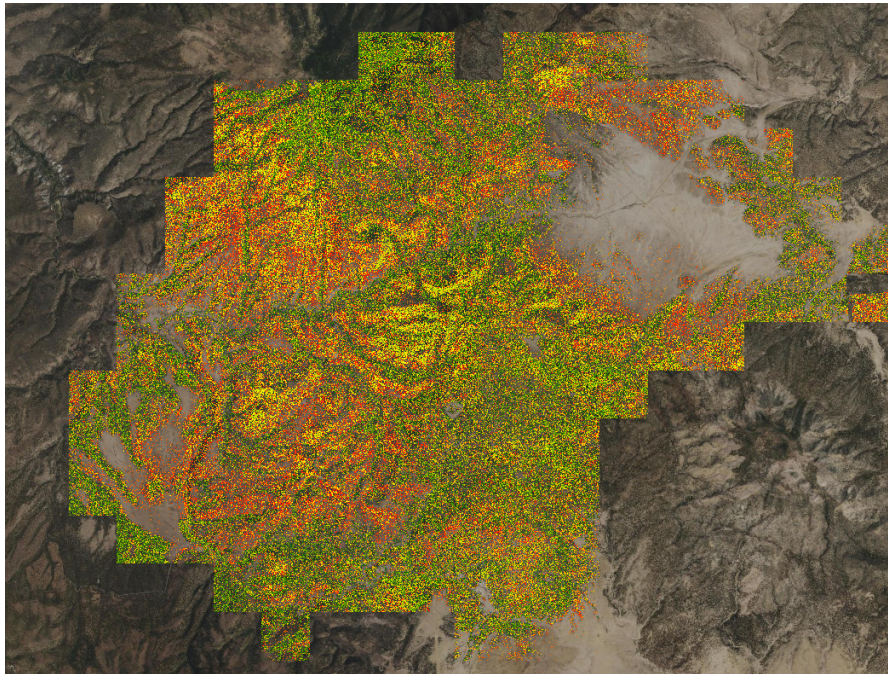


# EXERCISE 2b

## Forest Stratification



### Introduction

This exercise will focus on using the skills you have acquired in previous exercises and build upon them to stratify the forest into different classes using the lidar-derived canopy height and canopy cover layers. This is something you may do when trying to delineate stands or when creating a sampling scheme based on lidar sampled cover and height. If your Forest already has these two basic lidar derivatives, you can use this workflow to create stratifications where you can then randomly place field plots. This ensures that you are more likely to sample the full range of possible vegetation characteristics within the study area.

The first portion of this exercise will introduce you to the reclassify tool, which enables you to stratify a continuous raster into user-defined height classes. The second portion of the exercise focuses on using the raster calculator to stratify the study area using both the canopy height and the canopy cover rasters. As with other exercises, the concepts here are the rudimentary beginnings, and you will want to apply your own knowledge of your forest and expand these techniques to get an appropriate and useful product in the future.

### Objectives



- Use the raster calculator to create a raster that separates the study area based on specific canopy height and cover characteristics.

### Required Data

- **GilaCHM\_10m.tif** – Tree height in meters and horizontal units is in meters. This CHM has been resampled to a resolution of 10 meters and all height values below 2 meters are excluded.
- **GilaCC\_10m.tif** – Canopy cover expressed as a percentage in 10-meter resolution.

### Prerequisites

- **Install ESRI ArcMap on computer** and have basic understanding of how to use the software





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## Part 1: Set up ArcMap

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### A. Start ArcMap

1. If it is not already open start ArcMap by clicking on the Start button and navigating to **All Programs, ArcGIS** and then open ArcMap.
2. Open a blank map.

### B. Add The Data

1. Click the **Add Data** button.
2. Navigate to `\ProjectData\Lidar\` and add **GilaCHM.tif** and **GilaCC\_10m.tif**

**Note:** We are going to use a coarser spatial resolution (10 meters) canopy height layer to reduce noise in the data and so that it is the same resolution as the canopy cover raster. Often, we do not necessarily need the data to be at such a high spatial resolution (e.g., 1m) if we are looking for larger trends on the landscape. In this case, we are trying to stratify the entire area of interest by height and cover to create 9 categories describing the different combinations of heights and canopy cover percentages (e.g., short and dense, short and medium density, short and low density, medium height and dense, etc.). Therefore, down sampling the canopy height data to 10 meters is appropriate.

## Part 2: Determine the Stratification Values and Reclassify the Canopy Height Raster

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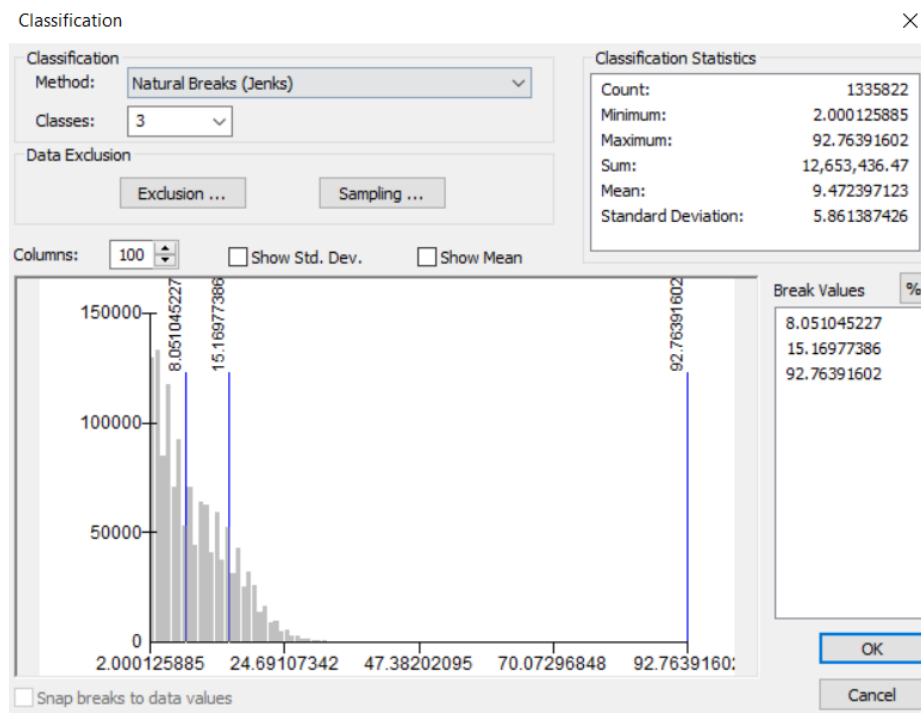
In this section, you will focus on changing the canopy height raster symbology from “stretched” to “classified,” which enables you to split the data into different categories using a few different methods. The goal is to split the height data into three categories (short, medium and tall) using information from the histogram to ensure that the height data is split evenly between the 3 categories. Once you split the data into those categories in the Layer Properties, you will then use the Reclassify tool to essentially cement those categories so that you can easily do some raster math later in the exercise.

### A. Change Symbology and Classification of The Height Layer

1. Double click on the **GilaCHM\_10m.tif** in the Table of Contents to open the layer properties.
2. Click on the **Symbology** tab and change the symbology type to **Classified** (Left side of the window).
3. Click on the **Classify** button.
4. Change the number of **Classes** to **5**.
5. The default method is **Natural Breaks**. We will change this and **manually** set our break values.
6. You will want to experiment with the break values, so go ahead and do so and see what happens to the raster when you change the **Break Values**.
  - i. Explore changing some of the other methods of classification and see the difference. Try Standard Deviations, Equal Intervals, etc...

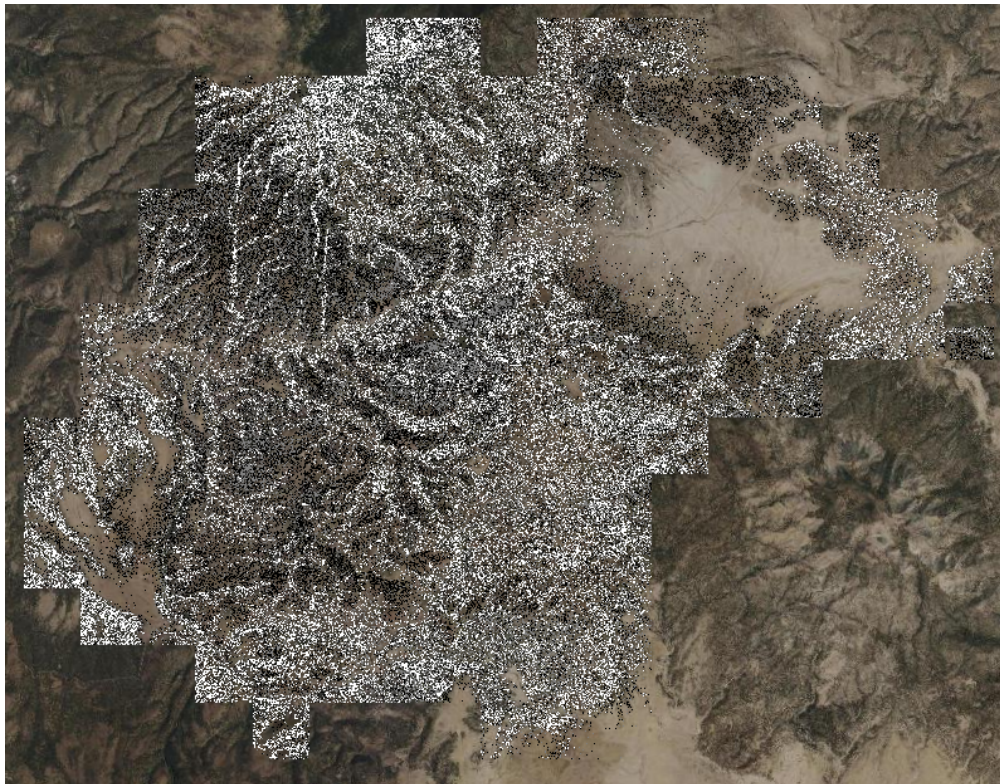
**Note:** for more information on these data classification methods, refer to ESRI's help information: <https://pro.arcgis.com/en/pro-app/help/mapping/layer-properties/data-classification-methods.htm>.

7. Choose **Quantile** as the Method in the Classification window.
  - i. Quantile separates the data equally among the user-defined number of classes.
8. Choose **3** as the number of classes.



9. Click **OK** and then **OK** again to close your Layer Properties window. Your raster should now resemble the following figure.
  - i. Remember, that this 10m resolution CHM has values of 2m and less removed.





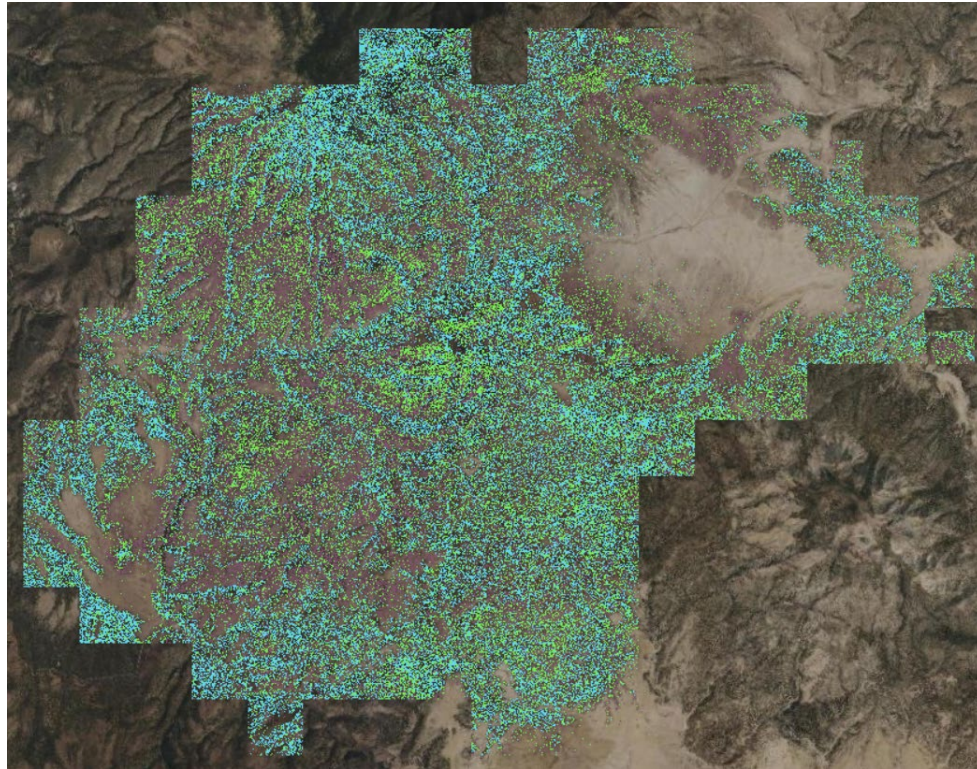
## B. Reclassify the Canopy Height Raster

The previous section showed you how to classify the height into 3 different categories via the Layer Properties window. However, you can do the same thing in the Reclassify tool, if so desired. The main difference is that the reclassify tool doesn't *just* change the symbology. Instead, the reclassify tool takes those categories and reclassifies them as a new value. In this case, those categories will be relabeled as 1, 2 and 3.

1. From the ArcToolbox navigate to **Spatial Analyst Tools, Reclass, Reclassify**
2. Use the **GilaCHM\_10m.tif** as your input raster.
  - i. The **Reclassification** window with values you have already set in the symbology should automatically be populated with those values. If you need to change them or redo them you can click the **Classify** button and follow the previous steps.

**Note:** We are going to leave the **NoData** values as NoData but be aware that there are a few values within the raster that are NoData pixels. These values were outside of the range we used when creating this raster layer so most likely that means there is no vegetation there. When we compose the final Stratification model these areas will also be output as NoData. In the future you may want to reclassify those values but for this exercise we will leave them as NoData.

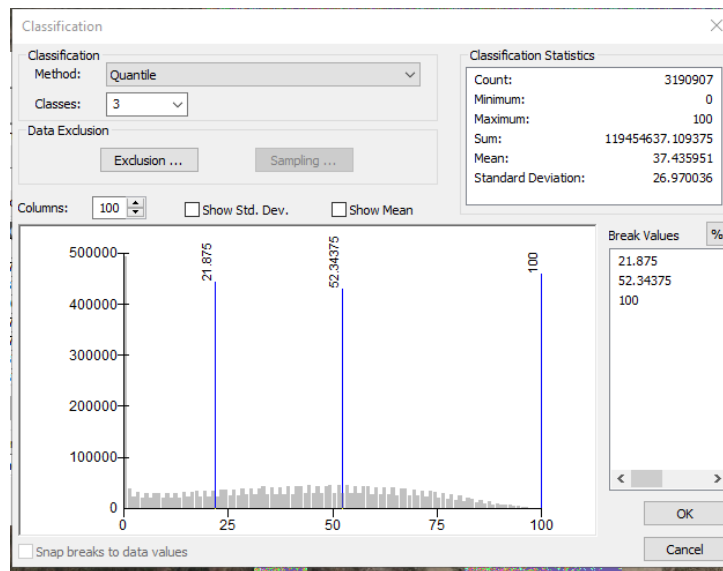
3. For the output raster navigate to the **Outputs** folder and name your raster **Height\_Reclass10m.tif**
4. Click **OK** to run the process.
5. Your output should look similar to the figure below. The colors will vary.



### C. Reclassify the Canopy Cover Raster

Now that we have reclassified the Canopy Height, we need to reclassify the Canopy Cover layer into three height bins. These canopy cover bins are: 0-33%, 33-66%, and 66-100% and will be used to create **9 different strata** using the three categories from each raster dataset.

1. Open up the **Reclassify** tool from **Spatial Analyst Tools, Reclass**.
2. For input raster, select **GilaCC\_10m.tif**
3. Select the "Classify" button and change the Classification Method to "**Quantile**" with "**3**" Classes. Then select **OK**. The classification should look similar to below:



4. Now under “Old Values” change them to meet our canopy cover classes of 0-33, 33-66, 66-100. To make this work, make sure there is a space on either side of the “-”. The Old Values should look similar to this:

The Reclassify dialog box shows the 'Reclassification' table with the following values:

Old values	New values
0 - 33	1
33 - 66	2
66 - 100	3
NoData	NoData

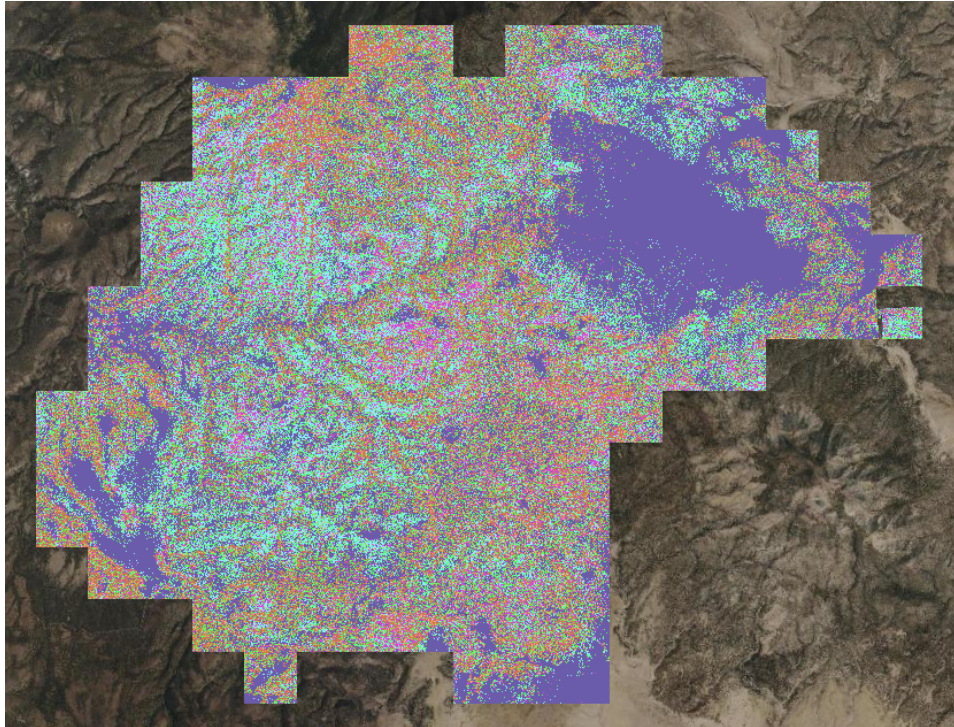
The 'Input raster' is 'GilaCC\_10m.tif' and the 'Output raster' is 'Z:\GilaLidarTraining\Outputs\Cover\_Reclass10m2.tif'. The 'Reclass field' is 'VALUE'.

5. Save it as **Cover\_Reclass10m.tif** to the **Outputs** folder.
6. Select **OK**.





7. Your output should look like this (colors may vary):



**Note:** This was an example of how to reclassify one raster. If you are only interested in the heights of trees for your specific application, then this is a good way to break up your data for analysis. However, we will typically use more information to stratify the forest. In the next section, we will describe how to combine the canopy cover and height rasters into one classification scheme using the Raster Calculator. The reclassified height breaks you created in this section will be applied to that classification.

## Part 3: Stratify the Forest Using Combine Tool

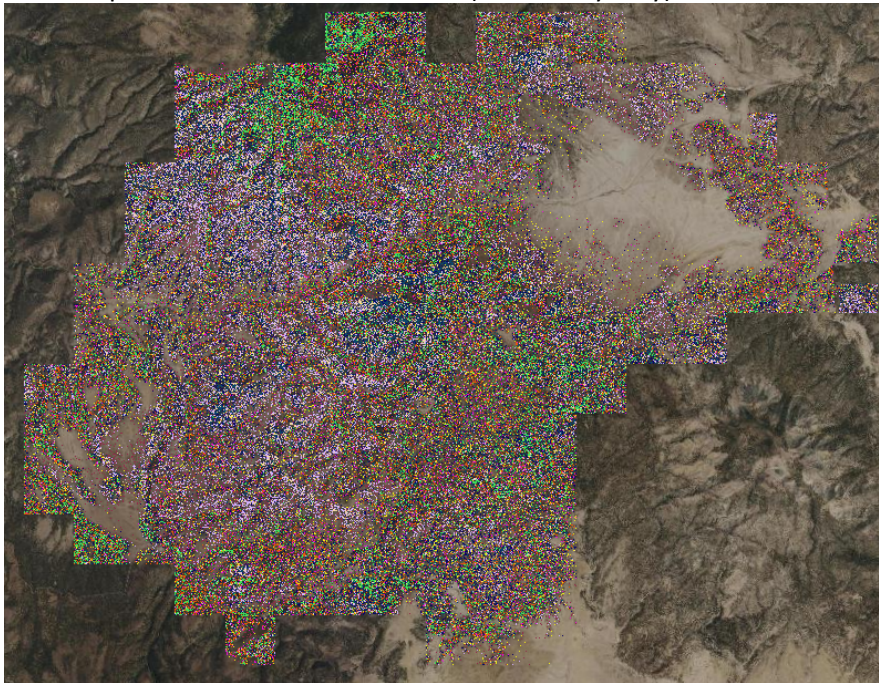
Now that we have determined the height classes and cover classes, we are going to use the “Combine” tool to create our 9 strata output. The nine stratifications can be seen in the table below and will populate using the combine tool. The combine tool is a local functions tool and doesn’t require complex Raster Calculator Syntax. If you remember, local functions calculate new values cell by cell, or individual cells, rather than multiple cells being utilized for one new value. Note that we are going to use the reclassified height data, which now has those height ranges split up into classes 1, 2 and 3.

Stratification	Height Condition	Cover Condition
1	>2 & ≤ 6 feet	≤ 33%
2	>2 & ≤ 6 feet	> 33 & ≤ 66 %
3	>2 & ≤ 6 feet	> 66 & ≤ 100 %
4	>6 & ≤ 12 feet	≤ 33%
5	>6 & ≤ 12 feet	> 33 & ≤ 66 %

Stratification	Height Condition	Cover Condition
6	>6 & <= 12 feet	> 66 & <= 100 %
7	>12 & <= 93 feet	<= 33%
8	>12 & <= 93 feet	> 33 & <= 66 %
9	>12 & <= 93 feet	> 66 & <= 100 %

**Note:** refer back to this table once you have created your final raster. You can use this to rename your classes from 1-9 to more intuitive classes (e.g., short & low cover; medium & low cover; high & low cover, etc.).

1. Open the **Spatial Analyst Tools**, go to **Local**, and select **Combine**. This tool will combine all the classes from two or more input rasters, creating a new raster with a unique value for every combination of classes from the input rasters. In this case, the two input rasters have 3 classes each, so the total number of possible output classes is 9.
2. Select **Cover\_Reclass10m.tif** and **Height\_Reclass10m.tif** as the input rasters.
3. Call the output **GilaStrata\_10m.tif** and save it in the **Outputs** folder.
4. Click **OK** to run the tool.
5. Your output should look similar to this (colors may vary):



6. In the “Table of Contents”, select the newly created strata layer, right click on it and open the attribute table. It should give you the values of the height and cover along with the nine newly assigned values.

**Congratulations!** You have completed the Forest Stratification exercise. You should now have a rudimentary knowledge of how to use the combine and reclassify tools to stratify a forest. You can always make more complex classifications that are more knowledge-based or field data-based, such as integrating additional variables such as species.