

# Project Summary

## Rocky Mountains Cooperative Ecosystem Studies Unit

**Project Title:** Characterize rapid landscape scale change in woodlands using time series imagery

**Discipline:** Natural  
**Type of Project:** Research  
**Funding Agency:** National Park Service  
**Other Partners/Cooperators:** University of Idaho  
**Effective Dates:** 9/15/2010 - 8/31/2015  
**Funding Amount:** \$181,315 (FY11: \$1266701 FY10: \$54,645)

**Investigators and Agency Representative:**

NPS Contact: Brian F Jacobs, Bandelier National Monument; 15 Entrance Rd, HCR-1, Suite 15  
Los Alamos, NM 87544, Phone: 505-672-3861 x545, Fax: 505-672-9607, brian\_jacobs@nps.gov

Investigator: Jeffrey A. Hicke, Department of Geography, University of Idaho, PO Box 443021, Moscow, ID 83844-3021, 208-885-6240; jhicke@uidaho.edu

**Project Abstract:** Recent drought in portions in the southwestern U.S. has caused widespread mortality of piñon-juniper woodland overstory exacerbated by elevated temperatures. Unpublished park data suggest Bandelier lost nearly 95% of its piñon overstory and almost 30% of juniper during this drought. Colorado piñon pine (*Pinus edulis*) is susceptible to bark beetle when stressed and experienced dramatic levels of mortality in upper elevations of Bandelier National Monument (BAND). Less dramatic and somewhat lagged in time behind the piñon die-off was mortality observed in one-seed juniper (*Juniperus monosperma*), which lacked exacerbating insect or pathogen agents, in lower mesa areas of the monument. Climate change scenarios suggest recent episodes of forest die-off in the Southwest including BAND may be typical of events to come. Another impact on BAND is the recently implemented five-year (2007-2011) mechanical thinning program intended to stabilize rapidly eroding soils and cultural resources.

Given the large extent and rapid onset of these disturbances, land managers must have the tools to facilitate assessment and monitoring of landscape scale vegetation change. Moreover, management actions needed to address anticipated or emerging climate induced resource challenges will themselves require feasible methods for timely detection and monitoring of rapid change at landscape scales. Recent advances in high-resolution multi-spectral imagery and associated data as well as image processing and interpretation methods and spatial modeling provide new opportunities to monitor landscape scale change remotely. The 2000-2004 mortality of piñon across the southwestern U.S. prompted the use of repeat imagery including remote sensing to retrospectively document timing, intensity, and spatial patterns of forest die-off, and predictive modeling and mapping methods in particular are directly applicable to the current proposal. This project will use remotely sensed imagery to map tree mortality at BAND and use multiple aerial images to quantify spatiotemporal patterns of mortality. We will also explore the capability of high temporal but coarse spatial resolution Landsat and MODIS imagery. Resulting patterns of tree mortality will be modeled with environmental variables that include soil, climate, and vegetation structure. Finally, we will determine the effectiveness of restoration treatments in promoting understory vegetation using airborne and satellite instruments.

**Objectives**

Project objectives: quantify recent (~1999-2010) mortality and thinning of tree overstory cover

- Search multiple aerial and satellite imagery archives for relevant data, including but not limited to QuickBird, Ikonos, Geoeye, Landsat, ASTER, ALI, and SPOT)
- Geo-rectify and classify spatial data to build the imagery and ancillary data time series
- Delineate spatial and temporal patterns of mortality and mechanical thinning
- Evaluate the capability of coarser resolution satellite imagery (Landsat, MODIS) for detecting tree mortality and providing more detailed estimates of the timing of mortality events

**Outcomes with Completion Dates:** May 31, 2015

List of Products: a) geo-rectified collection of relevant imagery; b) classification of spatial data to build the imagery and ancillary data time series; and c) spatial and temporal delineations of mortality and mechanical thinning

**Keywords:** University of Idaho, Nez Bandelier National Monument, drought, piñon-juniper, Colorado piñon pine, bark beetle, mortality, repeat imagery, remote sensory