**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

**NASA John C. Stennis Space Center**

**Southern Rockies Ecological Forecasting**

Utilizing NASA Earth Observations to Identify and Predict Suitable Mule Deer Habitats to aid Southern Rockies Landscape Conservation Cooperative in Habitat Conservation and Restoration Planning

**Objective:**

Correlate NDVI, phenological data, and other habitat quality variables such as patch size with known mule deer locations to determine migration patterns and suitable habitat locations. This information will be used to predict future mule deer habitat, allowing the end-users to prioritize habitats to be conserved and restored.

**Community Concern:**

Mule deer are a migratory wildlife species that require specific habitat characteristics including connectivity corridors between their lower elevation winter habitats and higher elevation summer habitats. John Rice, the Science Coordinator of the Southern Rockies Landscape Conservation Cooperative (LCC), expressed a need for the “development of applied science tools that use remotely sensed data to enable resource decision-makers to characterize habitat quality at a landscape scale.” This would include predictive geospatial habitat quality models that would assist end-users in determining appropriate areas to focus habitat conservation and restoration efforts.

**Partner Organizations:**

Southern Rockies LCC (End-User, POC: John Rice, Science Coordinator)

Western Association of Fish and Wildlife Agencies (WAFWA) Mule Deer Working Group (End-User, POC: Jim Heffelfinger, Chair)

The Southern Rockies LCC reached out to DEVELOP Langley to discuss needs for a project involving using remotely sensed data to develop predictive habitat models for mule deer over large regions. DEVELOP has since contacted the Science Coordinator of the Southern Rockies LCC, as well as members of the mule deer working group, to define the scope of this needed project. Project results will be provided to partners via video conference and email. Partners will benefit from this work by incorporating project results into their decision-making processes, allowing for greater understanding of mule deer migration patterns and habitats at a broad scale.

**Letters of Support:** Requesting letter of support from Southern Rockies LCC, John Rice, Science Coordinator

**Decision Making Process:**

Currently, land managers identify suitable habitat with ground surveys that do not provide a comprehensive understanding of how and when mule deer are using different habitat patches. There is a need for a landscape-scale solution that allows for the development of a predictive habitat model based on historic and recent mule deer migrations. Decisions regarding the planning of land conservation and restoration need to be made and results of this project will provide partnering organizations a mechanism that would help wildlife managers to better prioritize management of habitat areas on a landscape-scale.

**Earth Observations:**

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| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Aqua** | MODIS | Spectral vegetation indices and phenology products |
| **Terra** | ASTER, MODIS | Global elevation datasets, spectral vegetation indices, phenology products |
| **Landsat 8** | OLI | Spectral vegetation indices, land cover classifications |
| **Landsat 5** | TM | Spectral vegetation indices, land cover classifications |

**NASA Earth Observations Highlighted:** This project will use MODIS, ASTER, and Landsat data to correlate seasonal changes in vegetation, elevation, landcover, and other habitat factors with existing mule deer GPS collar movements during seasonal migrations. MODIS data products resident to the ForWarn system will primarily be used to assess the role of vegetation phenology in influencing seasonal mule deer migrations, tracking average “green-up” dates, and correlating green-up and brown-down trends with migrations. Phenology products and spectral vegetation indices will provide foraging habitat quality and biomass estimations that can be correlated with deer locations. Mule deer migration patterns include seasonal changes in elevation that will be plotted using ASTER-based digital elevation model datasets to assist in determining suitable habitats. Landsat-derived land cover datasets will provide current and historical land use/land cover information which is critical in determining patch size and winter/summer habitat connectivity. These parameters will provide the inputs necessary to define current habitat extent, predict how these habitats could change with respect to vegetation health and land development, and provide a greater understanding of mule deer usage of the region on a landscape-scale.

**Ancillary Datasets:**

GPS collar data from mule deer provided by the mule deer working group and the Southern Ute Indian Tribe, NRCS 2011 NLCD, NOAA NCEI climate variables, and preexisting mule deer habitat maps, such as those available online (e.g., http://www.gis.usu.edu/current\_proj/muledeer.html)

**Models:**

Lifemapper Species Distribution Modeling (LmSDM) (POC: Jeffery Cavner, Lifemapper Software Engineer)

**Decision Support Tools & Analyses:**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Seasonal Vegetation Phenology | Prioritization of mule deer land areas to be conserved or restored | Field surveys, GPS collar data |
| Foraging Habitat Type and Condition Maps | Prioritization of mule deer land areas to be conserved or restored | Field surveys, GPS collar data |
| Mule Deer Range Maps | Prioritization of mule deer land areas to be conserved or restored | Field surveys, GPS collar data |
| Species Distribution Model Outputs | Prioritization of mule deer land areas to be conserved or restored | Field surveys, GPS collar data |
| Methodology and Tutorial for Use of LmSDM | Prioritization of mule deer land areas to be conserved or restored | Field surveys, GPS collar data |

*Seasonal Vegetation Phenology* – MODIS and Landsat data will be processed to create geospatial products depicting rangeland phenology, average “green-up” dates, and growing season dates as they relate to the migration patterns of mule deer. In the second term of the project, phenology patterns will be one of the input parameters for modeling the distribution of mule deer throughout migration.

*Foraging Habitat Type and Condition Maps –* Geospatial mapping products depicting mule deer foraging habitat types and conditions will be derived from MODIS and Landsat data. These maps will also be used as predictive modeling inputs.

*Mule Deer Range Maps* – Maps correlating foraging habitat, vegetation phenology, and GPS collar locations of mule deer will be created in order to assist end-users in prioritizing areas for conservation and management.

*Species Distribution Model Outputs* – Phenology, existing vegetation cover and land classifications, elevation, and other habitat factors will be used as inputs in the Lifemapper Species Distribution Modeler to produce visual representations of mule deer habitat usage on a landscape-scale.

*Methodology and Tutorial for Use of LmSDM* – Tutorials detailing pre-processing and use of the Lifemapper Species Distribution Modeler will be provided to end-users so that parameters can be altered and updated as needed for habitat management purposes.

**Project Details:**

**National Application Area Addressed:** Ecological Forecasting

**Source of Project Idea:** Southern Rockies LCC reached out to LaRC DEVELOP with this project idea.

**Study Location:** Southern Rocky Mountains (Idaho, Wyoming, Utah, Colorado, Arizona, New Mexico)

**Period being Studied: TBD**

**Advisors:** Joseph Spruce (Senior Scientist and Lead Science Advisor at NASA SSC), James “Doc” Smoot (Senior Scientist and Assistant Science Advisor at NASA SSC), Dr. Kenton Ross (NASA DEVELOP National Science Advisor, LaRC)

**Participants Requested:** 4

**Project Timeline:** 2 Terms: 2015 Fall to 2016 Spring

**Multi-Term Objectives:**

* **Term 1 (Proposed Term)** – Correlate vegetation quality and biomass estimates with currently understood mule deer habitat locations to be used in future term to model migration routes and predict habitat changes
* **Term 2** – Create model that shows mule deer seasonal migrations in relation to previously correlated habitat requirements, also focus on creation of tutorials and handoff to partners for continued use by end-users

**Previous Related DEVELOP Work:**

2014 Summer and Fall (Ames Research Center) – Great Basin Climate I & II: A Geospatial Assessment of Fire Events in the Great Basin Ecoregion and Its Relation to Cheatgrass Spread Under Changing Climate Conditions

2015 Summer (Stennis Space Center) – Texas Disasters I: Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands

2015 Summer (Stennis Space Center) – Mississippi Ecological Forecasting: Using NASA Earth Observations to Locate Potential Habitat for the Dusky Gopher Frog

**Software & Scripting Requested:**

* ERDAS IMAGINE - land classification, raster processing, image manipulation and enhancement/Landsat 8 OLI, Landsat 5 TM, Aqua and Terra MODIS, elevation datasets
* ArcGIS – raster processing and image manipulation, map creation/Landsat 8 OLI, Landsat 5 TM, Aqua and Terra MODIS, elevation datasets, in-situ data
* R – statistical correlation analysis, Landsat 8 OLI, Landsat 5 TM, Aqua and Terra MODIS, elevation datasets, in-situ data
* QGIS – Utilization of Lifemapper plug-in for visualization of species distribution and creation of predictive migration pattern model; correlation analysis, land classification, raster processing, image manipulation and enhancement, Landsat 8 OLI, Landsat 5 TM, Aqua and Terra MODIS, elevation datasets