**NASA DEVELOP National Program**

****NASA John C. Stennis Space Center

**Fall 2015**

**Short Title: Southern Rockies Ecological Forecasting**

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

**VPS Title:** More Energy, But Less Movement: Saving Habitats for Mule Deer

**Project Team & Partners**

**Project Team:**

Ross Reahard (Project Lead), ross.r.reahard@nasa.gov

Teresa Fenn

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**Advisors & Mentors:**

Joseph Spruce (NASA Stennis Space Center)

James “Doc” Smoot (NASA Stennis Space Center)

Dr. Kenton Ross (NASA Langley Research Center)

**Partner Organizations:**

Southern Rockies Landscape Conservation Cooperative (End-User), POC: John Rice

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

**Project Details**

**Applied Sciences National Application Addressed:** Ecological Forecasting

**Study Area:** Southern Rocky Mountains (ID, WY, UT, CO, AZ, NM)

**Study Period:** TBD

**Earth Observations & Parameters:**

Aqua, MODIS – Phenology products, vegetation indices

Landsat 5, TM – Land cover classification, vegetation indices

Landsat 8, OLI – Land cover classification, vegetation indices

Terra, ASTER, MODIS – Global elevation datasets, phenology products, vegetation indices

**Ancillary Datasets Utilized:**

* GPS collar data provided by the mule deer working group and the Southern Ute Indian Tribe – mule deer locations
* NRCS 2011 NLCD – land cover
* NOAA NCEI – climate variables
* Preexisting mule deer habitat maps

**Models Utilized:**

* Lifemapper Species Distribution Modeling (LmSDM)

**Software Utilized:**

ERDAS IMAGINE – land classification of Landsat imagery

ArcGIS – raster manipulation/analysis, image enhancement & map creation of Landsat ETM+, NPP VIIRS, Aqua/Terra MODIS

**Project Overview**

**80-100 Word Objectives Overview:**

With ever-increasing amounts of habitat loss and fragmentation due to anthropogenic effects among ungulate communities, it is becoming progressively vital for ecologists to prioritize the conservation and restoration of potential future habitats. This project focused on the mule deer species found in the Southern Rocky Mountains. Coupling GPS collar data with NASA Earth observations, we characterized and predicted suitable habitats for mule deer utilization when current habitats are lost due to many different types of anthropogenic effects.

**Abstract:**

Mule deer, *Odocoileus heminonus*, are migratory ungulates found in the western region of the US. This species plays a major role in ecosystem processes and serves as an important ecological indicator. With increasing impacts from anthropogenic activities, changes in mule deer population numbers reflect changes in other species found in the same habitat. Therefore, studying the habitats and migration routes occupied by mule deer provides insight into the habitats that decision-makers should focus on. Their migration routes require multiple stopover sites, for forage and rest, which are connected together by corridors between different seasonal habitats. Recently, stopover sites have been used less frequently, due to energy development and migration routes, and have been impacted by larger, concentrated urbanization. In response, this project used NASA Earth observations to predict suitable mule deer habitats. MODIS data resident to the ForWarn system was used to determine the role of vegetation phenology in migration. MODIS phenology products and spectral vegetation indices were also used to determine forage quality and biomass estimations. ASTER digital elevation model datasets plotted seasonal migration changes in elevation. Landsat 5 TM and Landsat 8 OLI land cover datasets provided current and historical land use and land cover which determine patch size and connectivity between summer and winter habitats. By correlating NASA Earth observations with GPS collar data, this project developed multivariate models to determine characteristics of mule deer habitats and migration routes. The products will enable resource decision-makers to determine appropriate areas for conservation and restoration.

**Community Concerns:**

* Mule deer are a migratory wildlife species that require specific habitat characteristics including connectivity corridors between different seasonal habitats.
* John Rice, the Science Coordinator of the Southern Rockies LCC, expressed a need for the development of remotely sensed data utilization that will aide decision-makers in characterizing habitat quality.
* Mule deer play a large role in the processes of their ecosystems and are an important ecosystem indicator species.
* Increased levels of human development in mule deer habitats have demonstrated behavioral changes as well as migration pattern changes.

**Current Management Practices & Policies**:

Currently, land managers use ground surveys to identify suitable habitats. This is limiting because the information used does not provide a comprehensive understanding regarding how and when the mule deer are using different habitat patches. John Rice expressed the need for a landscape-scale solution that will allow for the development of a predictive habitat model based on historic and recent mule deer migrations. Decisions regarding land conservation and restoration are necessary, therefore the results of this project should provide a mechanism that will help wildlife managers to better prioritize management of habitat areas on a landscape-scale.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Seasonal Vegetation Phenology | Aqua MODISTerra ASTER & MODISLandsat 8 OLILandsat 5 TM | Prioritization of mule deer land areas to be conserved or restored |
| Foraging Habitat Type and Condition Maps | Aqua MODISTerra ASTER & MODISLandsat 8 OLILandsat 5 TM | Prioritization of mule deer land areas to be conserved or restored |
| Mule Deer Range Maps | Aqua MODISTerra ASTER & MODISLandsat 8 OLILandsat 5 TM | Prioritization of mule deer land areas to be conserved or restored |
| Species Distribution Model Outputs | Aqua MODISTerra ASTER & MODISLandsat 8 OLILandsat 5 TM | Prioritization of mule deer land areas to be conserved or restored |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

What category do the tools your project is creating fall within? [Category I to V]

If your decision support tools fall within Category IV, fill out this section:

**Software Title:** Insert here (ex. DEVELOP National Program Python Package)

**Software Abbreviation:** Insert here (ex. dnppy)

**Technical Point of Contact:** Insert full name, permanent email, and node here. Also include whether employed through SSAI or Wise County. (Team member who knows the most about the software.)

**Brief Description of the Software:** Insert here (ex. The dnppy package will be used to functionalize common programming tasks in the geospatial community, specifically for working with NASA data products. It will include functions for processing satellite data and assist in structuring analysis to reduce the startup time for DEVELOP teams to learn programming and create tools for end users.)

**Type of Code:** *Executable Code* and/or *Source Code* (Select one or both)

**Will the software include any embedded computer databases?** *Yes* or *No* (Select one)

**Does the software use or call any open software or libraries?** *Open Source* and/or *Proprietary/Commercial* (Select one or both)

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Ex. Arcpy module | Ex. group license through ArcGIS | http://www.esri.com/software/arcgis |
| Ex. Python | Ex. Open source license | http://opensource.org/licenses/Python-2.0 |
|  |  |  |

**Full Software Description and Plan**

**Introduction/Objective:**

What motivated the creation of this software, what problem does it address?

**Applications and Scope:**

Where and how will this software be used to influence decisions?

**Capabilities:**

What can it do better than what was previously available?

**Interfaces:**

How is one expected to use the software? For example, command line, GUI, script execution, etc.

**Assumptions, limitations, & Errors:**

What areas that the software could be improved upon in the future? This is where limitations of the theory, model, science, etc should be briefly documented. If the tools only work for a specific scenario, say so.

**Testing:**

What validation techniques and testing strategy will be used to build confidence in the software?