THE SIERRA NEVADA BIGHORN SHEEP

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Introduction

The Sierra Nevada Bighorn Sheep is a majestic animal that mainly roams high up in the mountains. The animals are about three feet tall at the shoulders with rams weighting 220 lbs. and ewes weighing 140 lbs. Rams have a lifespan of about 10 to 12 years and can range up to 100 km2. Ewes have a lifespan of about 12-20 years and can range up to 50 km2. Mating occurs during November to December with ewes having one lamb per year after being pregnant for 5 to 6 months. Sierra Nevada Bighorn Sheep prefer higher elevations as steep slopes and a clear and wide range of sight allows the animals to spot and evade predators, mainly the Mountain Lion. During the summer, the animals may usually be found in steep, mountainous areas of 10,000 – 14,000 ft. During the winter, the animals may usually be found in lower elevations of 5,000 – 9,000 ft. The Sierra Nevada Bighorn Sheep also prefers to avoid densely wooded or vegetated areas. Some examples of their diet consist of grasses, sedges, shrubs, herbaceous plants, and forbs during the summer. During the winter, they rely on whatever has been spared from the winter snow and cold. Such food includes grass roots, woody plants, willows, sage, and rabbit brush. Therefore, habitat is an extremely important component for their survival.

The species has been labeled as endangered since 2000 after an emergency listing in 1999. Due to the threat of disease from domestic livestock, loss of habitat, and predation, the species fell to an estimated 150 animals at the lowest levels. Due to conservation efforts, the number of Bighorn Sheep has increased to 400 as of 2010. However, the population is still in a precarious situation due to the still small numbers that have to face low genetic diversity, increased overall effects from adverse effects, and a lamb survival rate of less than 50%. Further conservation of habitats and protection of the population is required to ensure survival of the species.

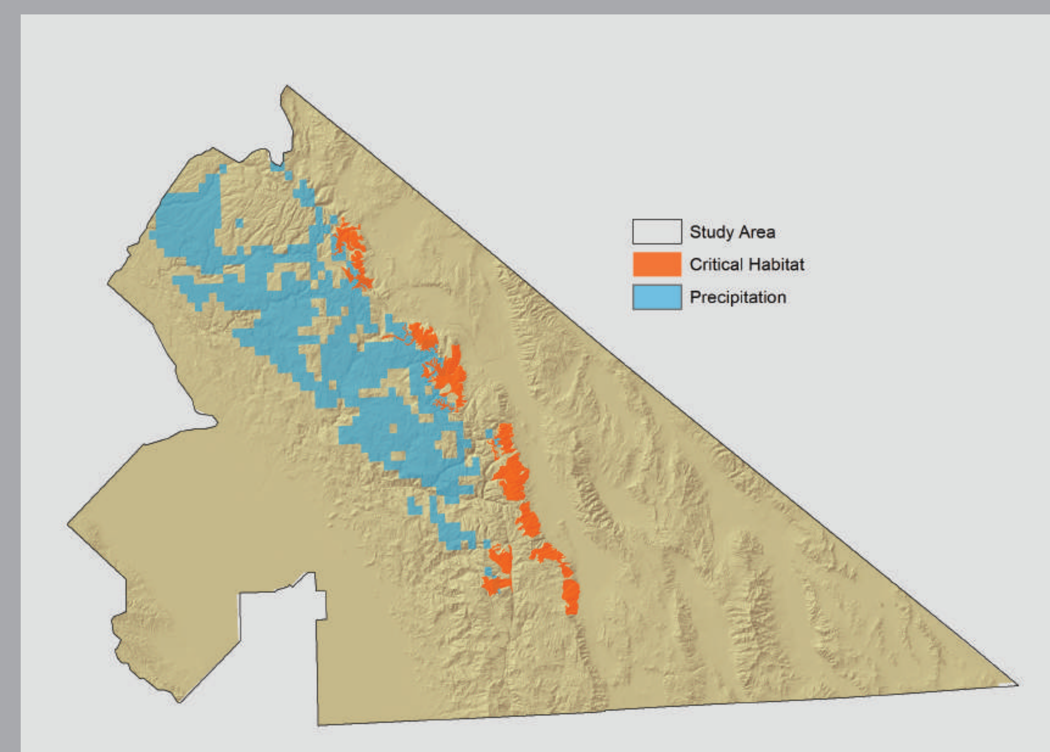
Our research question is the following:

Is it possible to create an accurate distribution map of the Sierra Nevada Bighorn Sheep that is based on easily accessible, public data in a limited time frame?

To address the issue, we collected data about the Sierra Nevada Bighorn Sheep. Then we searched through government sources that would provide detailed data. Finally, we processed and analyzed the data to result in a distribution map.

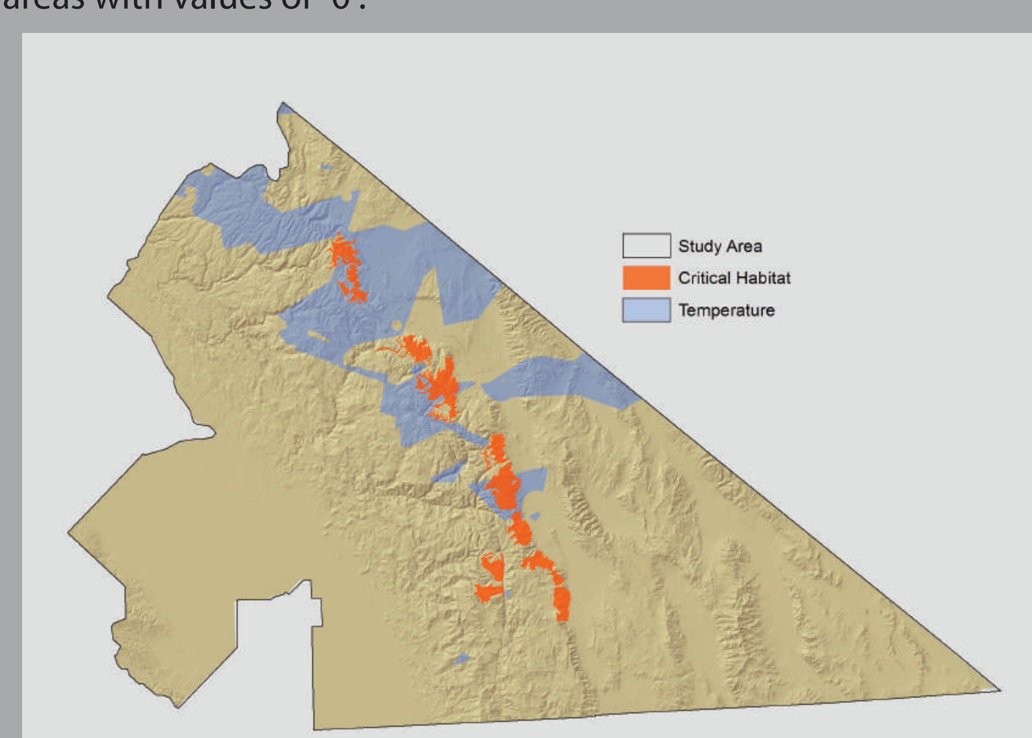
"Then we searched through government sources that would provide detailed data. Finally, we processed and analyzed the data to result in a distribution map. The wild sheep ranks highest among the animal mountaineers of the Sierra. Possessed of keen sight and scent, and strong limbs, he dwells secure amid the loftiest summits, leaping unscathed from crag to crag, up and down the fronts of giddy precipices, crossing foaming torrents and slopes of frozen snow, exposed to the wildest storms, yet maintainaing a brave, warm life, and developing from generation to generation in perfect strength and beauty."

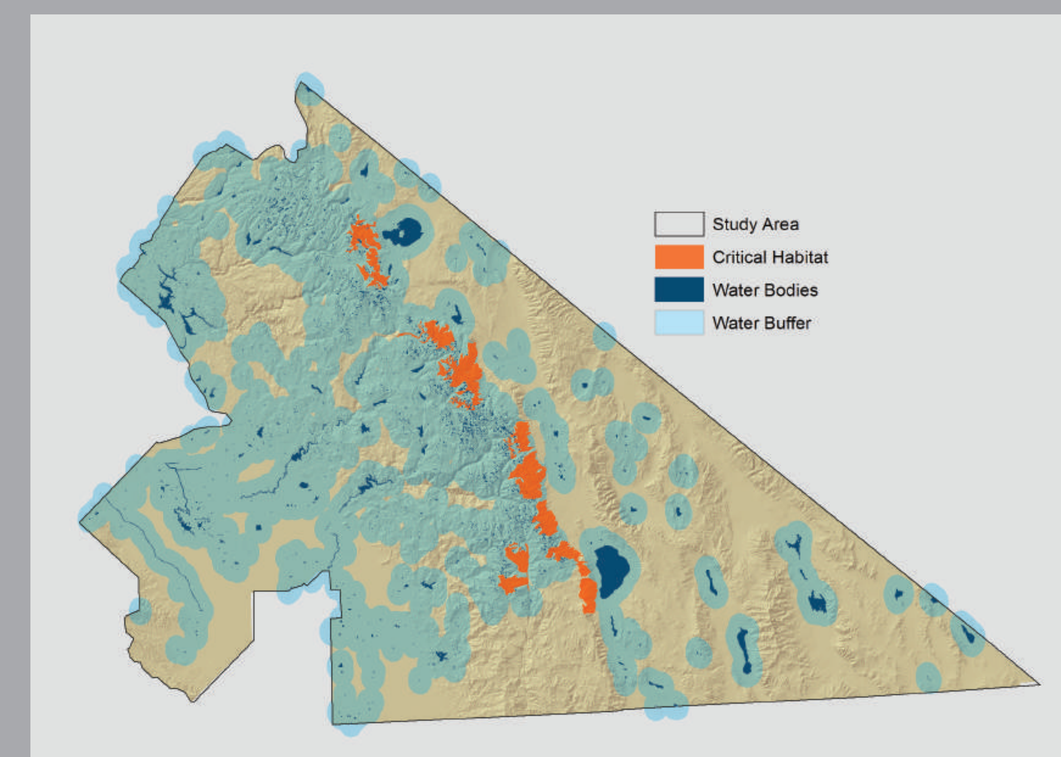
--John Muir



The study area is composed of the Fresno, Inyo, Madera, Mariposa, Mono, Tulare, Tuolumne counties. This area is located in the northeastern section of California and was selected as the critical habitat falls within these counties. The projection was set as NAD_1983_UTM_Zone_10N as California is within UTM Zone 10. A file geodatabase was created to store the various raster and shape data for the project. NED, NLCD, temperature, precipitation, hydrology, critical habitat, and county data was imported into the geodatabase prior to further analysis. All rasters were reprojected to NAD_1983_UTM_Zone_10N as necessary and resampled to a cell size of 30 for future calculations.

To analyze temperature data, we took the spreadsheet of precipitation data from NOAA and used the Display X/Y Tool to generate spatial point data onto the map. The points were then clipped to the study area. Finally, the IDW tool, with default values, was run on the point data to provide a raster map of temperature. The resulting raster was clipped to the critical habitat area and then converted to point data for each section. The resulting attributes from the data was imported into Excel for analysis. In Excel, the tabular data was analyzed by utilizing the COUNTIF formula to count the number of times each temperature range appeared in the critical habitat. Utilizing the Reclassify Tool, every temperature range, except for the range selected from Excel was set to "0". The Excel range result was set to "1". For the precipitation data, we took the resampled data and clipped it to the study area. The data was then clipped to the study area and then converted to point data with the Feature to Point Tool. The attributes were exported to Excel and then ran similar analysis as with temperature data. The resulting raster, after reclassifying, showed areas with favorable precipitation with values of "1" and other areas with values of "0".

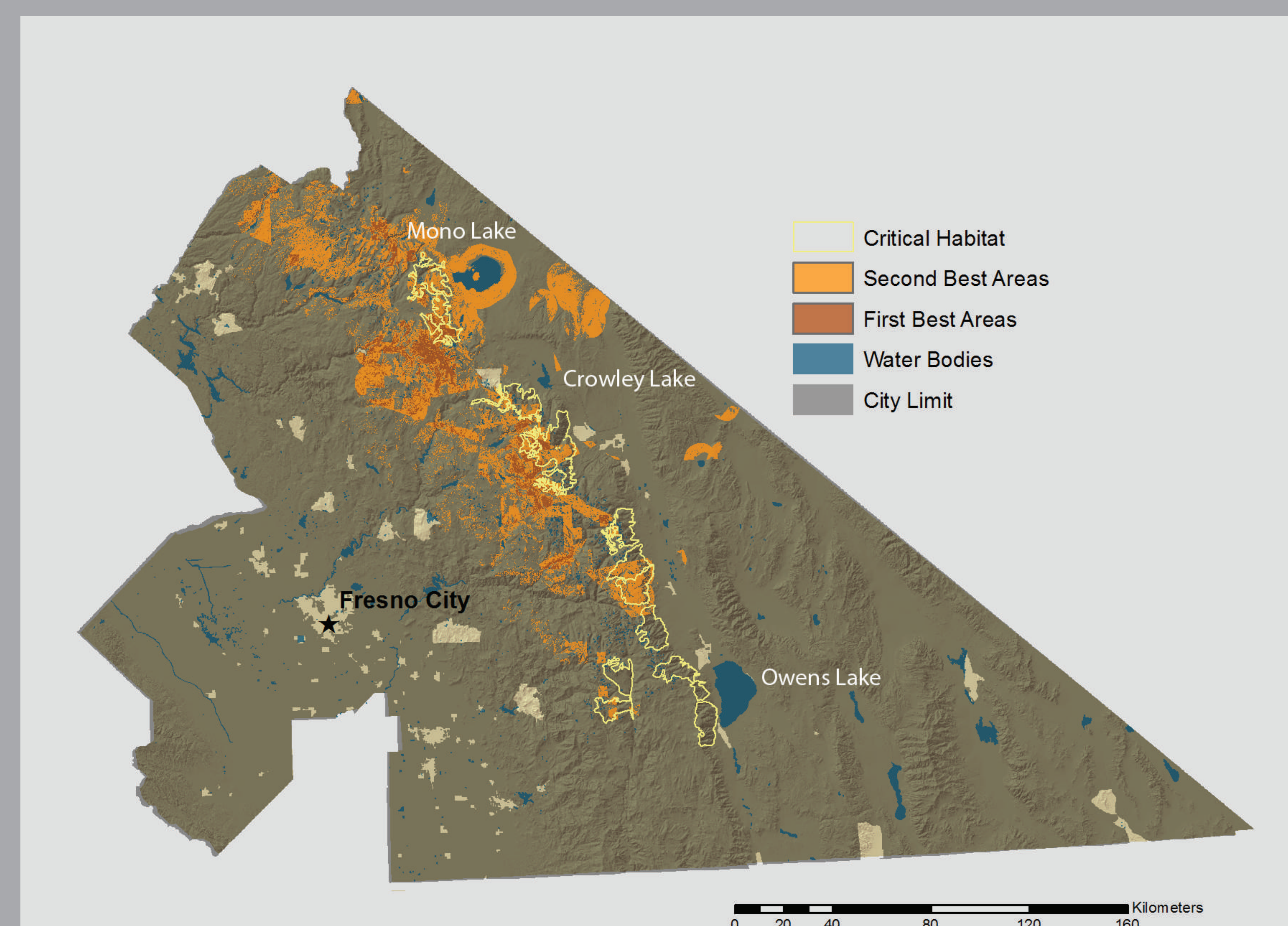




For analysis of water body and city restrictions, the polygon data of the water bodies and city limits acquired from ESRI were clipped to the study area. The water body layer was converted to raster and reclassified to have the value of 1 wherever there was water. For the city data, the city limit polygon data was first used to clip the study area polygon. The resulting clipped polygon was used in the Erase tool to create a new polygon of the study area with the city limit areas removed. This provided a polygon that showed where sheep could not live. The polygon was then converted to raster and reclassified to set valid areas as 1.

Map Method

The final analysis consisted of using the Raster Calculator to "add" the various resulting rasters from the prior analysis. The following formula is a direct copy of the formula used to create a resulting raster of possible distribution based on the various factors analyzed in the project:



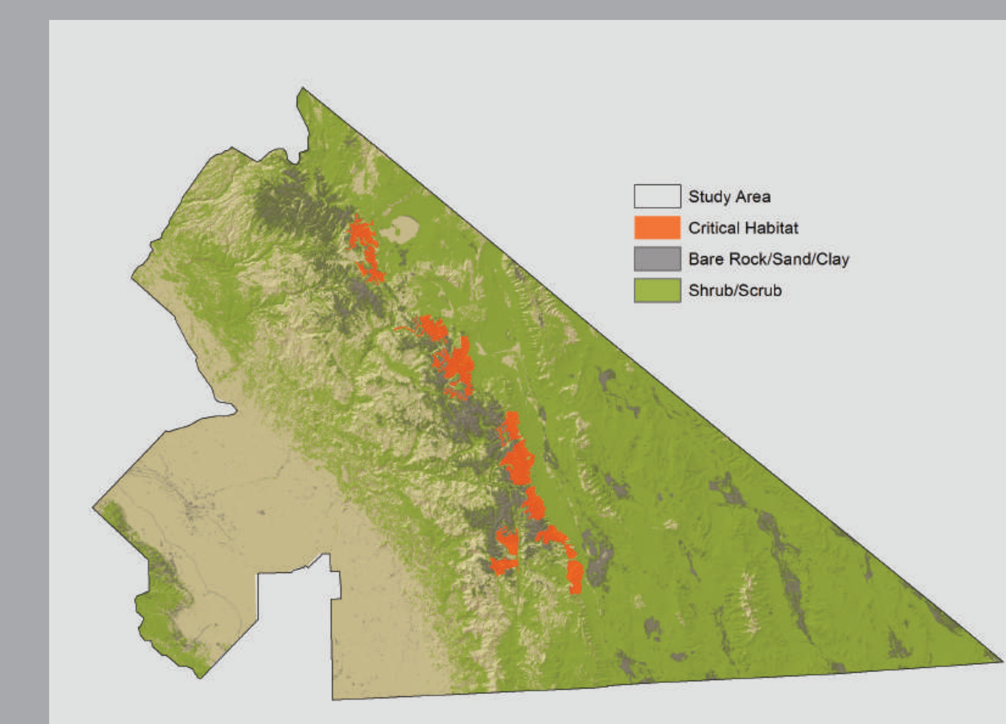
Results

The map showed an interesting result of our attempt at distribution mapping. It appears about half of the existing critical habitats are covered by the resulting distribution map, which shows the analysis was not fully accurate. As critical habitat areas are created from the best science available to researchers for preservation purposes, a distribution map should include a majority of the critical habitats. The resulting areas most likely for a theoretical distribution are mainly to the west of the existing critical habitats. The areas are mountainous and would provide the type of area that would allow the sheep to easily spot and escape predators. The next best areas are more likely found in the northern half of the study area. A significant area to notice is Mono Lake that could provide a reliable source of water for the sheep.

Methodology

To analyze land cover data, the land cover was run with the Extract by Mask tool, utilizing the critical habitats as the mask. The resulting attribute table was exported to Excel for similar counting and analysis as temperature and precipitation counting. From that, two main land covers, numbered "31" and "52" were selected. Afterwards, the Con tool from the Raster Calculator was utilized to pick out the areas with shrubs and rocky or relatively clear areas. The following is the formula utilized:

Con((("nlcd_final" == 52)|("nlcd_final" == 31)),1,0)

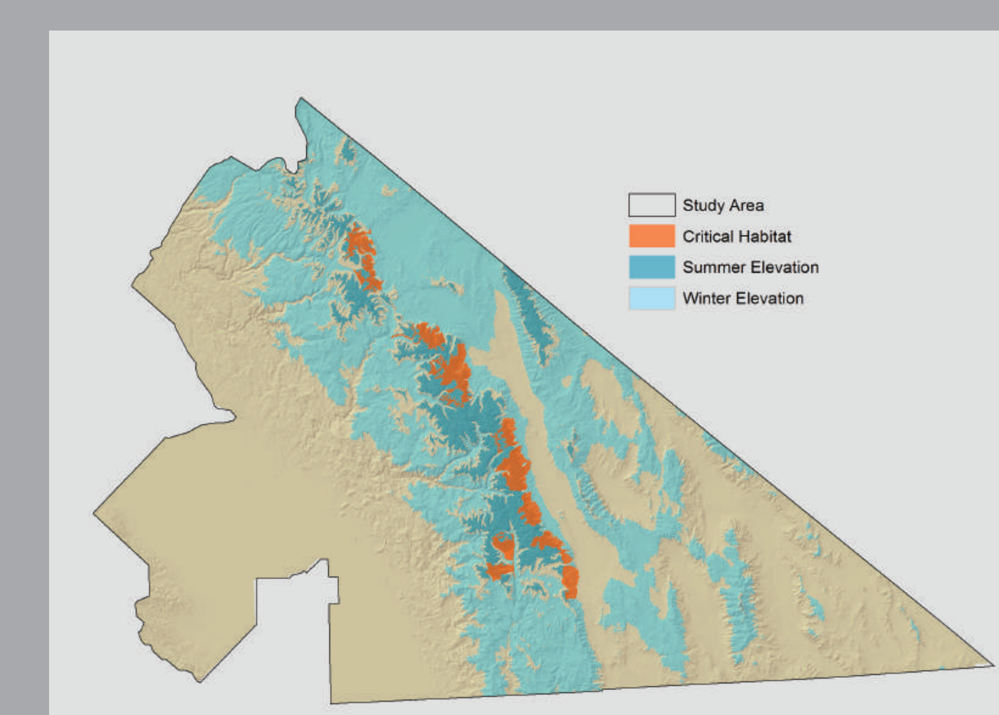


The formula created a new raster that had a value of 1 for areas with NLCD values of 52 and 31. All other areas were set to a value of 0.

For elevation, the NED data was combined into a single raster through the Mosaic tool with the option to update Overlays, create pyramids, and update statistics enabled. The resulting raster was clipped to the study area. The Con tool was run to select winter and summer elevation ranges of the sheep. The following formulas were utilized:

Con((("ned_reclip" >= 1524) & ("ned_reclip" <= 2743.2)), 1,0)

Con ((("ned_reclip" >= 3048) & ("ned_reclip" <= 4267.2)), 1,0)



These formulas calculated the winter and summer elevation ranges respectively. The values utilized were converted from feet to meters. The resulting two rasters had a value of 1 for ranges the sheep were most likely to frequent and a value of 0 for all other areas.