

NASA DEVELOP National Program

Summer 2016 Project Proposal

USGS at Colorado State University

Laramie Mountains Ecological Forecasting II

Utilizing NASA Earth Observations to Evaluate the Habitat Carrying Capacity for Mule Deer and Elk in the Laramie Range, Wyoming

Project Overview

Objective: To support state efforts in evaluating carrying capacities of mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) in the Laramie Mountain Range, and in planning habitat improvement efforts such as prescribed burning.

Community Concern: Aspen stands provide critical habitat for wildlife and are one of the most species rich vegetation community types in Wyoming. Mixed age stands of aspen are associated with a high diversity of herbaceous understory species and are important for ungulate fawning, fawn rearing, forage, and cover from predators. However, sudden aspen decline is a growing concern, in addition to declining mule deer populations, throughout the Western US. As a result, land management agencies are planning habitat improvement efforts, such as prescribed burning, to stimulate aspen regeneration. The public values aspen communities for aesthetics, wildlife viewing, and recreation, among other landscape benefits.

National Application Area Addressed: Ecological Forecasting

Study Location: Laramie Mountains, Wyoming

Study Period: January 1985 to October 2015

Advisor: Paul Evangelista (Natural Resource Ecology Laboratory, Colorado State University)

Source of Project Idea: This project idea was motivated by ongoing interactions with one of our current DEVELOP project partners, Ryan Amundson, Statewide Habitat Biologist with Wyoming Game and Fish Department. Ryan inquired if we could use similar methods to those employed by the Fall 2015 FC Wyoming Ecological Forecasting Team to map aspen cover in the Laramie Range. These maps will assist agency efforts in estimating the carrying capacities of ungulates in the area. Project collaborator Amanda West suggested taking this research one step further; using the aspen cover map to evaluate the bioclimatic niche of aspen in the study area. This niche model can be used to forecast suitable aspen habitat across space and in future potential climates.

Partner Overview

Partner Organizations:

Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?
Wyoming Game and Fish Department	Ryan Amundson, Senior Wildlife Biologist	End-User	No
Natural Resource Ecology Laboratory at Colorado State University	Dr. Amanda West, Postdoctoral Fellow	Collaborator	Yes

End-User Overview

End-User's Current Decision Making Process:

Currently, field surveys are the only tool being used to estimate aspen cover in the Laramie Mountain Range, and these surveys are limited by financial resources and accessibility (much of the area is inaccessible due to lack of roads and trails). The limited number of field surveys are extrapolated over the entire mountain range; therefore, aspen cover estimates are incomplete. Furthermore, comparisons of aspen regeneration in burned vs. unburned sites in this region have not been conducted to date.

End-User's NASA Earth Observations Capacity:

Wyoming Game and Fish Department – The end-user is familiar with NASA Earth observations; however, a lack of training and resources prevents the organization from adopting methods to utilize these resources. Wyoming Game and Fish was an end-user of the Fall 2015 Wyoming Ecological Forecasting Project and the agency recognizes how maps created from remotely sensed data can strengthen their capacity to address wildlife habitat concerns across the state.

Collaborator & Boundary Organization Overview

Collaborator Support:

Natural Resource Ecology Laboratory (NREL), Colorado State University – This collaborator and boundary organization was involved in the development of this project, has field data that will be used in this project, and will provide mentorship to the DEVELOP team. NREL has previously worked with the end-user on projects in the southern Medicine Bow Mountain Range, Wyoming, and will serve as the liaison with the end-user to maintain communication throughout the DEVELOP term.

Boundary Organization Dissemination:

Natural Resource Ecology Laboratory (NREL), Colorado State University – The Natural Resource Ecology Laboratory will disseminate results to the End-User during the term closeout.

Project Communication & Transition Overview

In-Term Communication Plan:

The team will communicate with project partners on a weekly basis via email and meetings throughout the term. The Center Lead and team lead will be the primary points of contact for the project partner.

Transition Approach:

At the end of the term, the team will host a closeout to disseminate project results and hand off decision support tools. The end-user plans to begin using these products as soon as they are available to inventory all aspen stands in the region and begin planning habitat improvements, including prescribed burning.

Earth Observations Overview

Earth Observations:

Platform & Sensor	Parameter(s)	Use
Landsat 5 TM	Surface reflectance, greenness, moisture, differenced normalized burn ratio	This dataset provides the temporal (16 days) and spatial (30 m ²) resolution needed for mapping fire history in the Laramie Range, with images beginning in 1985. The differenced Normalized Burn Ratio is used by the Monitoring Trends in Burn Severity (MTBS) project to develop fire perimeter and severity

		products and is derived from Landsat legacy data.
Landsat 7 ETM+	Surface reflectance, greenness, moisture, differenced normalized burn ratio	This dataset provides the temporal (16 days) and spatial (30 m ²) resolution needed for mapping fire history in the Laramie Range, with images beginning in 1999. The differenced Normalized Burn Ratio is used by the Monitoring Trends in Burn Severity (MTBS) project to develop fire perimeter and severity products and is derived from Landsat legacy data.
Landsat 8 OLI	Surface reflectance, greenness, moisture	This dataset provides the temporal (16 days) and spatial (30 m ²) resolution needed for mapping current aspen cover and fire history in the Laramie Range, with images beginning in 2013. Spectral indices from Landsat 8 OLI have been used in prior species distribution modeling projects at the Fort Collins DEVELOP node.
Landsat 8 TIRS	Brightness temperature	This dataset will be used to derive additional covariates for species distribution modeling. For example, the team could explore using this dataset to examine correlations between surface temperature and soil moisture with aspen cover.
MODIS Aqua/Terra	Vegetation phenology	This dataset will be used to derive vegetation phenology, which is important in distinguishing aspen stands from surrounding vegetation.
Space Shuttle SRTM V2	Elevation, slope, aspect, Compound Topographic Index	This dataset will be used to derive topographic indices to be used as covariates in species distribution modeling for aspen.

Ancillary Datasets:

USFS Laramie District – Administrative Boundaries – Final Map Production

Natural Resource Ecology Laboratory – Aspen Field Data– Model Training and Validation

Climate North America – Current and future potential climate data – Model training

Models:

Generalized Linear Model (POC: Catherine Jarnevich: USGS Fort Collins Science Center)

Multivariate Adaptive Regression Spline (POC: Catherine Jarnevich: USGS Fort Collins Science Center)

Random Forests (POC: Catherine Jarnevich: USGS Fort Collins Science Center)

Boosted Regression Trees (POC: Catherine Jarnevich: USGS Fort Collins Science Center)

Maxent (POC: Catherine Jarnevich: USGS Fort Collins Science Center)

Decision Support Tool & End-Product Overview

End Products:

End Products	Partner Use	Datasets & Analyses	Software Release Category
Aspen Cover Map	Locations for evaluating critical mule deer habitat, estimating habitat carrying capacity	Field Surveys, MODIS, and Landsat	1
Aspen Cover in Burned vs. Unburned Areas Maps	Prescribed burn treatment	Estimation from local knowledge, Landsat	1
Aspen Bioclimatic Suitability Map	Forecast future suitable aspen habitat	Estimation from local knowledge	1
Topographic Indices	Assessing suitable aspen habitat	Field Surveys, SRTM	1

End-User Benefit:

"This project will help my agency in identifying critical parturition habitats (i.e. fawning and calving) for ungulates in the Laramie Range and improve our current estimates of habitat carrying capacity. These estimates are important in deciding how to manage wildlife numbers to alleviate competition among ungulates and mitigate habitat conservation" (personal communication with end-user Ryan Amundson). Furthermore, this project will provide the organization with a better understanding of how fire history in the Laramie Range relates to aspen regeneration. Maps of aspen cover will save the organization time, money, and personnel hours that are currently depleted by conventional surveying efforts.

Project Timeline & Previous Related Work

Project Timeline: 2 Terms: 2016 Spring (Start) to 2016 Summer (Completion)

- **Term 1:** 2016 Spring (FC) – Laramie Mountains Ecological Forecasting
 - The goal of the first term was to develop a detailed model of fire history for the Laramie Range for the years 1985 - 2015. This will be used to evaluate fire return interval for the study area and will provide data to be used during the second term of the project. Project partners were engaged on a weekly basis throughout the term and a meeting was scheduled at the end of the term to evaluate results.
- **Term 2 (Proposed Term):** 2016 Summer (FC) – Laramie Mountains Ecological Forecasting II
 - The goals of the second term will be to develop an aspen cover map for the Laramie Range and relate that back to the fire history map and fire return interval evaluation from the first term of the project. The aspen cover map will also be assessed to explore the relationship between aspen cover and mule deer and elk habitat availability, and the bioclimatic niche of aspen in the study area based on current and future potential climates. Project partners will be engaged on a weekly basis throughout the term, and a handoff will be scheduled at the end of the term to share project products.

Related DEVELOP Work:

Fall 2015 (Fort Collins), Wyoming Ecological Forecasting – Using Landsat 8 and Aqua and Terra MODIS to Target Cheatgrass Mitigation in a Post-Wildfire Landscape in Wyoming's Medicine Bow National Forest

Summer 2015 (Fort Collins), Ethiopia Ecological Forecasting – Mapping Fire History for Habitat Conservation in Ethiopia's Bale Mountains Using a Time Series of Landsat Data

Fall 2014 and Spring 2015 (Fort Collins), Arizona Ecological Forecasting I and II – Comparing WorldView-2 with Landsat 8 Imagery: Refining and Evaluating Invasive Tamarisk Mapping in Havasu National Wildlife Refuge

Summer 2014 (Fort Collins), Alaska Ecological Forecasting – Modeling Current and Future Invasion Vulnerability for Critical Habitat in Interior Alaska: Applying Novel Modeling Techniques for Invasive Species Risk Assessment in the Yukon Flats National Wildlife Refuge

Project Needs/Requests

Participants Requested: 4

Software & Scripting:

ENVI – Landsat imagery calibration and pre-processing

ArcGIS – Landsat imagery processing (study area designation, clipping, etc.), derivation of indices, map creation

Software for Assisted Habitat Modeling – Fit all modeling algorithms

Notes & References:

References:

Kirkpatrick, S and Abendroth D (2001). Aspen response to prescribed fire and wild ungulate herbivory. *In* Sustaining Aspen in Western Landscapes: Symposium Proceedings, USFS General Technical Report Rocky Mountain, 387 – 394.