**NASA DEVELOP National Program**



NASA John C. Stennis Space Center

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Southern Rockies Ecological Forecasting

Using NASA Earth Observations to Identify and Predict Suitable Mule Deer Habitats

 **Technical Report**

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# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Remote sensing, ecological forecasting, mule deer, southern Rockies

# II. Introduction

Mule deer, *Odocoileus heminonus*, are an economically and ecologically important species in North America. Many western states experience economic growth from tourists who travel to hunt or view these large animals. They play a large role in their ecosystems’ processes and serve as an ecological indicator for habitat quality. Usually, if the habitat is suitable for mule deer, it is suitable for many other animals in their food web (Kie et al., 2002). The mule deer population, however, faces the risk of losing their habit due to anthropogenic effects. In our study area, the Southern Rockies Landscape Conservation Cooperative (SRLCC), land is being lost due to energy, agricultural, and housing development (Sawyer et al., 2009).

Currently, decision makers rely solely on ground surveys to identify suitable habitats for mule deer. This method does not provide a comprehensive understanding of how and when mule deer are using different habitat patches. In an effort to improve the methodology for land managers, the SRLCC expressed the need for applied science tools that utilize remote sensing data to characterize habitat quality at a landscape scale. Along with the SRLCC, the Western Association of Fish and Wildlife Agencies (WAFWA) Mule Deer Working Group will benefit from predictive geospatial habitat quality models to better prioritize conservation management of key mule deer habitats.

This ecological forecasting project focused on the mule deer’s winter range within the SRLCC boundaries, which consists of areas within Idaho, Wyoming, Utah, Colorado, Arizona, and New Mexico. During the fall, migratory mule deer travel to their winter habitat at lower elevations around 3000 to 6000 feet above sea level (Russell, 1932). To qualify as a good winter habitat, the area must have thermal coverage, winter forage cover, adequate water supply, exposure to warmer temperatures, and minimal snow pack (Olson, 1992).

Mule deer require thermal cover in the winter for protection from cold temperature, high winds, and snowfall. This thermal cover should include vegetation such as dense juniper, evergreen trees, and shrubs at least three feet tall and the area should cover two to five acres. Seventy-five percent of the mule deer’s winter diet consists of trees and shrubs, specifically sagebrush (*Artemisia spp.*), antelope bitterbrush (*Prushia tridentata*), mountain mahogany (*Cercocarpus spp.*), and rabbit brush (*Chryosthanmus spp.*) Suitable mule deer winter habitats should have food availability close to thermal cover (Olson, 1992).

Areas that have recently been burned due to wildfires or prescribed burns may also serve as suitable habitats for mule deer. This is a delicate situation, however, and depends on fire severity. If the fire creates temperatures hot enough to kill important forage types such as sagebrush, antelope bitterbrush, and curl leaf mountain mahogany, two of which are vital winter food sources for mule deer, communities can be at risk. If the fire is maintained through prescribed burns, the results can be highly beneficial to mule deer populations. Prior to the fall migration, the winter range could benefit from late summer prescribed fires as they encourage browse plant growth. With increases in sprouting of true mountain mahogany, chokecherry, service berry, rabbit brush, snowberry, and aspen, the mule deer will have an increased source of winter forage and thermal cover (Olson, 1992).

There are few places within the SRLCC boundaries that meet all of these requirements, therefore it is vital that these areas are either conserved or restored. With remote sensing data, this project characterized high quality habitats for mule deer’s’ winter range then predicted suitable areas to focus conservation and restoration efforts.

# III. Methodology

**Data Acquisition**

1. Land Cover

The USGS 2011 National Landcover Database (NLCD) was acquired for the conterminous area of the United States at 30 meter ground resolution.

1. Southern Rockies LCC Boundary

The shapefile of the SRLCC boundary was downloaded through USGS’s Science-base catalog.

1. Mule Deer Habitat Ranges

Mule deer habitat range data was downloaded from Utah State University’s Remote Sensing and Geographic Information Systems Laboratory website.

1. Wildfire and Prescribed Fire Perimeters

Individual fire-level geospatial data was downloaded from the Monitoring Trends in Burn Severity (MTBS) project’s website. Temporal and spatial information was inputted into a data query search and fire perimeters that fell within the SRLCC and mule deer winter range boundaries were downloaded. These fires occurred between January 2010 and December 2014.

**Data Processing**

1. Land Cover
	1. Land Cover

Shape files of both the SRLCC boundary and the mule deer winter ranges were used to clip to NLCD to the study areas.

* 1. Mule Deer Habitat Ranges

The winter range data set was extracted from the dataset and used to clip the NLCD.

* 1. SRLCC Boundary

The land cover data from U.S. Geological Survey National Land Cover Dataset (NLCD) was used to describe the forage types in the SRLCC boundary by clipping the NLCD to the boundary’s shapefile.

* 1. Mule Deer Winter Range

The land cover data from U.S. Geological Survey National Land Cover Dataset (NLCD) was used to describe the forage types in the SRLCC boundary by clipping the NLCD to the mule deer habitats’ shapefiles.

**Data Analysis**

# IV. Results & Discussion

Insert images, graphs, maps, charts, etc. here. Choose the most important results to highlight here. No word cap, but two to six pages is a good range.

Things to discuss:

* Analysis of Results: What can you tell from your graphs, images, etc? What does this mean for your project?
* Errors & Uncertainty: What factors could you not account for, what things didn’t work out like you expected they would, etc.
* Future Work: If this project was to be selected for another term, what would be the focus? What other areas would be of interest?

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

* Joseph Spruce – Senior Scientist and Lead Science Advisor at NASA SSC
* James “Doc” Smoot – Senior Scientist and Assistant Science Advisor at NASA SSC
* Ross Reahard – SSC DEVELOP Center Lead
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* Jim Heffelfinger – WAFWA Mule Deer Working Group – Chair
* RS/GIS Laboratory – College of Natural Resources – Utah State University

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# VII. References

Kie, J., Bowyer, R., Nicholson, M., Boroski, B., & Loft, E. (2002). Landscape heterogeneity at differing scales: Effects on spatial distribution of mule deer. *Ecology*, 83(2), 530-544.

National Land Cover Database. US Geological Survey. *Conterminous United States land cover* (Data file). Retrieved from: <http://www.mrlc.gov/nlcd2011.php>

Olson, R. (1992). Mule deer habitat requirements and management in Wyoming. *Department of Renewable Resources: University of Wyoming*. Retrieved from: <http://www.wyomingextension.org/agpubs/pubs/B965R.pdf>

Russell, C. (1932). Seasonal migration of mule deer. *Ecological Monographs*, 2(1), 1-46.

Sawyer, H., Kauffman, M., Middleton, A., Morrison, T., Nielson, R., & Wyckoff, T. (2013). A framework for understanding semi-permeable barrier effects on migratory ungulates. *Journal of Applied Ecology*, 50, 68-78.

Utah State University’s Remote Sensing/ Geographic Information Systems Laboratory. *Mule deer mapping project* (Data file). Retrieved from: <http://www.gis.usu.edu/current_proj/muledeer.html>

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# IV. Appendices

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