**NASA DEVELOP National Program**

****USGS at Colorado State University – Fort Collins, CO

**Spring 2016**

**Short Title: Gunnison National Forest Agriculture**

**Subtitle:** Mapping Spruce Beetle Outbreak Severity and Distribution in Gunnison National Forest Using Landsat and Integrative Spatial Modelling

**VPS Title:** Beetle Spruce: Mapping Spruce Mortality in Southwest Colorado

**Project Team & Partners**

**Project Team:**

Eric Rounds (Project Lead), erounds202@gmail.com

Sarah Carroll

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**Advisors & Mentors:**

Dr. Paul Evangelista (Natural Resources Ecology Lab, Colorado State University)

Tony Vorster (Bioenergy Alliance Network of the Rockies)

Brian Woodward (DEVELOP – Fort Collins Center Lead)

**Partner Organizations:**

Bioenergy Alliance Network of the Rockies (BANR) (End-User) POC: Anthony Vorster

Montana State University, Spatial Sciences Center (End-User) POC: Dr. Rick Lawrence Colorado State University, Natural Resource Ecology Laboratory (NREL) (End User) POC: Nick Young

USDA Forest Service, Gunnison Ranger District (End User) POC: Matt Vasquez

USDA Forest Service, Rocky Mountain Research Station (End User) POC: Dr. Mike Battaglia

**Project Details**

**Applied Sciences National Application Addressed:** Agriculture

**Study Area:** Rocky Mountains, CO  
**Study Period:** September 2005 - October 2015

**Earth Observations & Parameters:**

Landsat 8, OLI & TIRS – land cover

Landsat 5, TM – land cover

SRTM V2 - elevation, slope, aspect

National Agriculture Imagery Program (NAIP) - Imagery for model input bands

**Ancillary Datasets Utilized:**

* USGS LANDFIRE 2012 – Existing vegetation type, tree dominated area

**Models Utilized:**

* Montana State University, Shannon Savage - svm.rf\_10xloop.R
* Montana State University, Shannon Savage - generic\_ZImodeling\_rinput.txt

**Software Utilized:**

ArcGIS - raster manipulation/analysis, imagery processing, and map creation

ENVI - raster mosaicking, imagery manipulation

R - statistical analysis, model application, figure creation

**Project Overview**

**Objectives Overview:**

Bark beetle outbreaks affect millions of acres of Colorado’s spruce and fir forests. As a result, land managers are facing an increasing number of management challenges. To assist in the management of spruce beetle infested forests, our team produced fine scale maps of spruce mortality in southwest Colorado for 2013 and 2015. Our results will be utilized by forest managers to inform treatment plans and decision making, manage wildlife habitat, and assess available biomass for fuel conversion.

**Abstract:**

Over the last fifteen years Colorado forests have experienced epidemic bark beetle outbreaks with increasing severity. These outbreaks affect forest health, wildlife habitat, wildfire regimes, and the safety of recreational forest users. The impacts of epidemic outbreaks are of great concern to land managers and project partners at the US Forest Service (USFS) who are working to maintain ecological integrity and safe public access in national forest lands. Since the decline of the Mountain Pine Beetle (*Dendroctonus ponderosae*), the spruce beetle (*Dendroctonus rufipennis*) epidemic has become the longest ongoing outbreak in the state. This project utilizes Landsat 8 OLI & TIRS, Landsat 5 TM, NAIP imagery, and forest health indices to produce spruce mortality data. These combined datasets are utilized in an integrative spatial model to produce fine scale maps of spruce mortality across the Rocky Mountains of Colorado for the years 2013 and 2015. This novel methodology and the resulting maps will augment the limited spruce beetle spatial data currently available for Colorado forests and potentially provide an improvement upon existing maps used by our project partners.

**Community Concerns:**

* A spruce beetle outbreak is actively occurring in the Gunnison National Forest in southwest Colorado. It is estimated that nearly 1.4 million acres of forest have been affected by the beetle since 1996 and that outbreak severity has increased in recent years.
* Land managers are concerned that increased tree mortality will reduce habitat quality and availability for species that rely on spruce forest characteristics, specifically the federally threatened Canada lynx (*Lynx canadensis*).
* Increased mortality and stands of dead trees will likely influence wildfire regimes and intensify wildfires.
* Dead and falling trees will pose a hazard to forest visitors engaging in recreational activities.

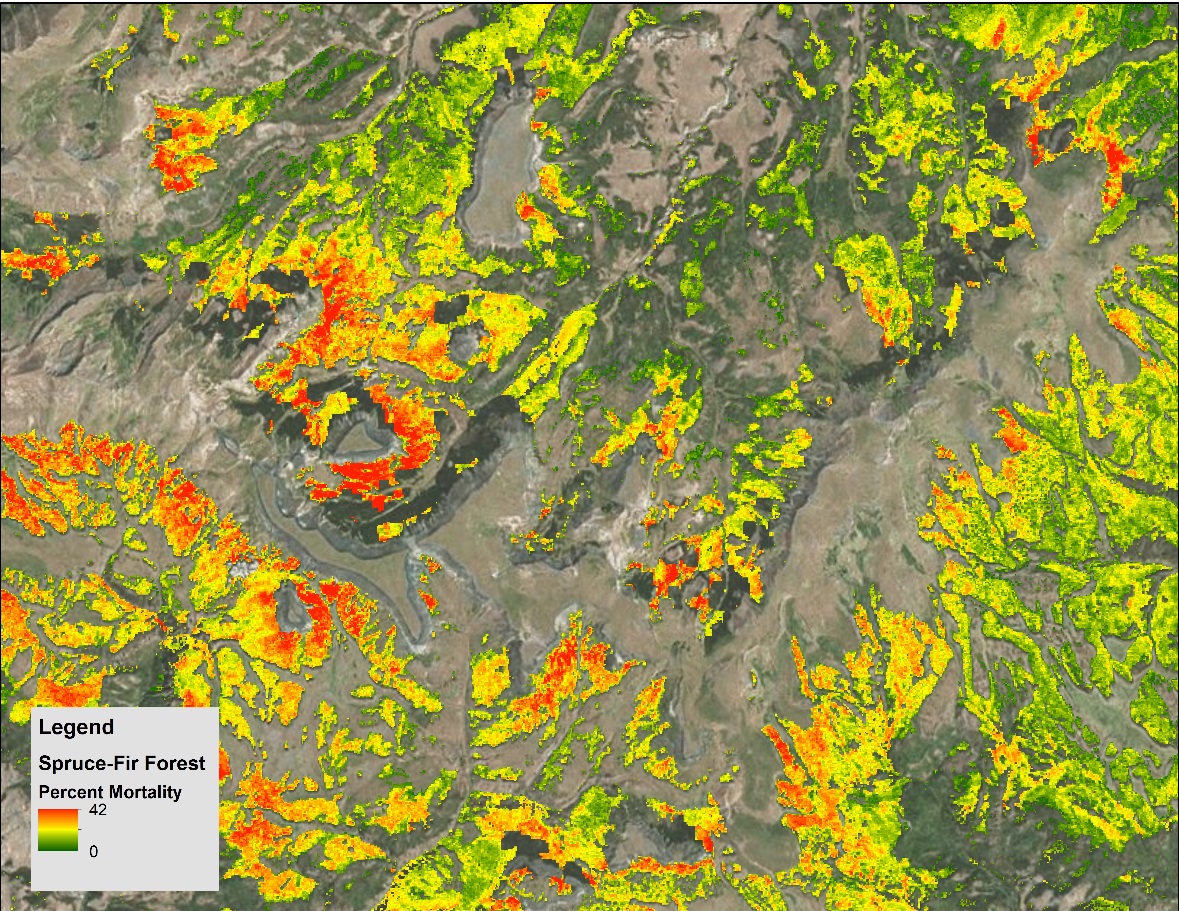
**Current Management Practices & Policies:**

Currently, the USFS conducts annual aerial surveys of Colorado forests to assess forest health. The maps created from these aerial surveys are the primary source of spatial data used for adaptive management planning and decision making. However, these maps are labor intensive and provide a rough estimate of insect-damaged tree distribution. In 2013 the USFS initiated the Spruce Beetle Epidemic and Aspen Decline Management Response (SBEADMR) project. The SBEADMR project proposes to apply treatment that includes the removal of dead and dying trees and intensive resiliency measures in remaining unaffected stands across Grand Mesa, Uncompahgre, and Gunnison National Forests.

**Decision Support Tools & Benefits:**

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| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Spruce Beetle Outbreak  Severity and Distribution  Map for the Gunnison  National Forest- 2013-2015 | Landsat 8 (OLI, TIRS)  Landsat 5 (TM)  SRTM V2  NAIP | Assessing available biomass for biofuel conversion, mammal habitat availability, and forestry treatment recommendations, biomass availability through time |
| Complete statistical analysis of Landsat data performance in the model | Landsat 8 (OLI)  Landsat 5 (TM)  SRTM V2  NAIP | Contribute to the discussion of the application of integrative spatial modeling and remotely-sensed databases for forest management within the scientific community. |

**Project Imagery**



Caption: Spruce mortality distribution and severity. Image Credit: Gunnison National Forest Agriculture Team.

**Software Release Requirements**

Category I