



DEER FEEDER SUITABILITY ANALYSIS

Property in the SE Funston Quadrangle, due East of
Anson, Texas

An in-depth look at the use of digitization and map algebra to create
a 5m-resolution raster of the suitability of deer feeder placement at
a hunting property

Shetina, Evan T

Problem

My family owns two adjacent deer hunting properties in the southeastern Funston quadrangle, which is about 25 miles northwest of Abilene. These two properties are vastly different from one-another; the Eastern property is mostly flat, homogenous lowlands, rich with water and vegetation, whereas the western property has rough terrain with differing soil types, vegetation thicknesses, and relatively sparse water.

Due to this discrepancy in the relative homogeneity of each property, my stepfather has only placed one deer feeder in the western property, compared to the four deer feeders in the eastern property.

This brings up the two core questions of this suitability analysis:

1. Is the current deer feeder location subpar, average, or excellent with respect to the overall distribution of possible locations on the property?
2. Using this methodology, what new locations can be proposed, and are these locations truly suitable for potential placement of deer feeders?

To answer these questions, I have combined various methods of data collection, satellite photo digitization, raster reclassification, and map algebra to produce a 5m-resolution raster of the overall suitability for deer feeder locations throughout the property.

Data Collection

To be able to quantify the suitability of a deer feeder placement, data were required in raster form for slope, tree cover, distance from tree line, proximity to creeks, and proximity to ponds.

None of these data are available in raw form, but can be created through GIS processing of raw data.

A slope raster can be created from a DEM of the property, which can be obtained as a 10-image, 1m-resolution Lidar of the SE Funston Quadrangle from the TNRIS DataHub (<https://data.tnr.org/collection/d55b62b3-fd81-4e15-a034-6fda56cde7de>) Figure 1 below shows one of these raw DEM raster images.

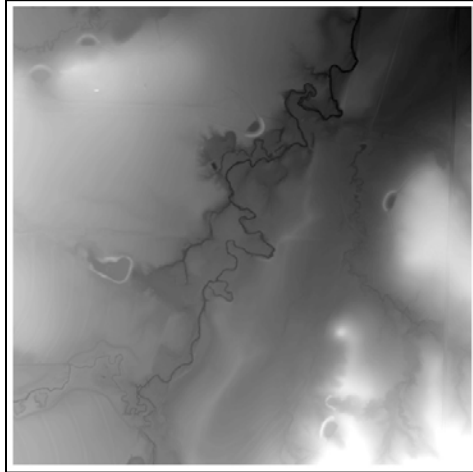


Figure 1: An ArcCatalog preview of fema14-1m_14SMB2924.img, one of ten 1m resolution Lidar DEM files downloaded from the TNRIS DataHub.

From there on out, however, the size of the property with respect to the scale of most readily-available datasets became apparent; the property is simply too small for most large-scale data collection operations to capture the finer differences in vegetation and water cover which need to be quantified.

Firstly, when comparing the land cover dataset, obtained from the 2016 National Land Cover Database on the TNRIS DataHub (<https://data.tnris.org/collection/89b4016e-d091-46f6-bd45-8d3bc154f1fc>), to a satellite photo obtained from TNRIS, the expected differences in vegetation density are at too low of a resolution to correlate in any meaningful way, as shown in Figure 2 below.



Figure 2: Clipped National Land Cover Database data overlain on a satellite photo within the hunting property boundary. The low resolution of the overlying raster makes the data show no meaningful correlation at this scale with any real-world change in land cover. Scale: 1:12,000.

Secondly, when taking overlying shapefiles for Texas streams and water bodies from 2014, obtained from TNRIS (<https://data.tnr.is.org/collection/af1ca25e-b38b-4203-90b8-d90f881963ae>) on top of the same satellite photo, streams varied slightly from their apparent courses and had contained missing paths. Water bodies, even more problematically, were entirely missing from the dataset due to their nature as temporary ponds. These issues are shown in Figure 3 below.

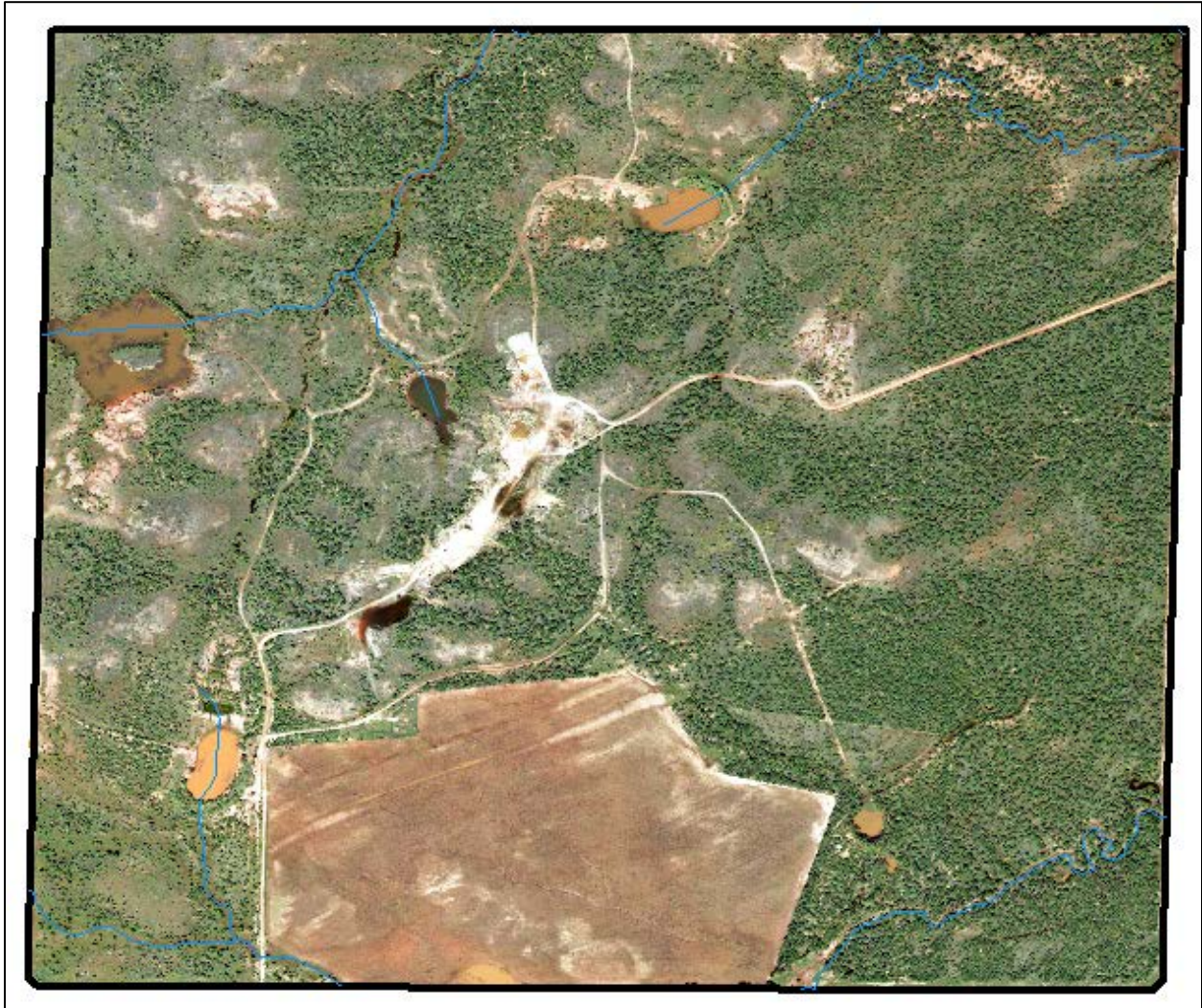


Figure 3: Clipped Texas Rivers, Streams, and Waterbodies shapefiles from the TNRIS DataHub overlain on top of a satellite photograph of the hunting property. Some stream forks are entirely missing from the stream shapefile, whereas all water body polygons are outside of the map extent, despite their clear presence in the satellite photograph. Scale: 1:12,000.

For this problem, this is the furthest extent data exploration and collection could go; the data for tree cover, distance from tree lines, and proximity to creeks and ponds needed to be produced, since no readily-available, meaningful data has been produced at the required resolution for this analysis.

Data Creation and Preprocessing

In order to be able to create raster files which will eventually quantify tree cover, distance from tree line, and proximity to creeks and ponds, raw data needed to be created to process into a proper format. In order to do this, four new shapefiles within a geodatabase needed to be created and then digitized with respect to the satellite photograph. The overarching process of creating and digitizing the shapefiles is gone through below.

Tree Cover, Pond, and Creek Shapefile Creation and Digitization

The shapefiles for all of these parameters were digitized alongside one another and cover very similar processes, so their steps will be covered together.

1. From ArcCatalog, three new files were created inside a new geodatabase. The shapefiles for tree cover and water bodies store polygon features, whereas the shapefile for the creek stores line features.

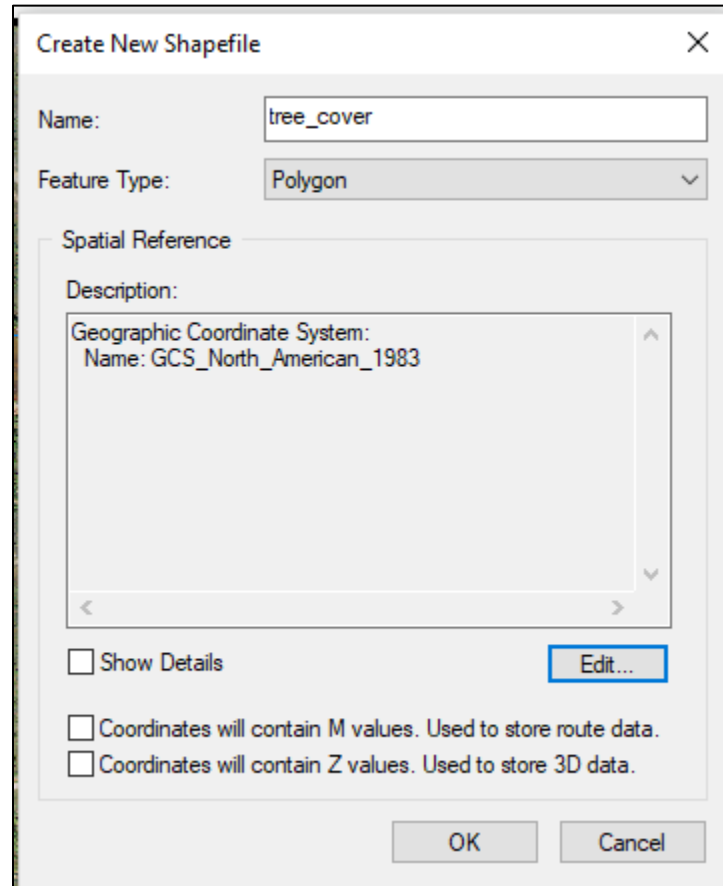


Figure 4: Use of the “Create New Shapefile” tool for the creation of the the tree_cover shapefile.

2. From ArcToolbox, the tree_cover file exclusively was given a new SHORT field called “Value” to store three different types of tree cover: none, heavy, and light, as notated in Table 1 below.

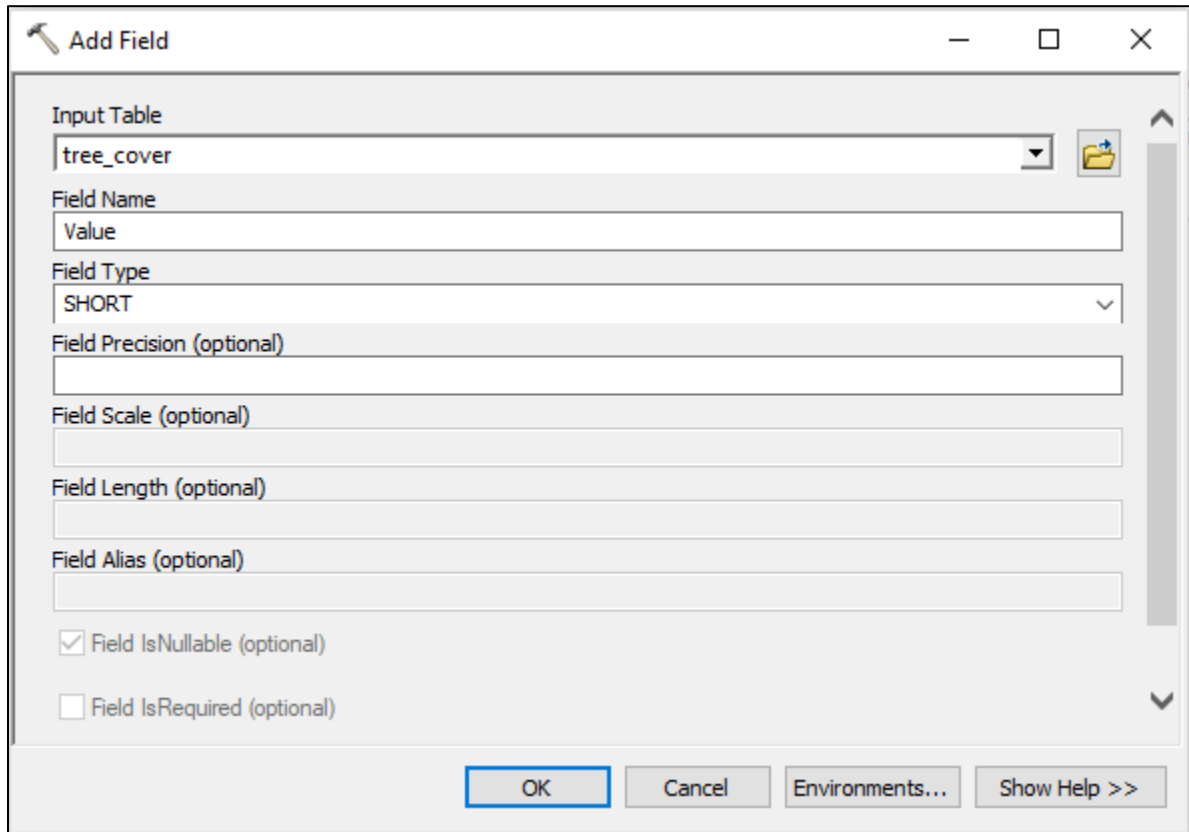


Figure 5: Use of the “Add Field” tool to create the “Value” field within the tree_cover shapefile.

Cover Type	Value
None	0
Heavy	1
Light	2

Table 1: Attributed values to different types of tree cover in the tree_cover shapefile, which were edited in the attribute table after the creation of the Value field.

3. After the two shapefiles were created and the tree_cover file was prepared to store data on the vegetation density, the satellite photo layer and property boundary layers were activated and editing mode was entered on the tree_cover shapefile, as shown in Figure 6.

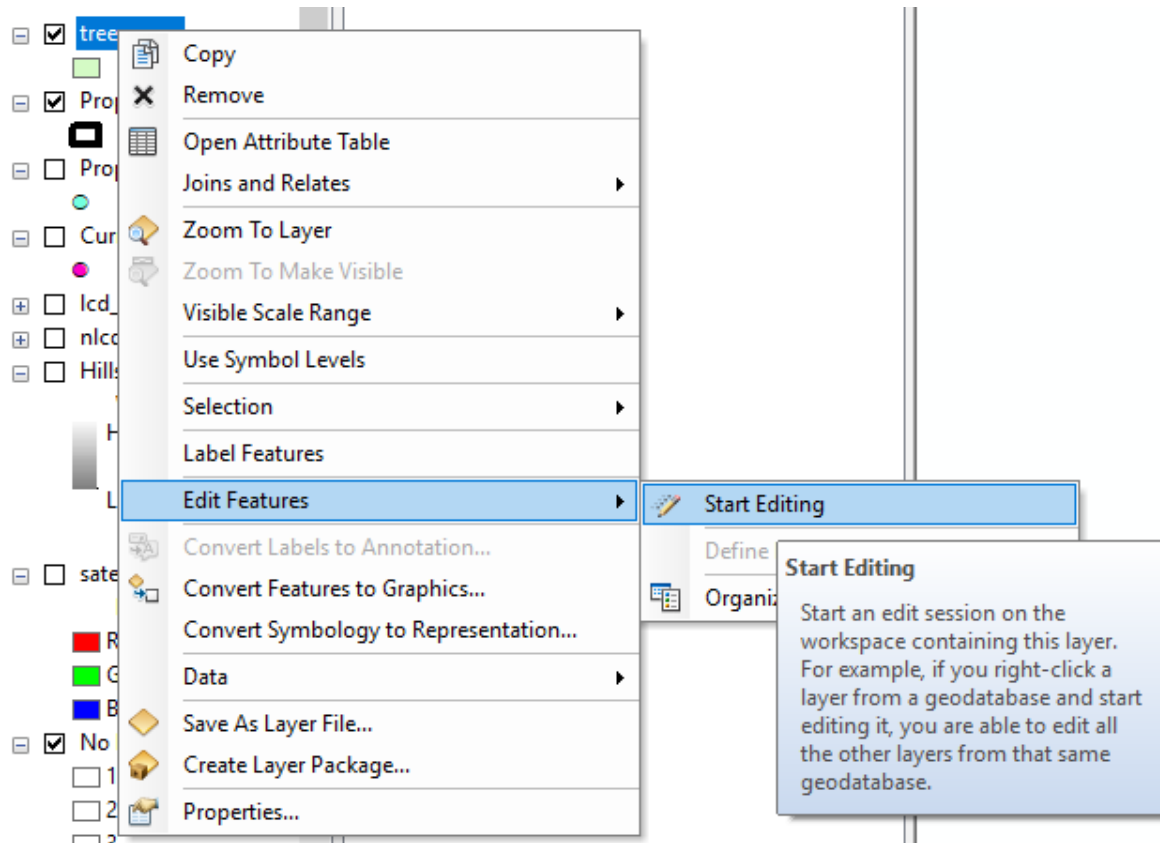


Figure 6: Entering editing mode from the table of contents to create polygons for tree cover type, digitizing from the satellite photograph.

4. Using the satellite photograph as a guide and digitizing tools to preserve topology, polygons were meticulously traced that filled the property's area completely, as shown in Figure 7. Areas of standing water were ignored in the tree_cover shapefile, however, the water_body shapefile was digitized around these features. A complete digitization of the tree_cover, water_body, and rivers shapefiles is shown below in Figure 7.

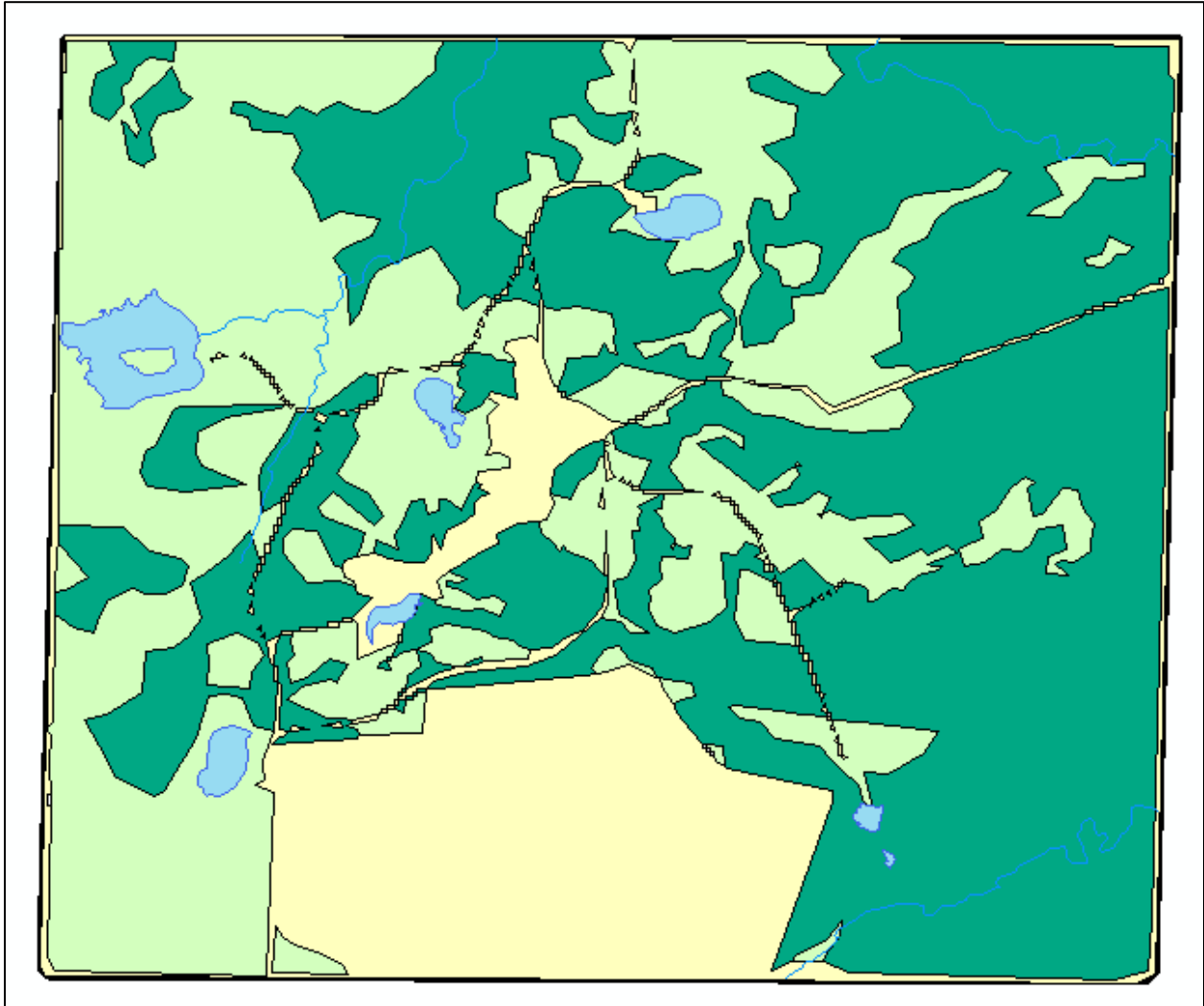


Figure 7: The completed tree_cover, water_body, and rivers shapefiles, obtained through digitization of the satellite photograph. Creeks and ponds are shown on top of the tree_cover shapefile in blue. Paths, farmland, and gravel constituted the areas classified as "open" in light yellow. Areas of sparse tree cover constituted the "light" areas in light green. Areas of dense tree cover defined the "heavy" areas in dark green. Scale: 1:12,000.

NOTE: The property boundary polygon was created in a very similar fashion to the other shapefiles before any of the other data creation had begun.

ArcGIS Processing

Classification Scheme

To begin processing the data to be analyzed in any meaningful way, a map algebra classification scheme had to be created first to guide all subsequent steps. Optimally, deer feeders are close to a tree line, placed in a lightly-covered area on flat ground, and are close to a source of water. The classification scheme presented below in Table 2 reflects these preferences.

Parameter	Trait/Value Range	Map Algebra Value
Land Cover*	Open	0
	Heavy	1
	Light	4
Proximity to Tree Line	< 10m	3
	10-30m	2
	30-90m	1
	> 90m	0
Distance from Standing Water	< 25m	3
	25-75m	2
	75-225m	1
	> 225m	0
Distance from Creek/Stream	< 25m	3
	25-75m	2
	75-225m	1
	> 225m	0
Slope of Topography	0-1 degrees	3
	1-5 degrees	2
	5-10 degrees	1
	>10 degrees	0

Table 2: Map algebra classification scheme for the eventual creation of a deer feeder suitability raster. The lowest possible value is 0 (least suitable), and the highest value is 16 (most suitable).

**Proximity to tree line will eventually be a buffer from only the heavy tree cover polygons, and as such, heavy tree cover will always get a +3 to the cell value. To compensate, light cover is given a +3 to its cell value so that their suitability will be identical without a nearby tree line.*

ArcGIS Processing: DEM to Slope Raster

The steps below were followed to convert the 10 image DEM to a 5m resolution slope raster of the property:

1. Using the mosaic tool, each image was pieced together into a single DEM raster to be clipped to the property boundary polygon, much as the satellite photograph was prepared.
2. With the DEM clipped to the property boundary, the slope tool from ArcToolbox, displayed in Figure 8 below, was used to create a raster of the slope at 1m of the property.

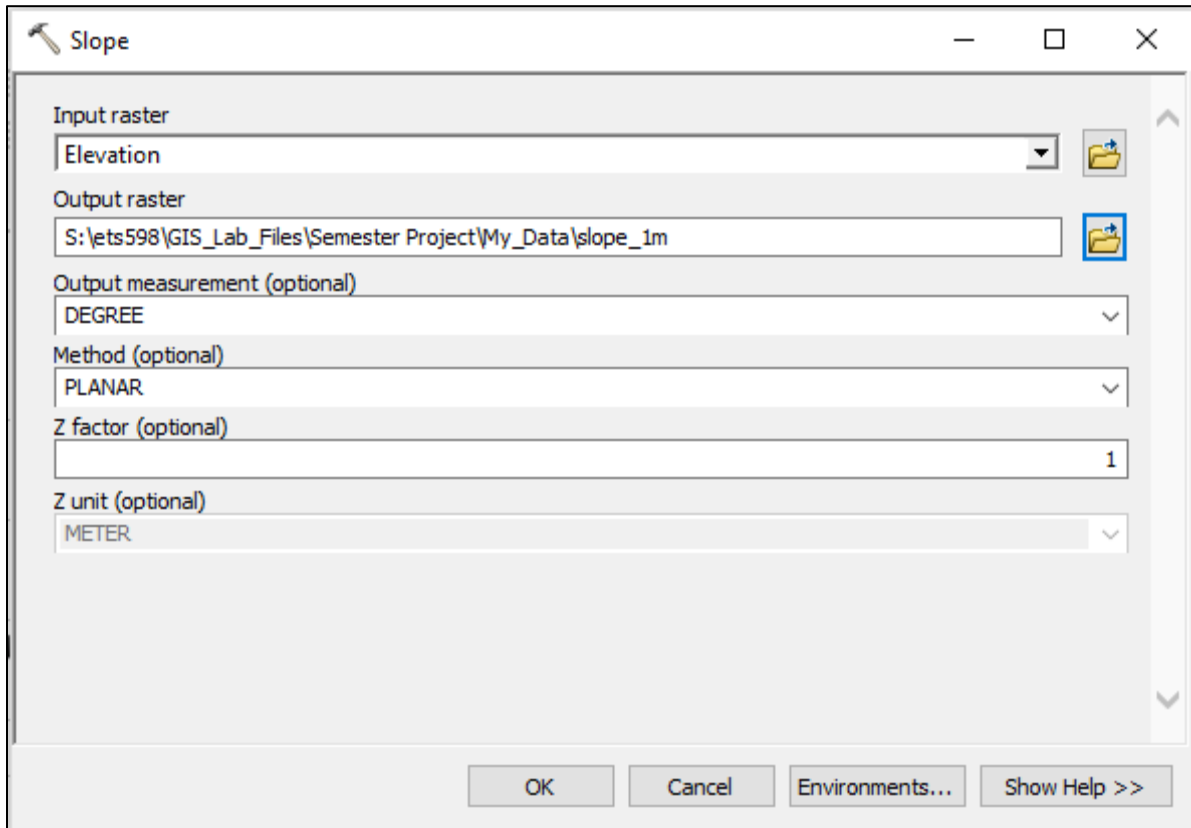


Figure 8: Use of the slope tool to create a 1m resolution raster of slope from the mosaiced/clipped 1m Lidar DEM.

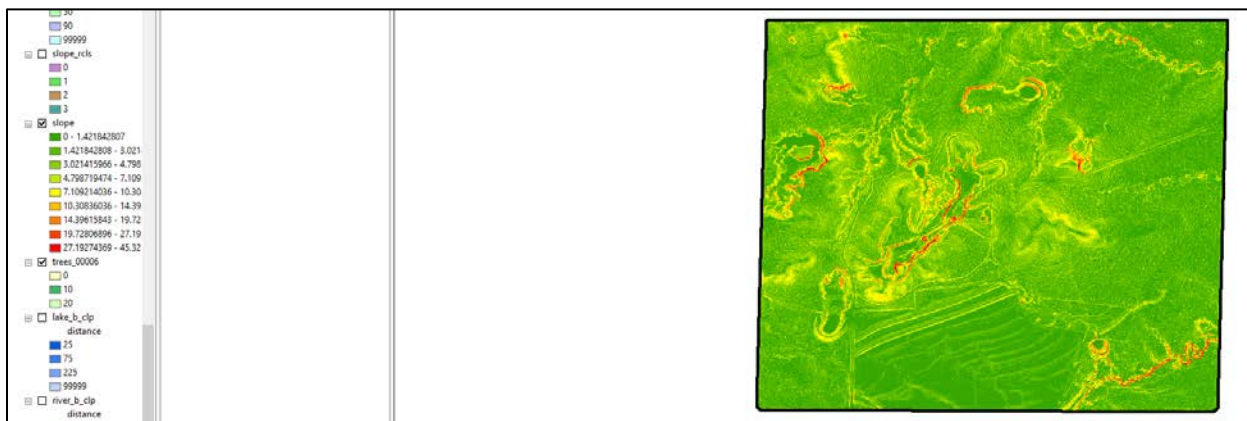


Figure 9: The 1m resolution slope raster within the property boundary polygon. The raster is automatically symbolized in strangely defined boundaries, shown in the table of contents.

3. Using the resample tool within ArcToolbox, the raster resolution was downgraded from 1m to 5m, since precision at a 1m resolution is not necessary for this problem.

4. Finally, using the reclassify tool, the 5m slope raster was converted from the strange boundaries shown in Figure 9 to the new values that will be used in the raster calculator from Table 2. The use of the reclassify tool for this situation is shown in Figure 9 below.

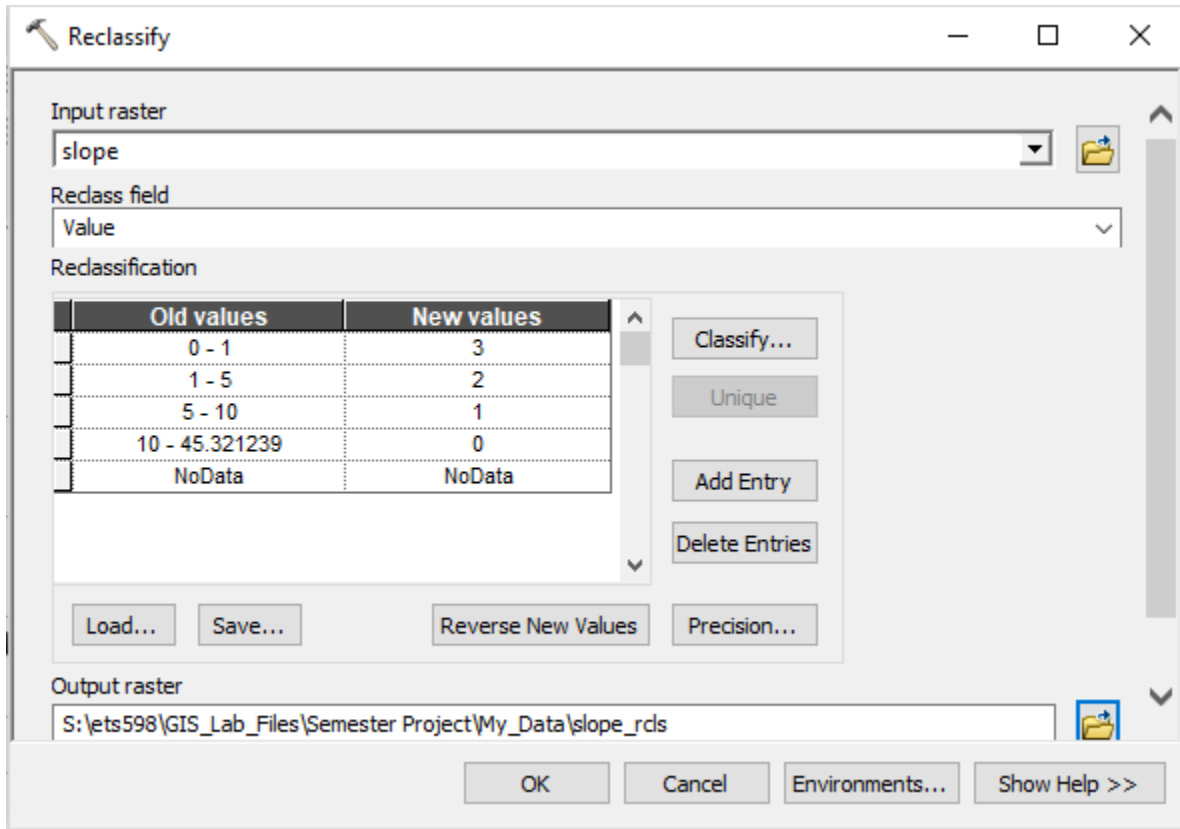


Figure 10: Reclassification of the slope raster file to the values displayed in Table 2.

ArcGIS Processing: Tree Cover Polygons to Raster

The process of converting the tree_cover shapefile to a workable, 5m resolution raster was similar to the creation of the reclassified slope raster, but differs in its first step:

1. From ArcToolbox, the Polygon to Raster tool was used to quickly convert the tree_cover shapefile to a 5m raster file, using the “Value” field to classify the raster.

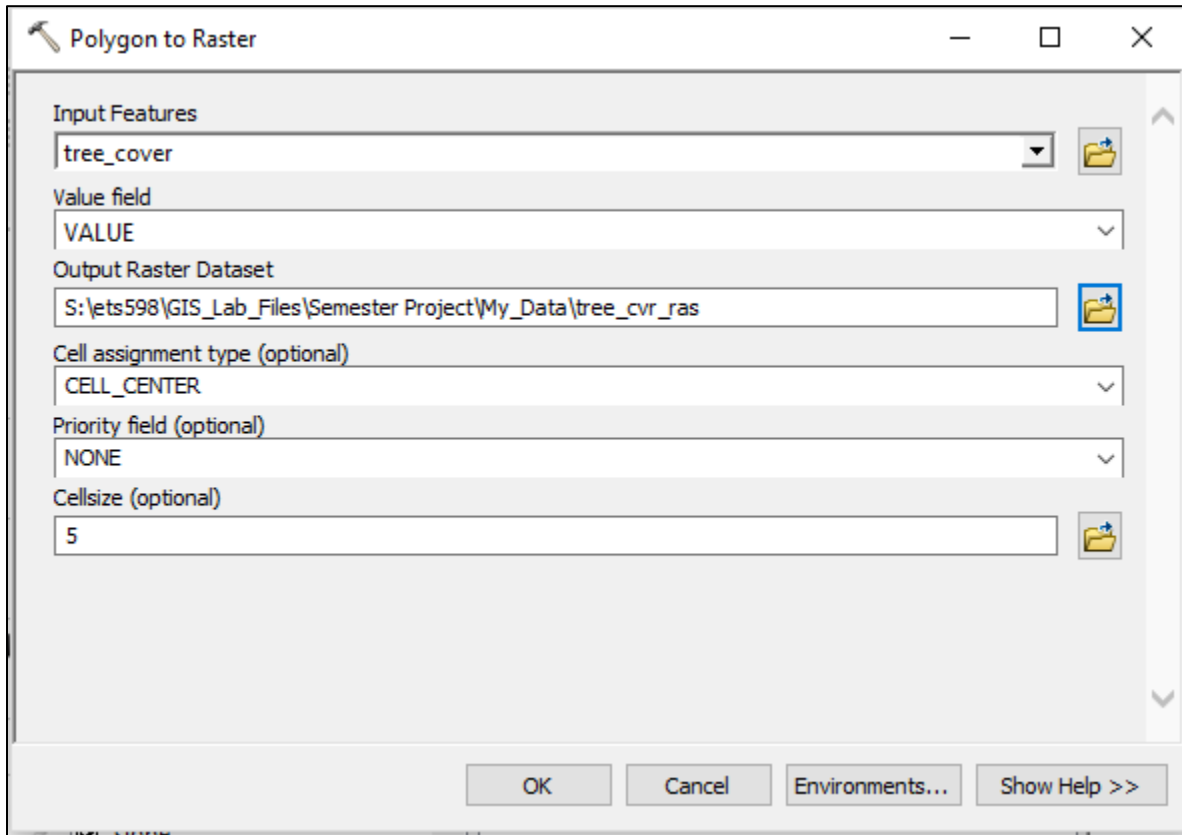


Figure 11: Use of the Polygon to Raster tool to create a 5m resolution raster from the digitized tree_cover shapefile.

2. The reclassification tool was used on the new 5m tree_cover raster in the same way as used in Figure 10, except with the numbers in the “Value” field being turned from 0, 1, and 2 to 0, 1, and 4, respectively.
3. As an extra step to ignore areas of water when considering the placement of deer feeders, a file called “nodata_5m” was created by repeating steps 1 and 2 with the water_body shapefile.

ArcGIS Processing: Proximity to Tree Line and Distance from Creeks and Ponds to Rasters

At this point, the current digitized shapefiles tree_cover, water_body, and river are not enough to directly convert to a raster yet. More ArcGIS processing must be done first to get the distance from these polygon and line features, then they may be converted to raster form and reclassified in the same way that the slope and tree cover rasters were.

1. A copy of the tree_cover shapefile was made and all instances of open and light cover polygons were removed by editing the file from the table of contents, navigating to its attribute table, and manually deleting all instances of 0 and 1 from the VALUE field, as shown in Figure 12.

tree_cvr			
	OBJECTID *	SHAPE *	COVER
▶	28	Polygon	1
	41	Polygon	1
	43	Polygon	1
	47	Polygon	1
	48	Polygon	1
	50	Polygon	1
	54	Polygon	1
	57	Polygon	1
	58	Polygon	1
	59	Polygon	1
	62	Polygon	1
	64	Polygon	1
	71	Polygon	1
	75	Polygon	1
	77	Polygon	1
	79	Polygon	1
	80	Polygon	1
	81	Polygon	1
	86	Polygon	1
	87	Polygon	1
	88	Polygon	1
	95	Polygon	1

Figure 12: The copied tree_cover shapefile, with all occurrences of 0 and 1 from the VALUE field removed.

2. From the edited tree_cover shapefile and the two water shapefiles, the multiple ring buffer tool within ArcToolbox was activated to create buffers in accordance with Table 2. The value of 99999m was used as the range for the final buffer to give every part of the property coverage in one of the rings. Use of the tool is shown below in Figure 13.

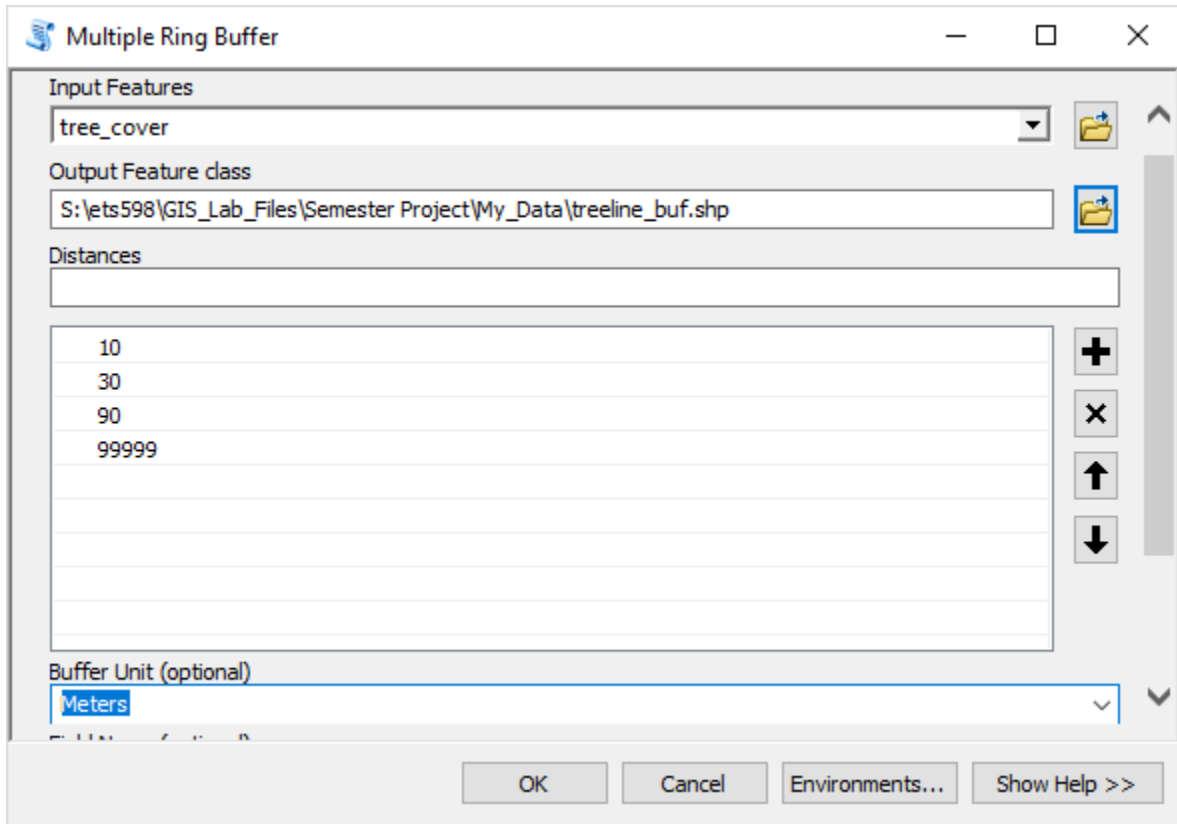


Figure 13: Use of the Multiple Ring Buffer tool to create zones of distance around the heavy tree polygons from the tree_cover shapefile. A nearly identical process was done to the water_body and river shapefiles to create zones of distance around them.

3. These new buffer shapefiles, treeline_buf, water_buf, and river_buf, were clipped to the property boundary polygon.
4. In a similar process to that shown in Figure 11, each of these 3 shapefiles were converted to 5m resolution rasters.
5. Finally, like Figure 10, the “distance” field created in each of the buffer processes was reclassified to match the values in Table 2. One of such reclassified 5m resolution buffer rasters, river_5m, is shown below in Figure 14.

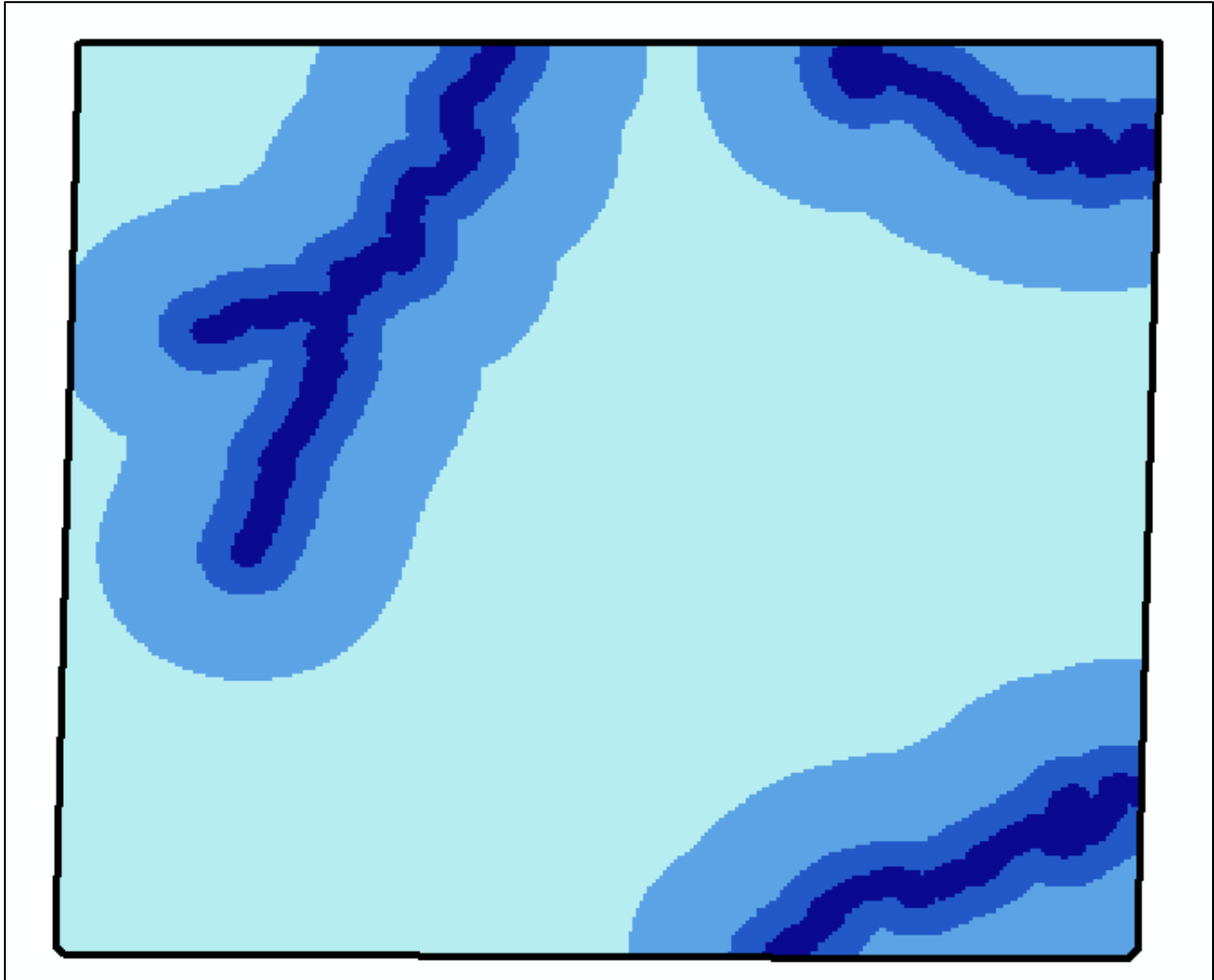


Figure 14: river_5m, the reclassified raster created from the multiple ring buffer of the rivers shapefile. Scale: 1:12,000.

ArcGIS Processing: Raster Calculator

After these steps, the data were ready for combination in the raster calculator. Accessed through ArcToolbox, all of the prepared rasters were simply added together to combine all of their values. The equation used in the raster calculator is displayed in Figure 15.

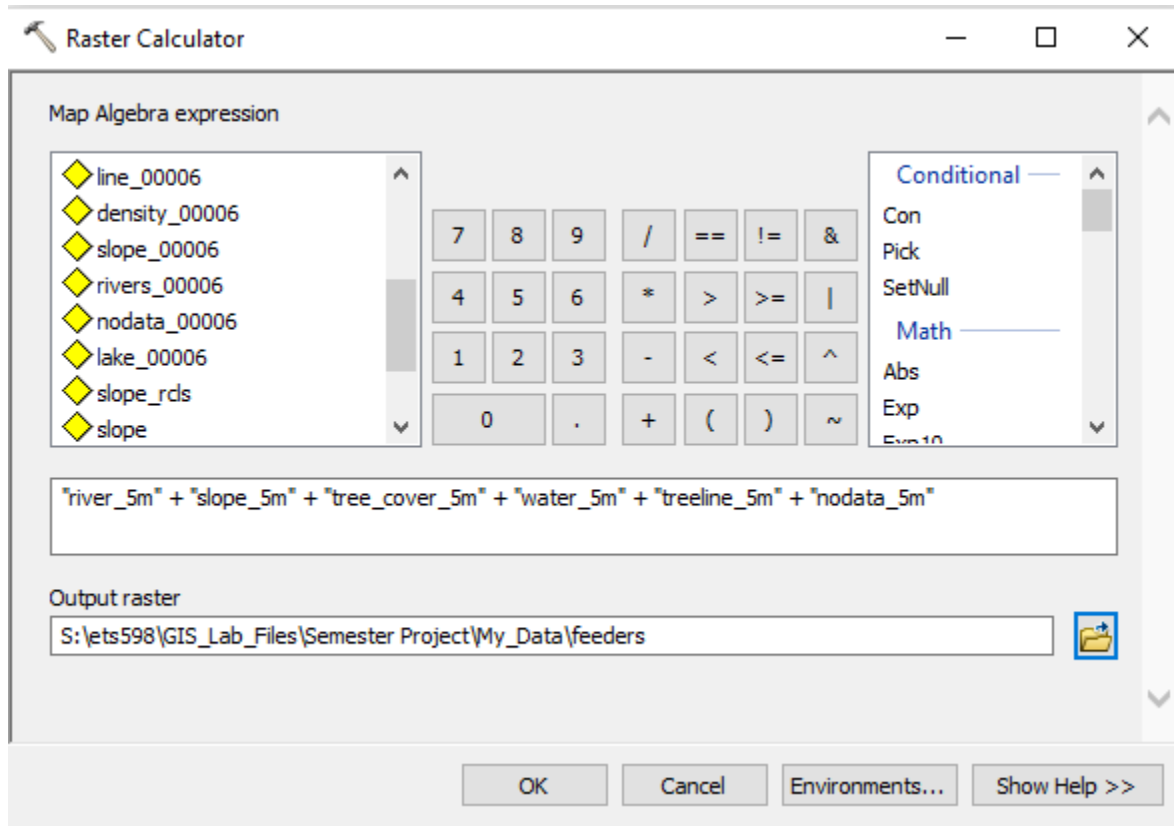


Figure 15: Use of the raster calculator to combine all of the data to produce the final raster of proposed deer feeder locations.

Output Raster and Satellite Photo with Proposed Locations Marked

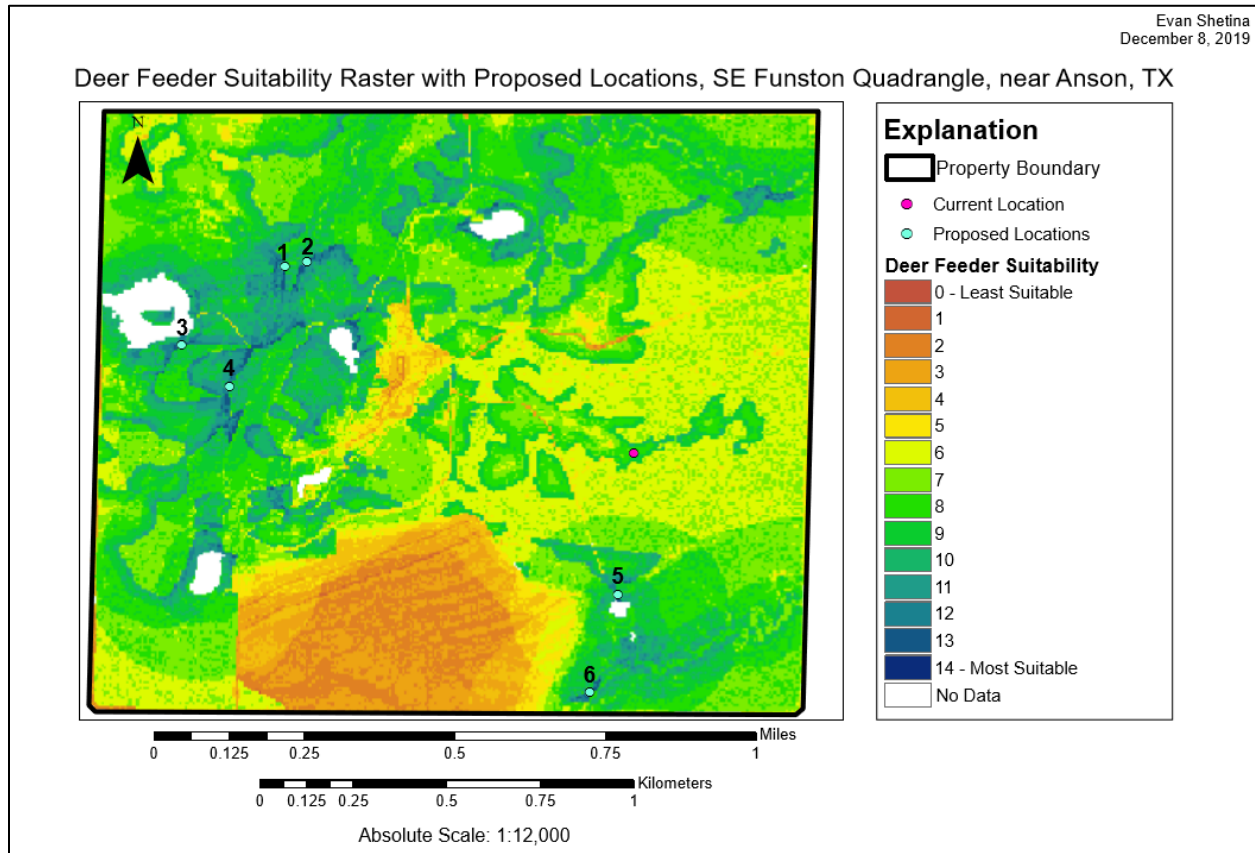


Figure 16: The final 5m resolution deer feeder suitability raster, with the current location and proposed locations marked. Proposed locations are clustered occurrences of values of 14, the highest value attained in the western property.



Figure 17: Proposed deer feeder locations, gathered from the suitability raster, overlain on the satellite photo with hillshade. Scale: 1:12,000

Analysis: Current Location

Firstly, the problem involved a question as to whether or not, with this classification scheme, the current deer feeder location is subpar, average, or excellent with respect to the distribution of suitability across the property.

The current deer feeder location, marked as a pink dot, lies on top pixels with a value of 8, as discovered with the identify tool (Figure 18). By accessing the VAT for the suitability raster and by navigating to the "Create a Graph" wizard, the distribution of pixels for each value can be found. This is shown in Figure 19.

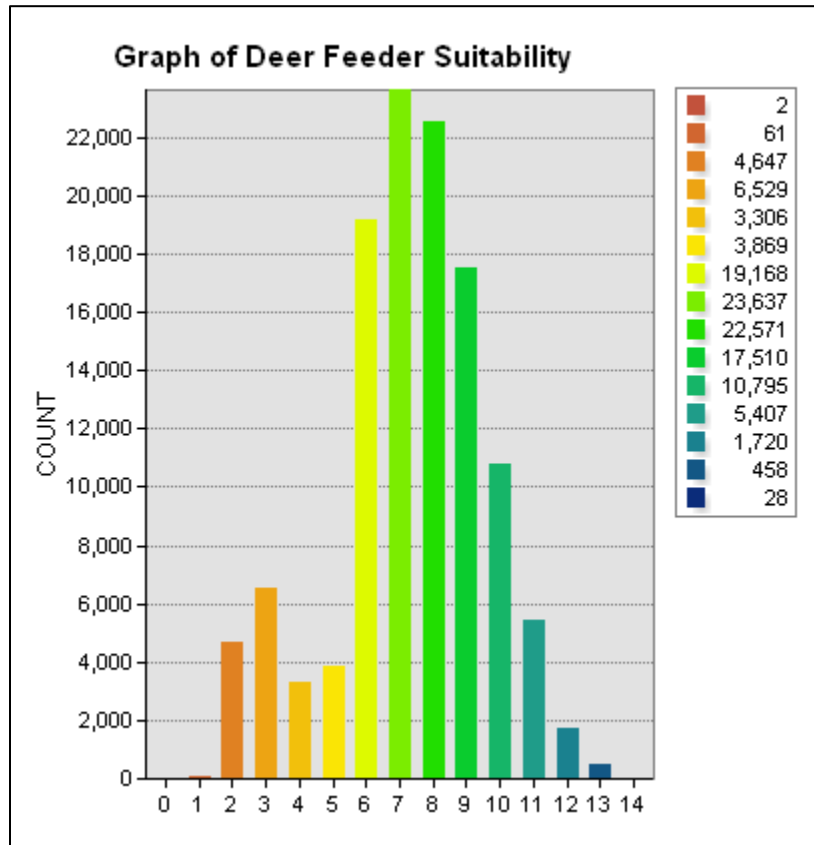


Figure 19: The distribution of occurrences of each pixel on the raster, showing an overall normal distribution centered around values of 7 with an abnormal spike around values of 3.

Data Analysis: Proposed Locations

While there were 28 occurrences of the value 14, displayed in Figure 19, they clustered around six points, displayed in Figures 16 and 17. These locations were almost all, as expected through the creation of the classification scheme, around a source of water and in close proximity to a tree line, in an area of low slope and light cover.

These locations would be optimal for both the placement of feeders and nearby blinds, as there is nearby open space in all of these cases. Close-up satellite photos of all six locations are shown below.



Figure 20: Two proposed locations on the northwestern side of the property. Scale: 1:2,000.



Figure 21: Two proposed locations on the southeastern side of the property. Scale: 1:2,000.



Figure 22: Two proposed locations on the northern side of the property. Scale: 1:2,000.

Conclusion

Firstly, when comparing the current location to the distribution of all possible locations, it can be statistically concluded that the present deer feeder is in a slightly above average location. Moreover, it is not near any extremely high values, suggesting the overall area of its location is also average to slightly above average.

Secondly, it was determined that maximums in these data could be found and identified, providing six spots that matched the desired criteria very closely; all of these locations are spots where a deer feeder could be built without restrictions (do not lie on trees, sources of water, etc.) and could be further evaluated for effectiveness.

Limitations and Improvements

Beyond standard errors in digitization and map algebra that left some blank, no data cells, the largest limitation of this method is that the actual movement patterns and sightings of deer were never considered. This method is a purely geographical analysis of the best locations for deer feeders, but their effectiveness always comes down to whether or not deer visit them.

With data of deer sightings, it would be possible to incorporate another raster into our calculation and further refine what the best spots would be, but these data are unlikely to be created by any agency on a property this small. These would have to be created by hand, much like most of the files that were used in this raster analysis if the results are to be improved any further.