Where Are The Deer?

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ES 551

14 December 2022

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Introduction

This project attempts to answer the question of where deer are most likely to be at the Olsen family ranch located on the Butler-Greenwood county line in Kansas, in vicinity of -96.532° W, 37.883° E.

Goals

The primary goal is to use GIS methods to determine areas with high likelihood whitetail deer activity and determine which pastures to moove cattle into to avoid cattle-deer interaction thus cattle-hunter interaction and incidents during deer season.

Ranchers in the area allow hunters to come from out of state in search of larger deer than are present in their home state. Whitetail Deer season runs from mid-September to mid-January in Kansas (KDWP, 2022). Out of state hunters typically participate in the firearm season, from 30 November to 11 December in 2022, this overlaps with winter calving season on the Olsen family ranch.

Figure 1. Comparison of Whitetail deer and Hereford calf. *Images from stock.adobe.com, combined by R. Olsen*

While a whitetail deer and a calf are obviously different enough that a hunter can tell the difference in all but the worst case of bloodlust, the difference is similar enough that an inexperienced hunter in poor weather conditions may make the mistake of confusing the two. To be fair, the author is not aware of any instances of a hunter making the mistake of killing a calf.

The increasing popularity of hunters coming from Texas to hunt the large population of larger Kansas deer however increases the chances of the mistake being made.

An additional goal for this project is to use QGIS as an alternative to ArcMap for the author's personal and education projects.

Data Acquisition

Data acquisition started with downloading a raster imagery from their sources. Digital Elevation Model (DEM) from Kansas Data Access and Support Center (DAS) for grids 14SQG1095, 14SQG1595, 14SQG1090, and 14SQG1590.

Hydrology data was downloaded from the USGS National Map Viewer for hydrologic unit 1107. The hydrodem.tif raster was used for the project.

Tree canopy data was downloaded from the Multi-Resolution Land Characteristics Consortium.

Shapefiles were created for fences and food sources by creating polygons in Google Earth Pro. Google Earth Pro was also used to generate a point shapefile for deer sightings and sites where deer have been killed. These shapefiles are not definitive, proper data generation would need to be completed for further research.

Methodology

All layers were brought into QGIS and projected into EPSG:26914 - NAD83 / UTM zone 14N.

The four DEM raster layers were merged into a continuous layer and the fence shapefile was used to determine the maximum extent of the study area. The QGIS function 'Clip Raster By Extent' function was used to draw a box around the study area on the DEM layer and executed, this allows the DEM layer to be used as the extent of further clipping. The layer was then exported.

The nlcd_2016_treecanopy_2019_08_31.img layer contains tree cover data. The layer was prepared by first clipping to the extent of the DEM layer and exported for further work. With the layer confined to the area of interest the QGIS raster calculator was used to extract all cells with a value greater than zero and the function 'Warp (Reproject)' was used to export the layer to a raster with a cell size of one and no-data cells set to zero. This resulted in a raster of the area of interest with a binary representation of trees, a value of one if trees are present and zero if trees are not present (Figure 2).

The stream layer was prepared from the hydrodem.tid raster by clipping to the extent of the study area and preparing in similar manner to the tree cover layer. The raster calculator was used to extract values at or below zero and the resulting raster was exported using the 'Warp (Reproject)' function with a cell size of one (Figure 3).

The deer layer was prepared by importing a point layer of sighting and merging it with a point layer of deel kills. The points were then classified by creating a weight field and assigning sightings a value of one and kill sites a value of three. A heatmap was then created using the QGIS function 'Heatmap (Kernel Density Estimation)' with a radius of 500 meters, the weight field as the weight and a quartic kernel shape. The resulting raster was then rescaled to 0-1 from 0-255; this is to give less weight to sightings as the intent is to determine where the deer will be, not where they have been for the purpose of this project. The raster was exported using the 'Warp (Reproject)' function to set no-data cells to zero and cell size of one (Figure 4).

To determine terrain slope that deer may be found, a slope layer was created from the DEM layer and the QGIS plugin 'Point Sampling Tool' created by Borys Jurgiel was used to extract slope data at those points. The raster calculator was used to extract slope values of less than maximum gained from the point analysis (17.29071°). The result of the raster calculation was exported using the 'Warp (Reproject)' function to set no-data cells to zero and cell size of one (Figure 5).

The food source shapefile was classified by assigning a value to the polygons in accordance with the assumed value. Alfalfa only fields were assigned a value of one because they are summer crops and not growing during deer season; alfalfa and/or wheat fields, fruit trees, and gardens were assigned a value of two because they are higher nutritional value but may or may not be growing during deer season; areas where hay bales are stored were given a value of three as they are year round sources of dried grass and alfalfa. Once classified, the food sources layer was rescaled from 0-3 to 0-1 and exported using the 'Warp (Reproject)' function to set no-data cells to zero and cell size of one (Figure 6).

With the five raster layers now having the same extent and cell size, a raster calculation could be performed. The raster calculator was used to add the rasters together, the resultant raster had a maximum possible value of five however the maximum value from the raster was 3.914. The result was from 0-3.914 to 0-4 and exported (Figure 7).

Results

GIS Product. The final grayscale raster was with a color scale and a map was prepared. Figure 8 shows the final product, a full resolution 20.1 MB PNG is available at https://tinyurl.com/4bcfxasv. Analysis shows that cattle are already being kept in the larger pastures away from likely deer locations that have crops and thicker tree coverage. The final decisions on the accuracy of the product will have to be made by the ranchers.

QGIS Usage. Using QGIS for this project was a frustrating and enlightening experience. QGIS is a very powerful tool but it does not have the polish and efficiency of ArcMap. Over the course of this project the author generated over 500 GB of data as mistakes and intermediate files. This was likely due to the author's inexperience with the ideal workflow for QGIS and the difference in functions between QGIS and ArcMap.

At one point QGIS was left to perform an all night function, the result was a corrupt project file and frozen computer. The project was able to be salvaged and rebuilt in a more efficient manner.

Over the course of the project the author developed an efficient enough workflow to result in a combined total of 37 GB in intermediate and final products. One advantage of QGIS is that intermediate files do not need to be saved to storage, they may be kept in memory for further manipulation then deleted when the desired result is achieved.

The major downfall with QGIS is its handling of raster data. The functions that are available in QGIS are not as efficient as those in ArcMap. When performing raster manipulation QGIS would often freeze, crash to desktop, or give unusable results; the latter is primarily due to the authors inexperience with the program and was not a problem as experience developed.

The second pitfall the author ran into was the need for any rasters used for raster calculations to have the exact same cell size and may give incorrect results if the extent of layer is not the same. This need is not explicitly mentioned anywhere in the program itself, this problem could have been avoided if the author had completed any of the free tutorials provided by the creators of QGIS.

Further Research

The results of this project are not definitive. The author would like to use a combination of UAS, game cameras, and landowner surveys to expand the scale and scope of the research. UAS are capable of observing wildlife with a minimum of interference, allowing data to be collected without stressing the subject and introducing error. Game cameras can be used to easily count populations passing through a fixed point. Farmers, ranchers, and hunters would be able to survey the wildlife, give counts, find bed-down sites, identify diseased animals, etc. Involving Game Wardens from KDWP would allow for a wider range of existing data and new data to be gathered, such as herd movements through radiolocation.

There is potential to greatly expand the scope and interest in the use of GIS methods for whitetail deer tracking.

Conclusion

As previously mentioned, the results are not definitive, more research is needed to determine the accuracy of the authors methods. The author will continue to develop skills with QGIS, while it may not be a stable enough tool for some applications, it is robust enough for the types of hobby and educational projects that the author has in mind.

Figures

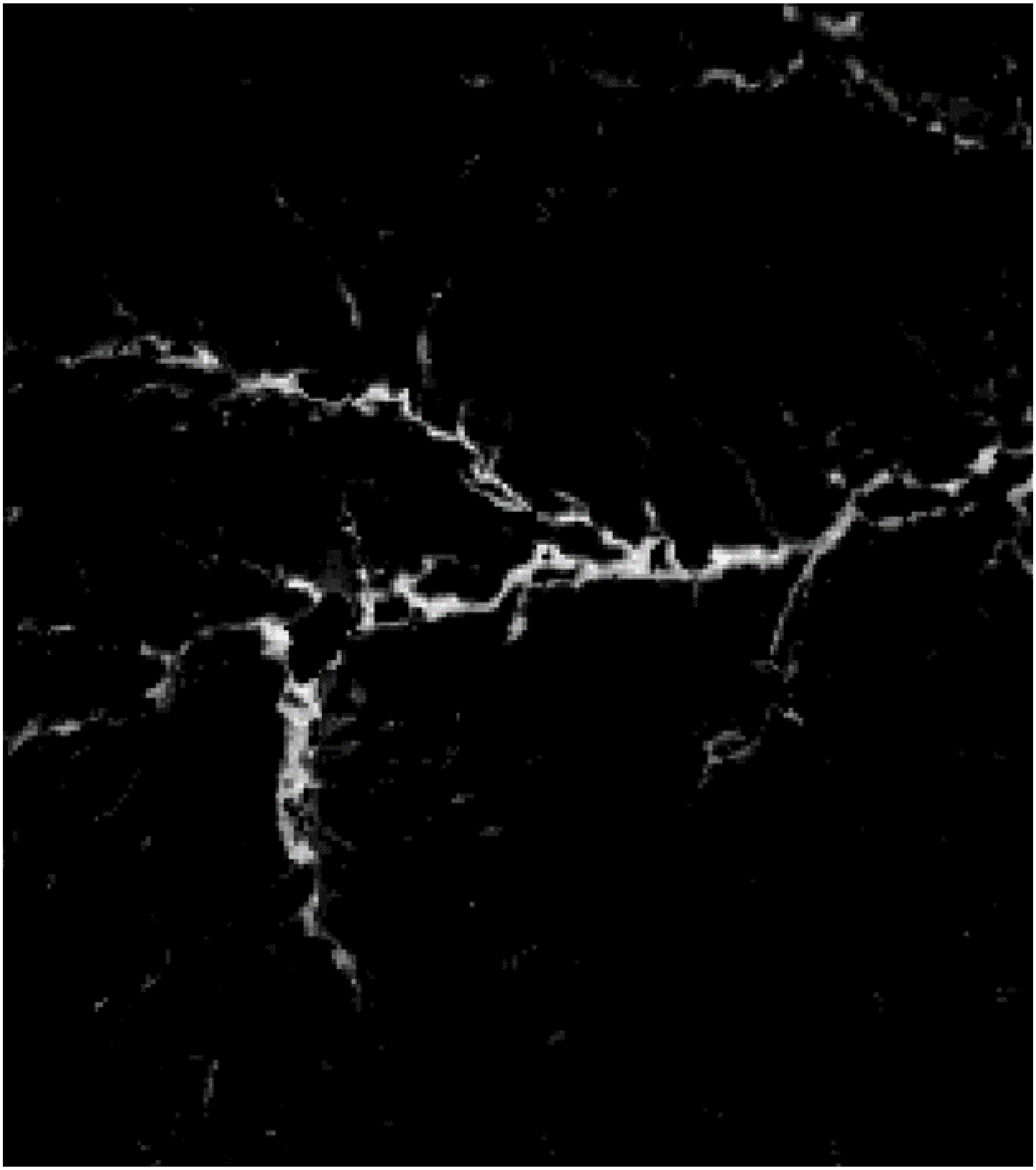

Figure 2. Resultant raster from processing the nlcd_2016_treecanopy_2019_08_31.img layer. *R. Olsen.*

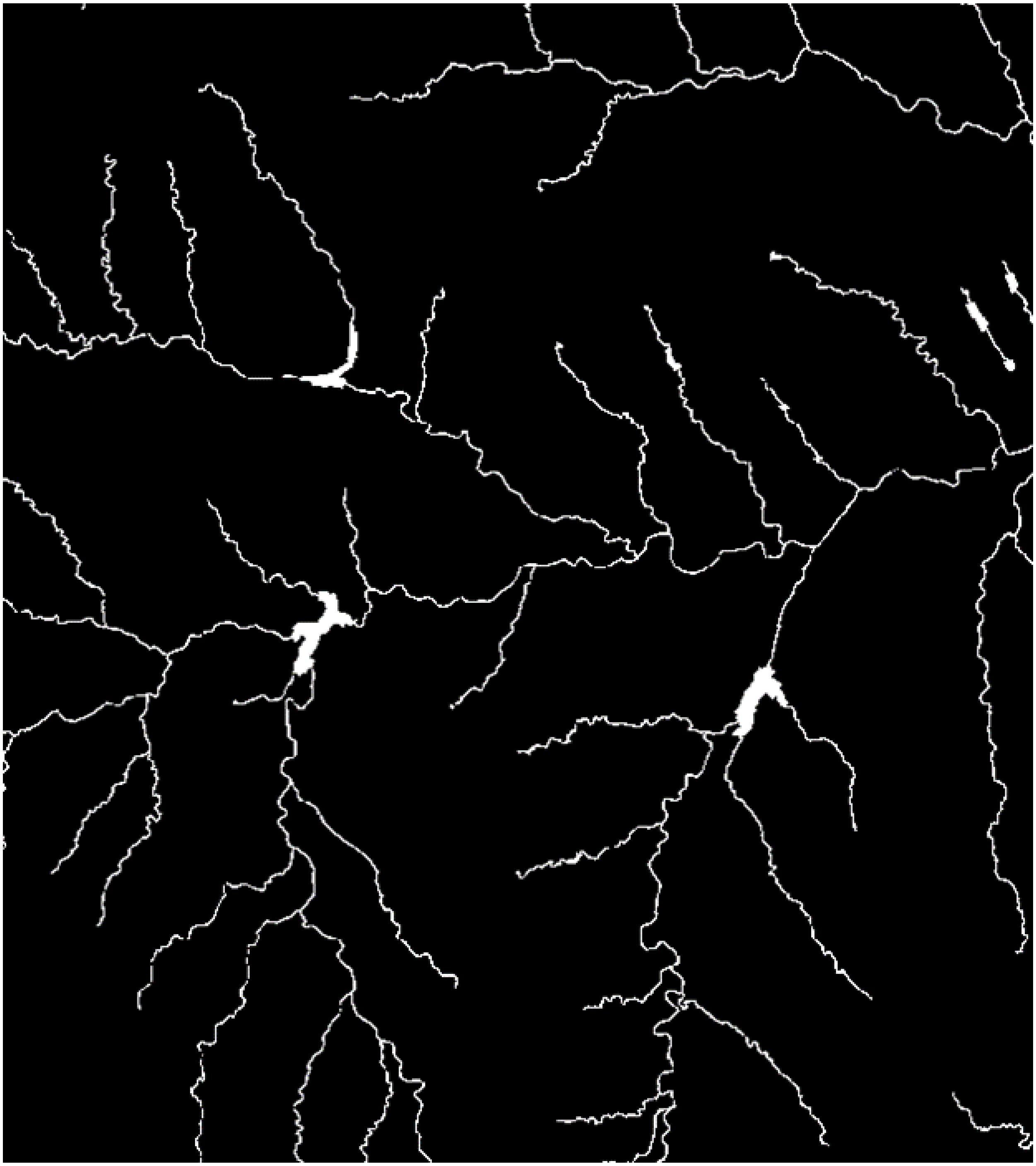

Figure 3. Resultant raster of processing the hydrodem.tif layer. *R. Olsen.*

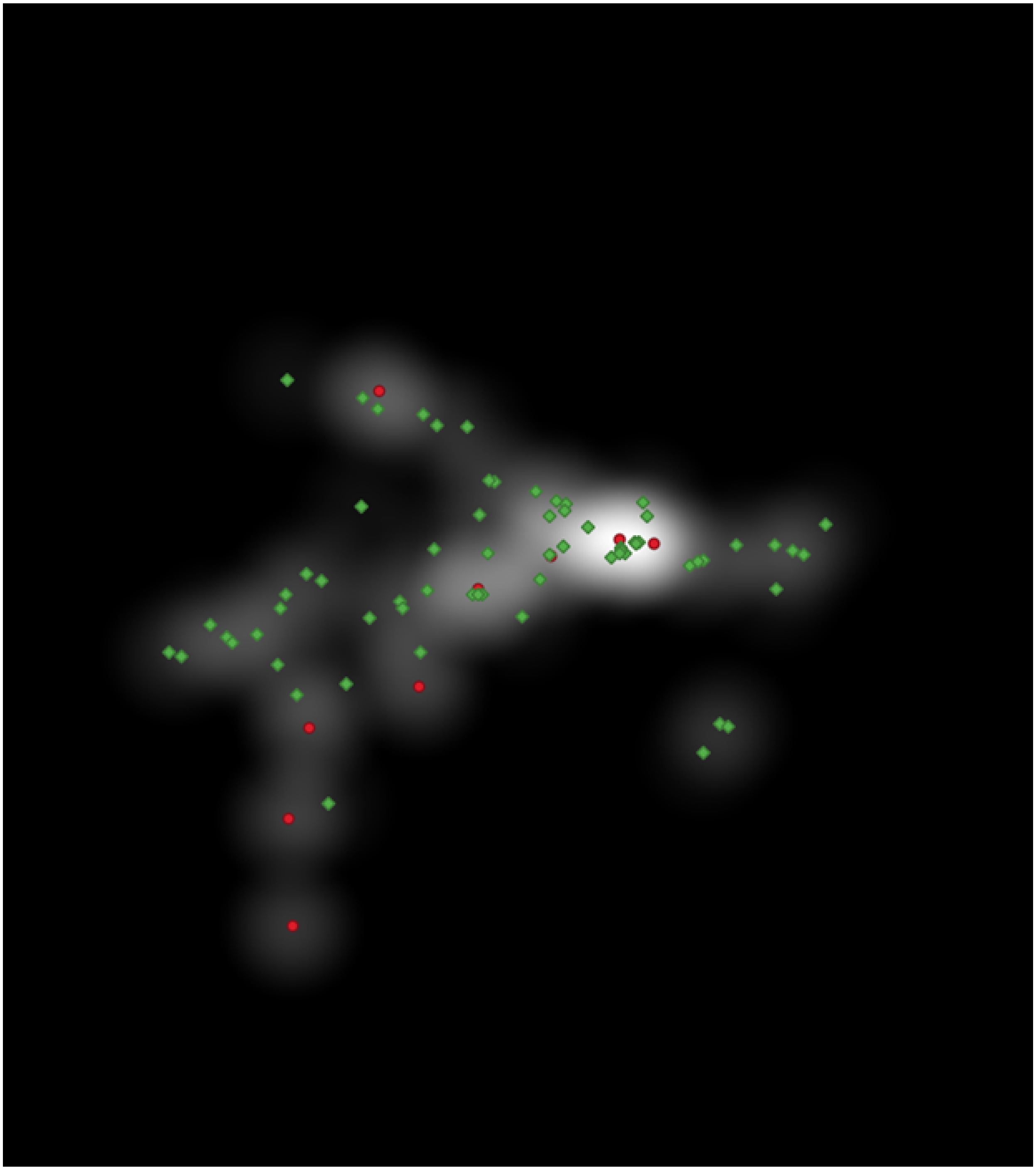

Figure 4. Resultant rafter after processing the deer point layer into a heatmap. The point layer is overlaid, sighting are green diamonds and kill sites are red dots. *R. Olsen.*

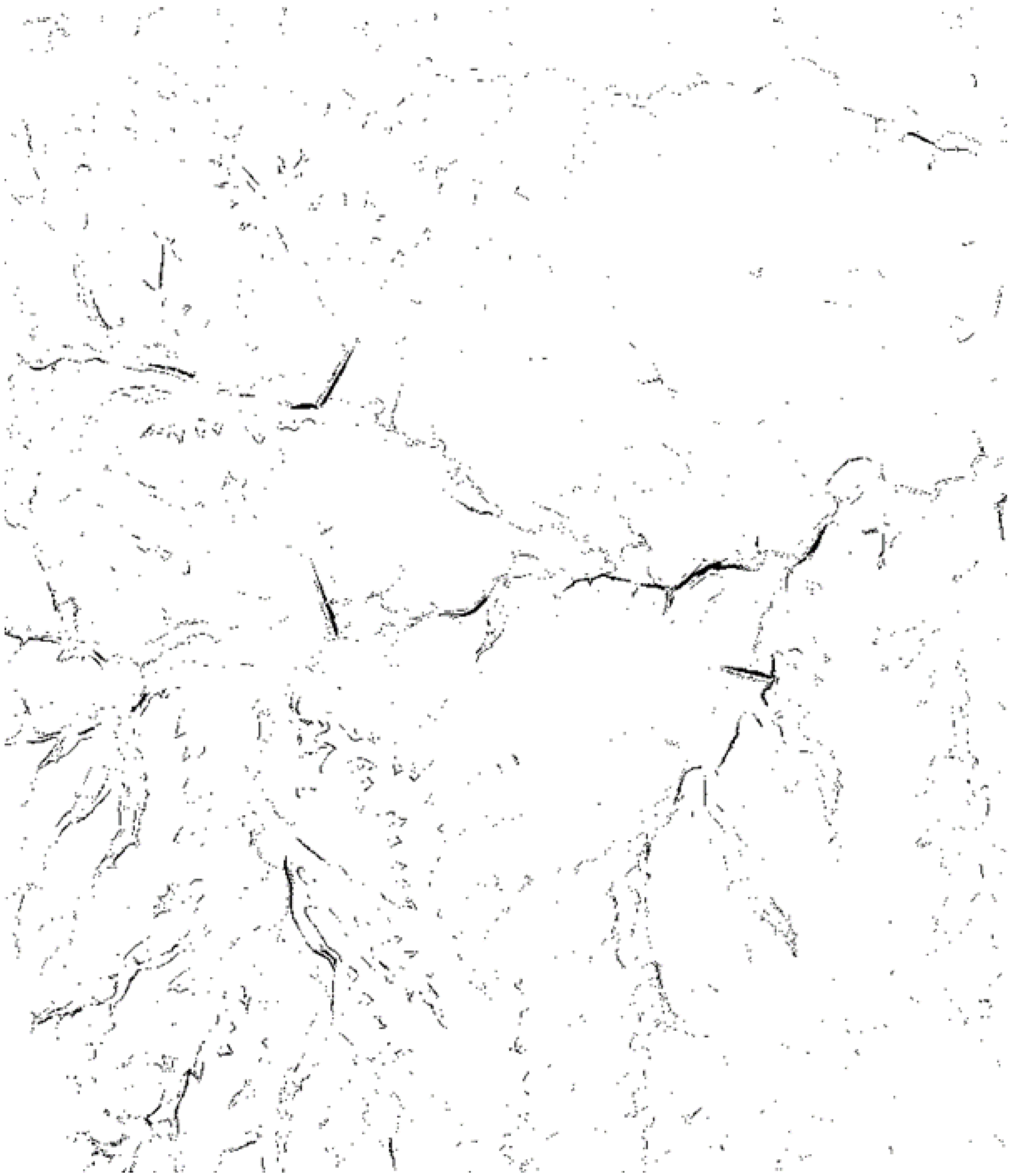

Figure 5. Resultant raster after performing a raster calculation using maximum the maximum slope value of the deer point layer. *R. Olsen.*

Figure 6. Resultant raster layer after classifying the food source layer. *R. Olsen.*

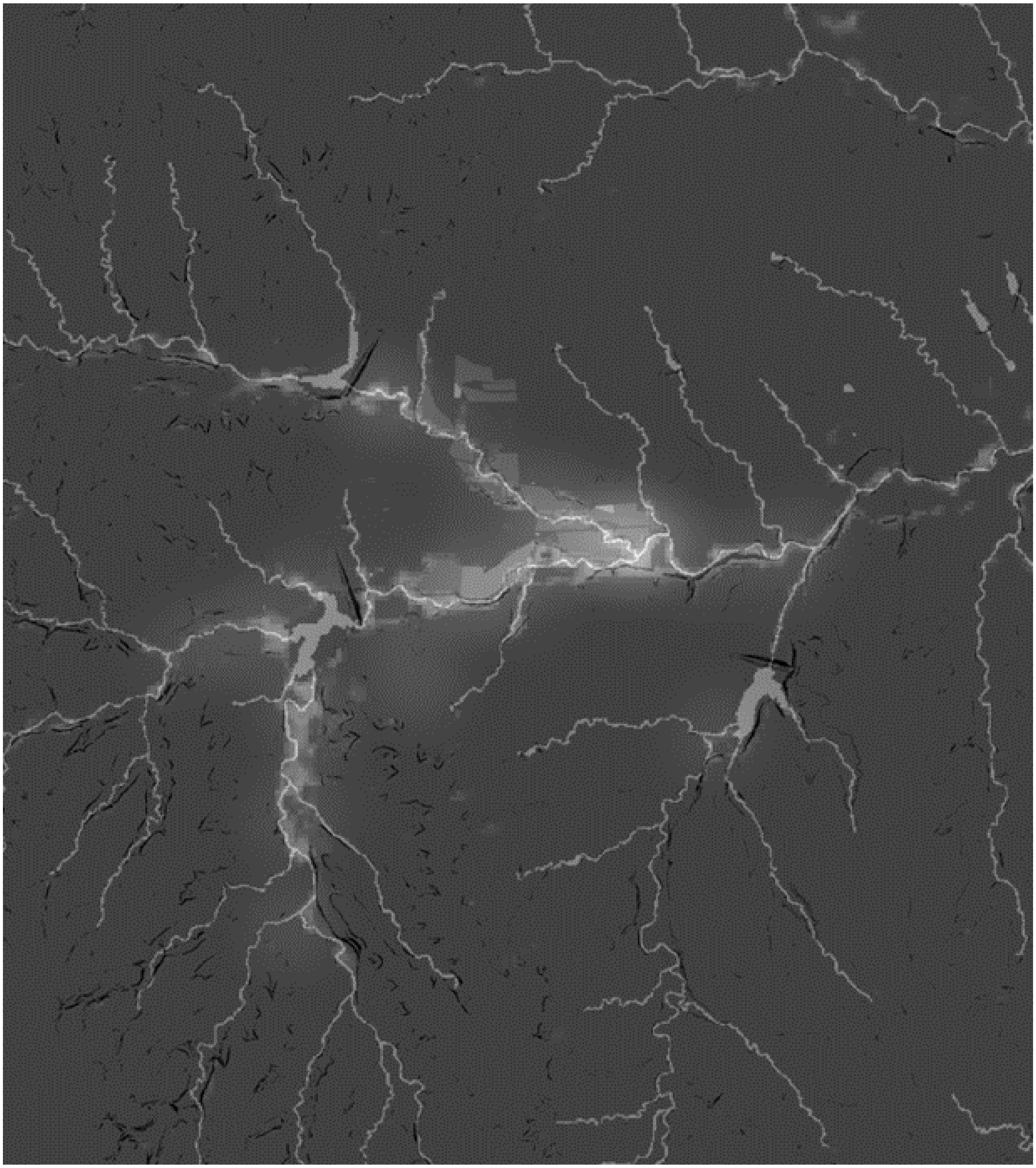

Figure 7. Resultant raster after adding the tree canopy, stream, slope, food source, and deer heatmap. *R. Olsen.*

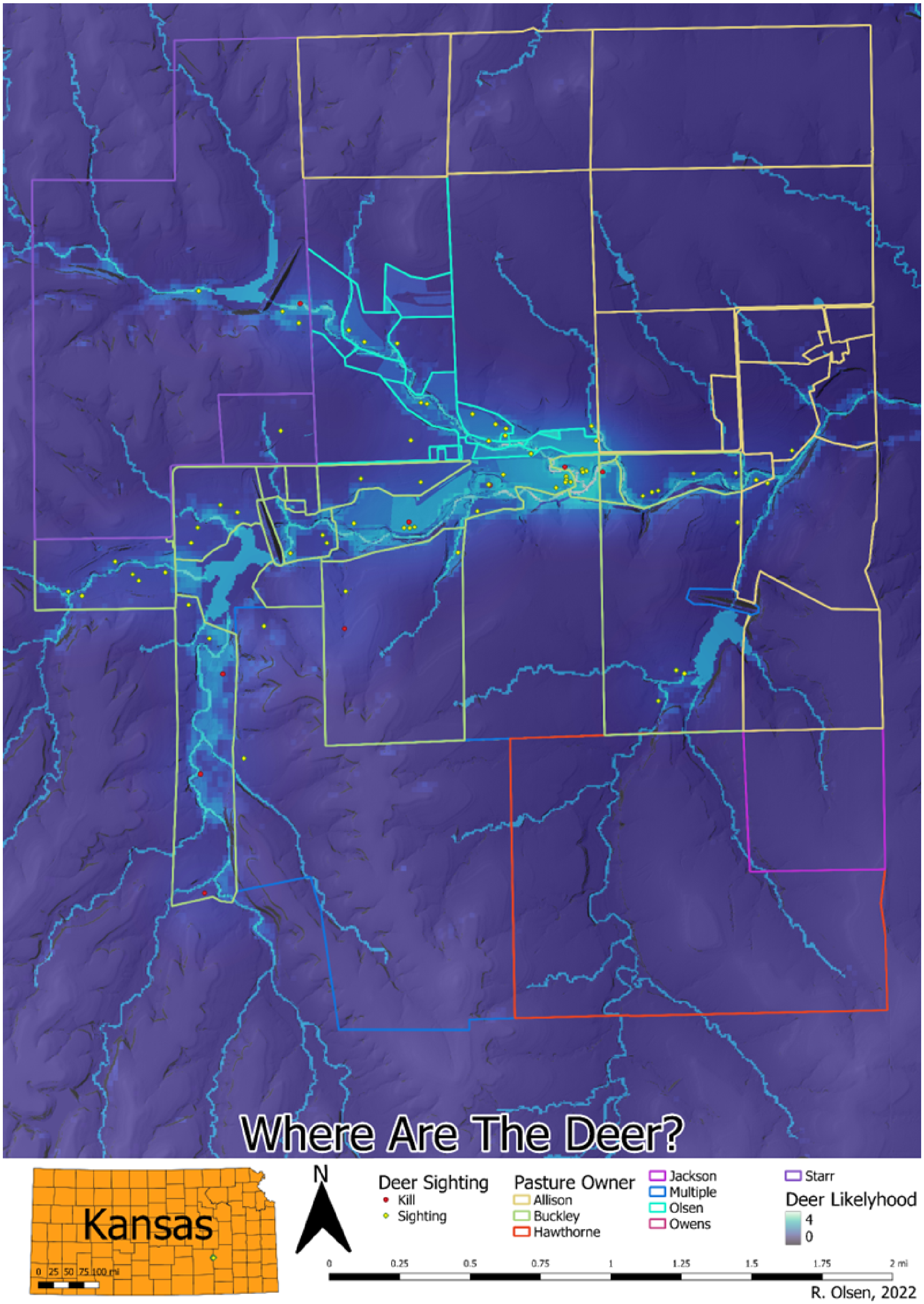

Figure 8. The final result of all processing. *R. Olsen.*

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