |
| 116 | Tree Cover = 16% |
| 117 | Tree Cover = 17% |
| 118 | Tree Cover = 18% |
| 119 | Tree Cover = 19% |
| 120 | Tree Cover = 20% |
| 121 | Tree Cover = 21% |
| 122 | Tree Cover = 22% |
| 123 | Tree Cover = 23% |
| 124 | Tree Cover = 24% |
| 125 | Tree Cover = 25% |
| 126 | Tree Cover = 26% |
| 127 | Tree Cover = 27% |
| 128 | Tree Cover = 28% |
| 129 | Tree Cover = 29% |
| 130 | Tree Cover = 30% |
| 131 | Tree Cover = 31% |
| 132 | Tree Cover = 32% |
| 133 | Tree Cover = 33% |
| 134 | Tree Cover = 34% |
| 135 | Tree Cover = 35% |
| 136 | Tree Cover = 36% |
| 137 | Tree Cover = 37% |

**Figure 13**. *Attribute table differences between 2010 and 2016 data*

To ultimately be able to determine the changes between the two datasets, the attribute tables needed to look similar. Both rasters for 2016 (tree cover and shrub cover) were put through the raster calculator again. A series of conditional statements were used to group the individual values into ranges and given values that corresponded to the earlier 2010 data. For example, the expression compiled all values between 110 and 119 for the 2016 tree cover (10%-19% tree cover) and returned a value of 101 (2010 range of 10-19% tree cover) with the combined count (Figure 14). This was done for both 2016 rasters and the output resembled the 2010 data exactly. All four datasets were then clipped to only display data within park boundaries (Figure 15).

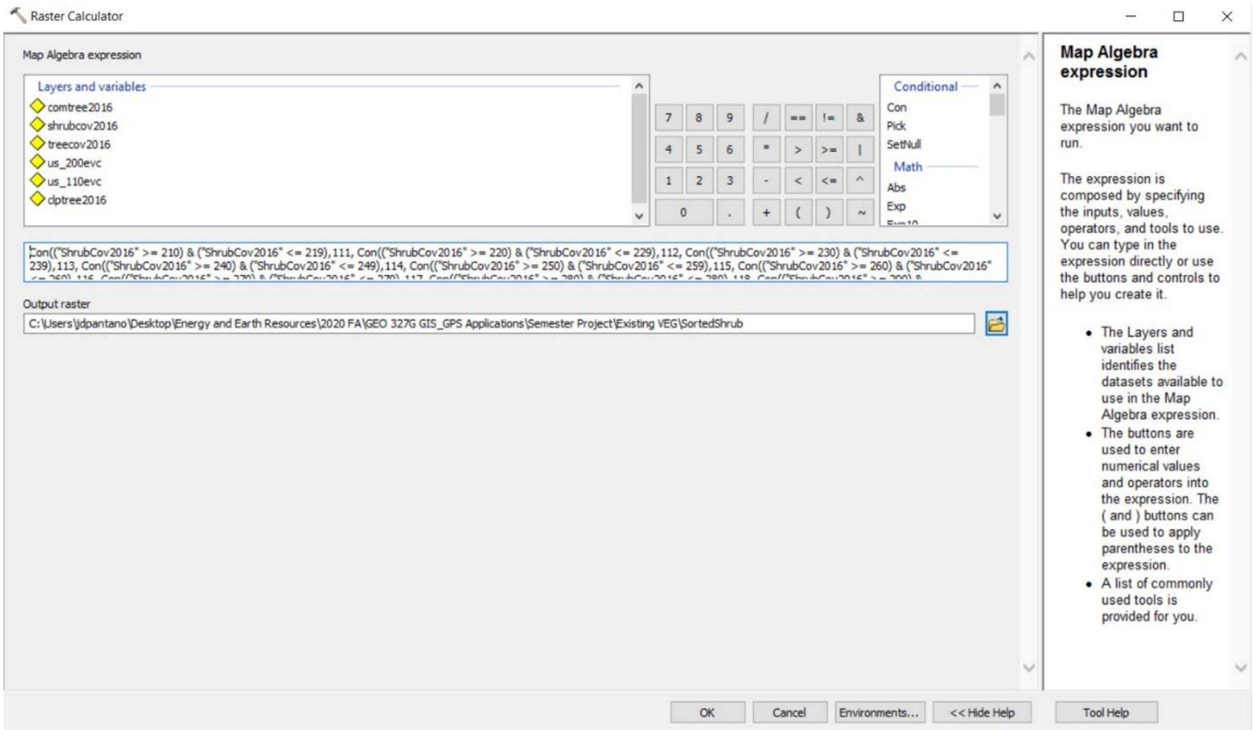



**Figure 14**. *Map algebra to sort the 2016 data into ranges*

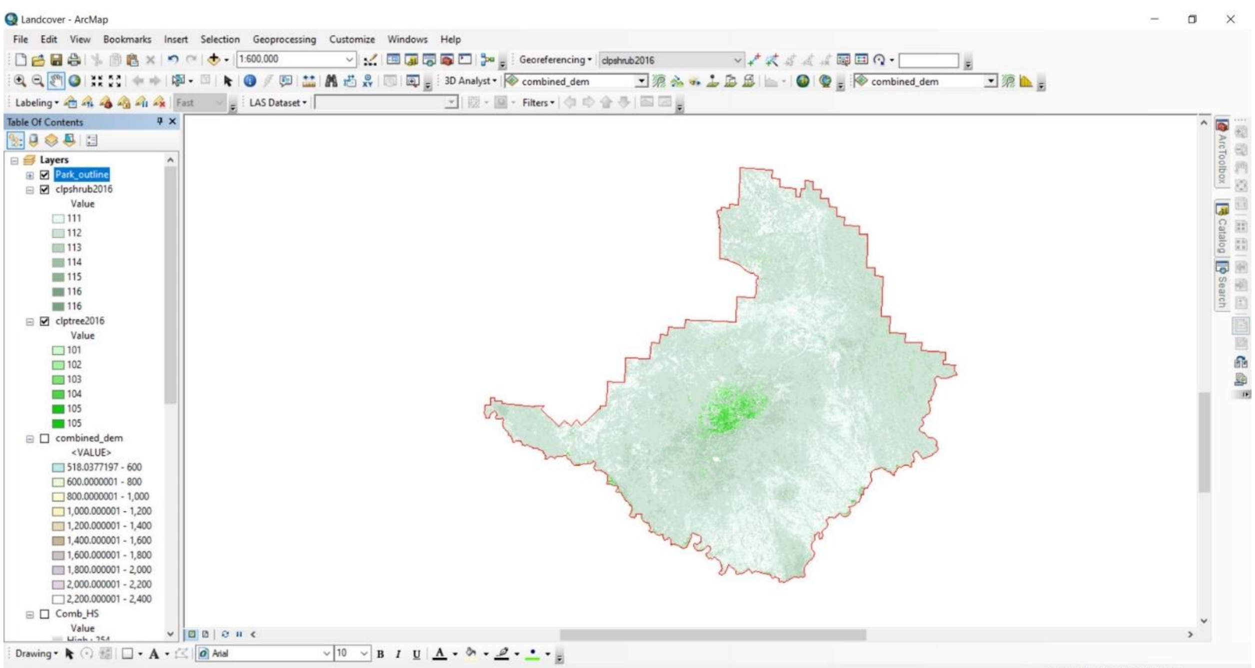



**Figure 15**. *Clipped and sorted landcover rasters*

The final step was to use map algebra to determine the change in vegetation from 2010 to 2016. A simple conditional statement was used that subtracted the 2010 values from

2016 and returned the data using the same range of values (Figure 16). Figure 17 shows the vegetation in 2016 that was not present in 2010, thus the growth between the years.

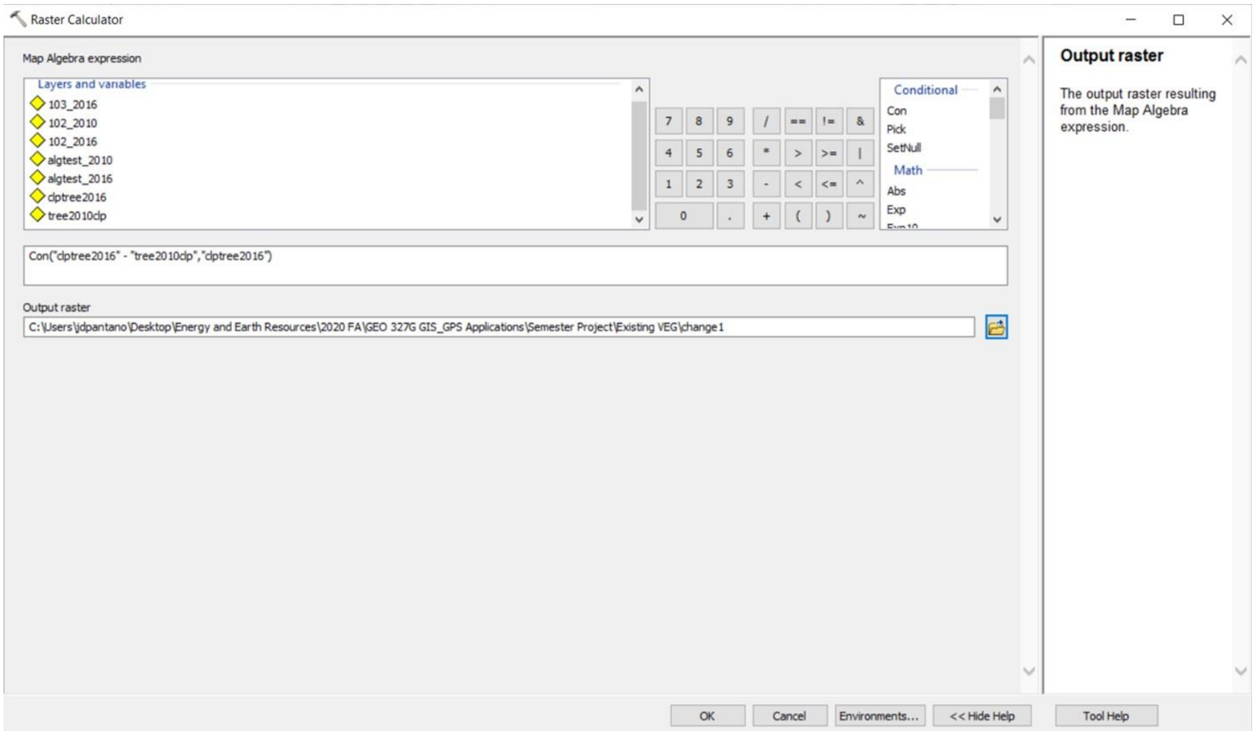



**Figure 16**. *Map algebra to determine changes in landcover*

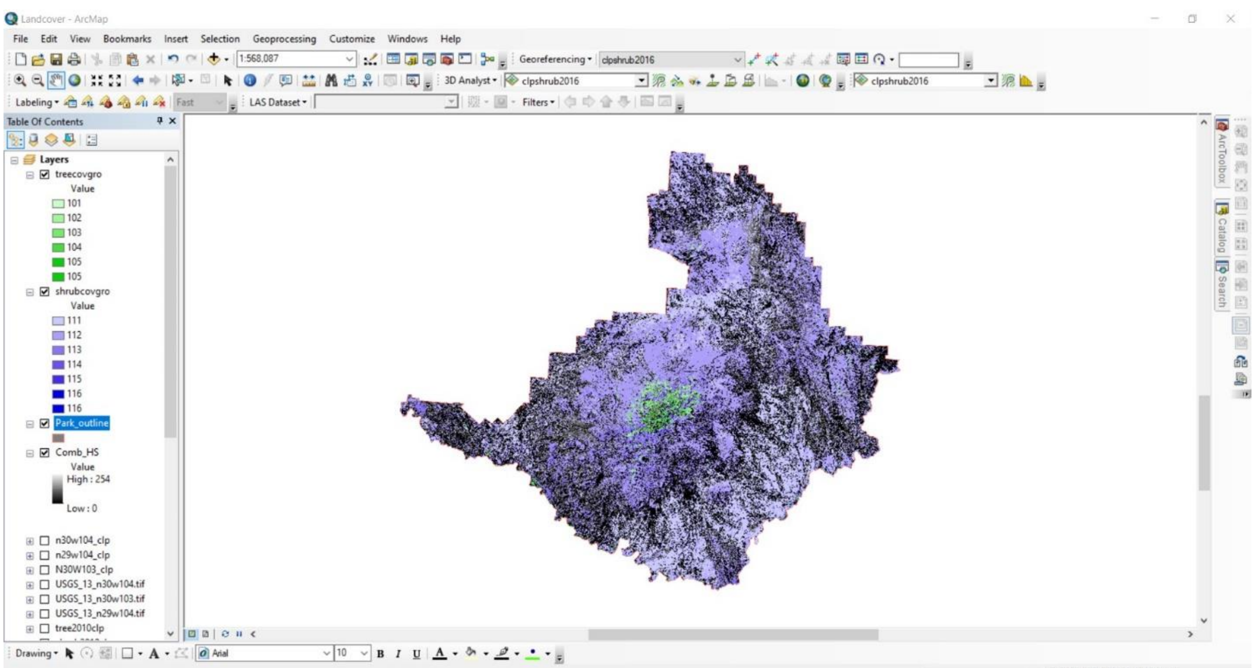



**Figure 17**. *Final raster showing the landcover growth from 2010 to 2016*

## **Discussion**

Looking at the final raster that depicts the growth between 2010 and 2016, significant tree and shrub growth did occur throughout the entirety of the park. It appears that most of the tree cover growth occurred in and around the highest elevations in the park, however closer review shows that the conservation of the riparian habitats also resulted in tree cover growth in the vicinity of streams and the Rio Grande (Figure 18). On a purely visual basis, the criteria for success as outlined in the project scope have been met based on the widespread shrub growth on slopes, the overall apparent growth in tree cover and shrub cover, as well as the growth in riparian habitats. Therefore, the conservation efforts of the BBCC can be considered successful, although there are some limitations to this assessment.

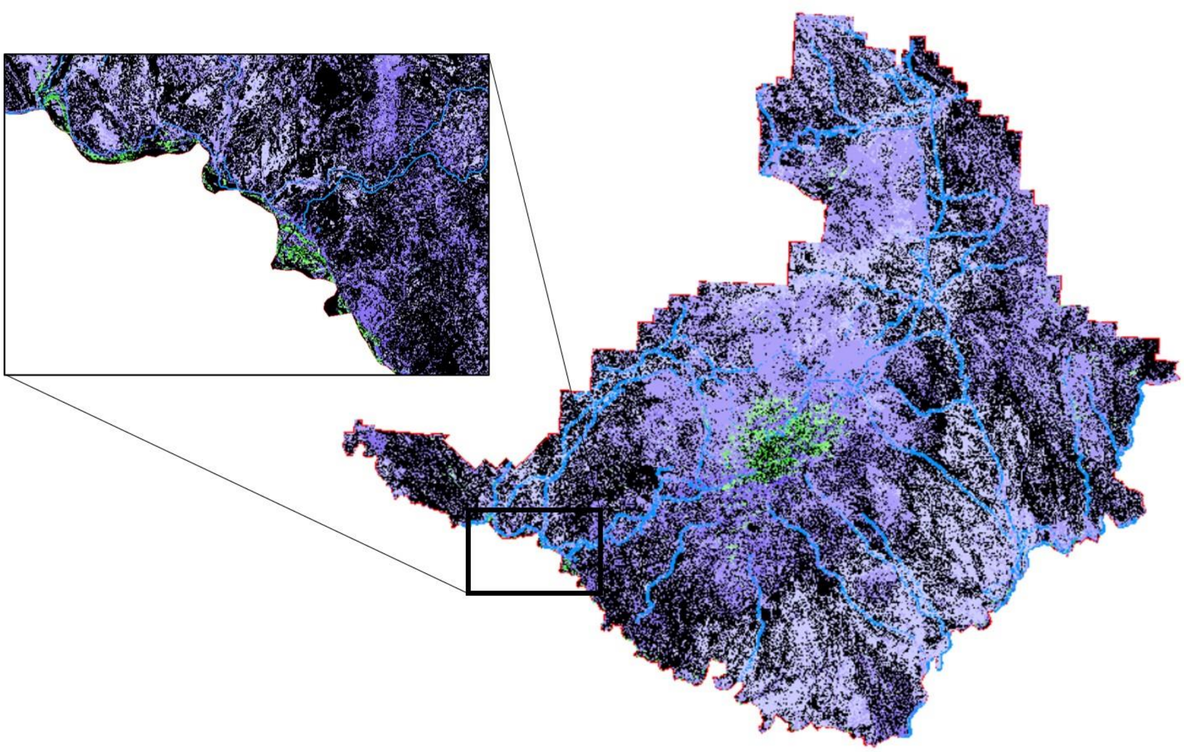


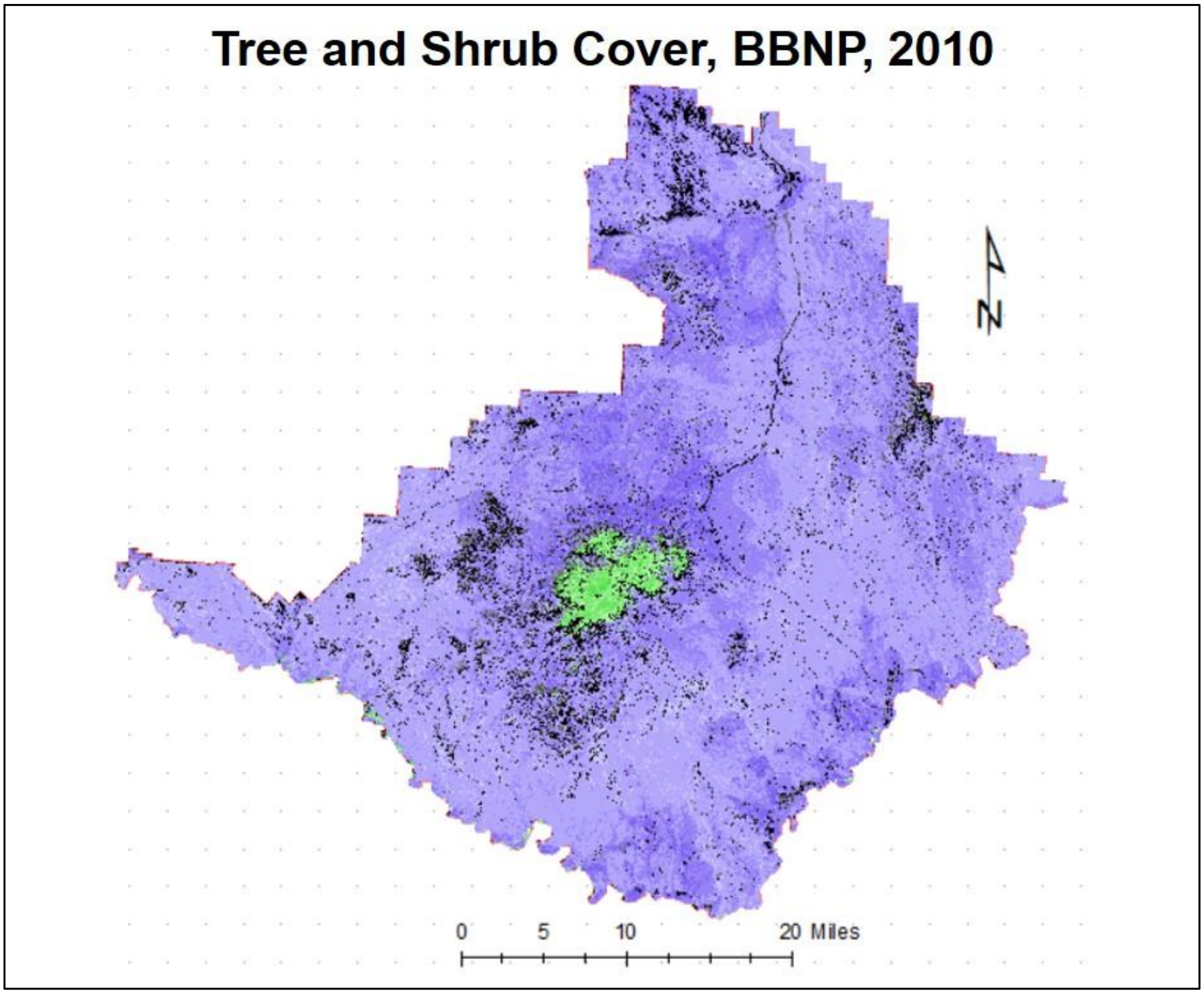
**Figure 18**. *Riparian tree cover growth*

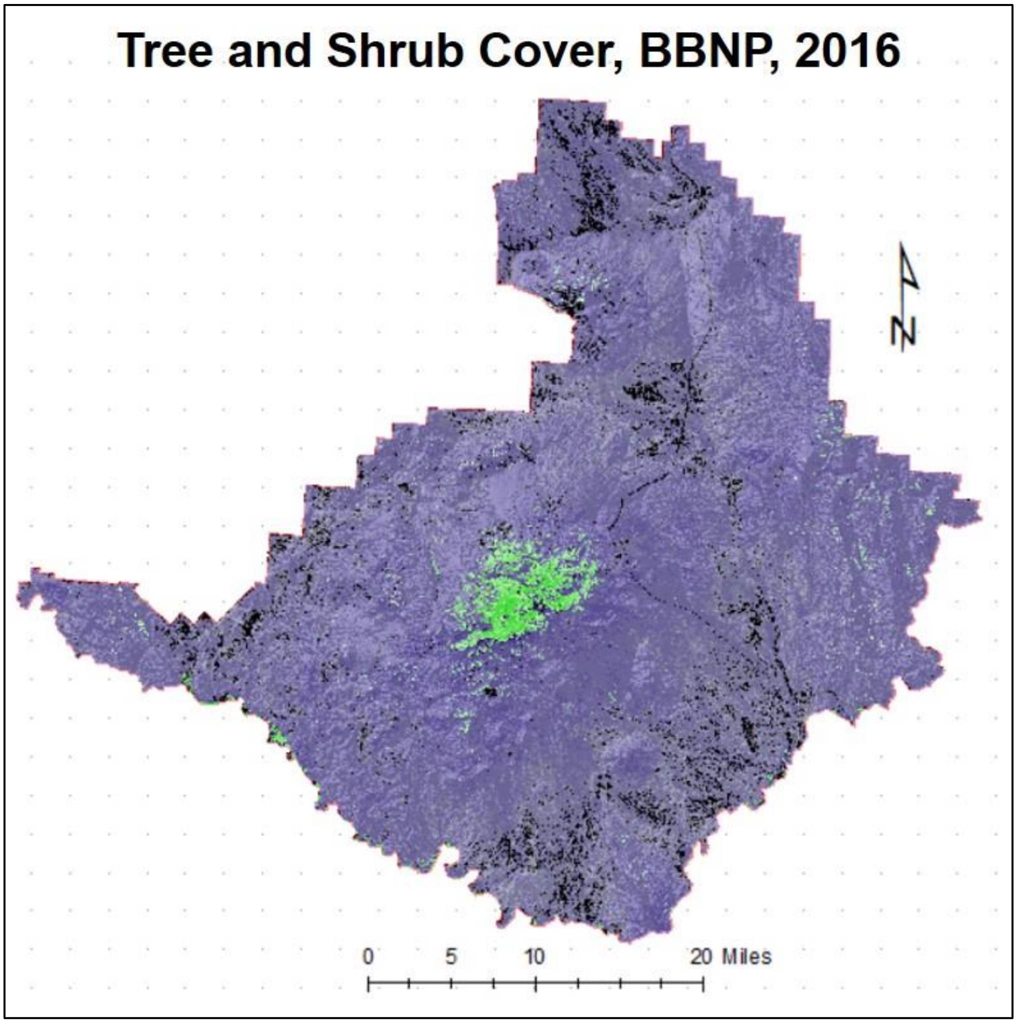
First, there is a limitation regarding the results of the map algebra between the landcover data in 2016 and the landcover data in 2010. The subtraction between the two rasters only returns the landcover present in 2016 that was not present in 2010. It does not consider the landcover that was present in 2010 that was destroyed or lost and therefore not present in 2016. To mitigate this limitation, the attribute table for both sets of data were used. Knowing that the raster has 30x30 cells and that the linear unit is in meters, it is possible to determine the net change in landcover between the two timeframes. The counts of each value were taken and converted into total area for both 2016 and 2010. The difference was found and totaled, as shown in Figure 19. Using the raw data, there was a net increase of 34.16 square miles of landcover which equates to 2.68% of BBNP. In comparison, if the loss in landcover between 2010 and 2016 is not considered, landcover present in 2016 that was not present in 2010 would account for 692.97 square miles and 54.5% of the park.

| | | 2016 | | | 2010 | | | Change | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Value | Name | Count | Area | % of BBNP | Count | Area | % of BBNP | Count | Area | % of BBNP |
| 101 | Tree Cover 10-19% | 10314 | 3.5840 | 0.2821% | 2929 | 1.0178 | 0.0801% | 7385.00 | 2.5662 | 0.2020% |
| 102 | Tree Cover 20-29% | 37488 | 13.0267 | 1.0252% | 21134 | 7.3439 | 0.5780% | 16354.00 | 5.6829 | 0.4472% |
| 103 | Tree Cover 30-39% | 28172 | 9.7895 | 0.7704% | 28954 | 10.0612 | 0.7918% | (782.00) | (0.2717) | -0.0214% |
| 104 | Tree Cover 40-49% | 17886 | 6.2152 | 0.4891% | 16383 | 5.6929 | 0.4480% | 1503.00 | 0.5223 | 0.0411% |
| 105 | Tree Cover 50-59% | 758 | 0.2634 | 0.0207% | 2608 | 0.9063 | 0.0713% | (1850.00) | (0.6429) | -0.0506% |
| 106 | Tree Cover 60-69% | | | | 304 | 0.1056 | 0.0083% | (304.00) | (0.1056) | -0.0083% |
| 111 | Shrub Cover 10-19% | 680611 | 236.5059 | 18.6129% | 107969 | 37.5182 | 2.9527% | 572642.00 | 198.9877 | 15.6602% |
| 112 | Shrub Cover 20-29% | 2303574 | 800.4702 | 62.9965% | 1892357 | 657.5762 | 51.7508% | 411217.00 | 142.8940 | 11.2457% |
| 113 | Shrub Cover 30-39% | 329127 | 114.3685 | 9.0007% | 1083648 | 376.5574 | 29.6348% | (754521.00) | (262.1889) | -20.6341% |
| 114 | Shrub Cover 40-49% | 13365 | 4.6442 | 0.3655% | 166992 | 58.0281 | 4.5668% | (153627.00) | (53.3839) | -4.2013% |
| 115 | Shrub Cover 50-59% | 1240 | 0.4309 | 0.0339% | 1050 | 0.3649 | 0.0287% | 190.00 | 0.0660 | 0.0052% |
| 116 | Shrub Cover 60-69% | 108 | 0.0375 | 0.0030% | 1 | 0.0003 | 0.0000% | 107.00 | 0.0372 | 0.0029% |
| | | | | | | | | **98314.00** | **34.16** | **2.6886%** |

**Figure 19**. *Net landcover change between 2010 and 2016*

The second and final limitation does not regard the data, but rather the cause of the change. Although the success criteria were met and the BBCC projects are being considered successful, there were other conservation efforts going on during this same timeframe. For example, several projects relating to invasive species management were undertaken during this same timeframe. Efforts to curb the feral hog population could be the driving factor in the increase in shrub growth or the removal of the saltcedar tree, which stunts the growth of surrounding vegetation, could have played a role in the increase in tree or shrub cover. Therefore, the final conclusion from this project is that although it appears that conservation efforts in BBNP have been successful, it cannot be definitively concluded that the BBCC has been successful in their specific projects.


Tree and Shrub Cover, BBNP, 2010
N
0 5 10 20 Miles


Tree and Shrub Cover, BBNP, 2016
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0
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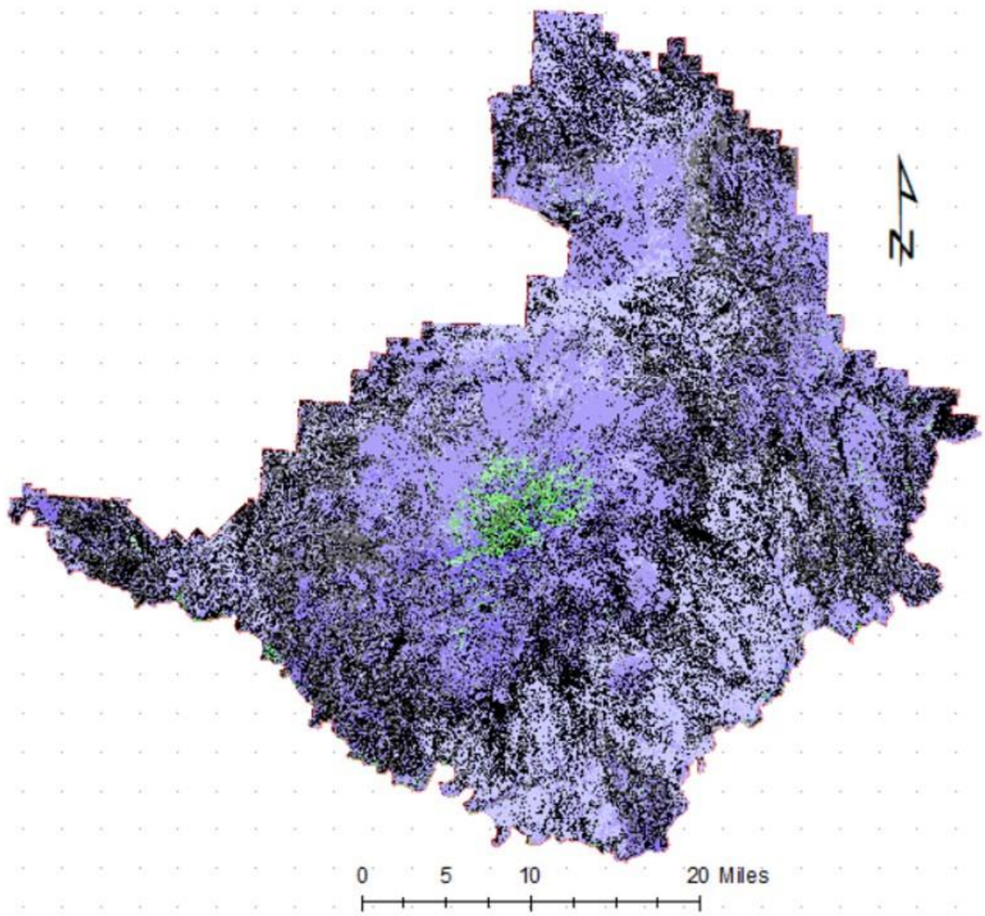
20 Miles

## Tree and Shrub Cover Change, BBNP, 2010-2016



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TNM Download. The National Map. U.S. Geological Survey. https://viewer.nationalmap.gov/basic/#/.