Using Earth Observations to Quantify Postfire Vegetation Recovery on the Colorado Front Range

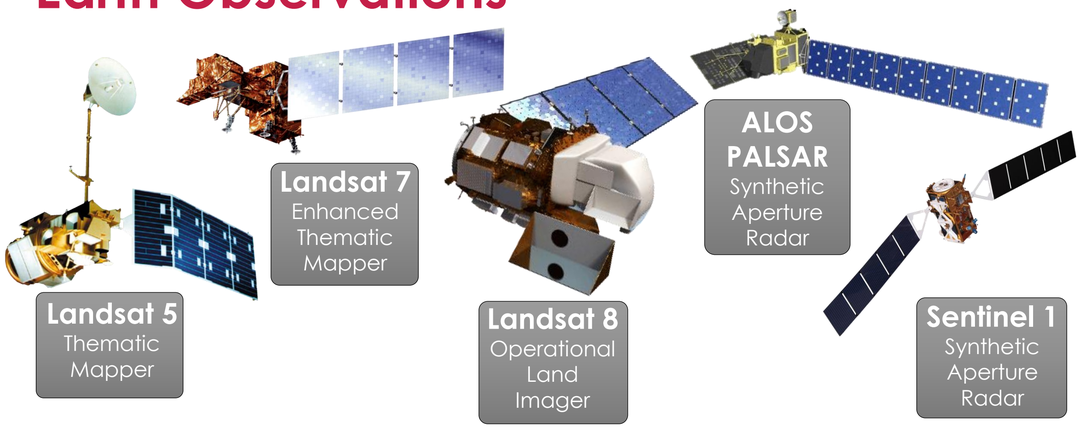
Abstract

Forest composition and structure in the Colorado Front Range has been altered by changing wildfire regimes. In particular, increased moderate- and high-severity fire significantly reduces forest cover following fire and often results in reduced seedling regeneration. Reduced tree canopy regrowth has chronic effects on upland ecological function and downstream water quality. This project partnered with the US Forest Service to estimate long-term vegetation recovery following four Colorado Front Range fires between 1996 and 2002—the Bobcat, Buffalo Creek, Hayman, and High Meadows fires—using Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper (ETM+), and Landsat 8 Operational Land Imager (OLI). The random forest algorithm was applied to produce maps of percent forest canopy cover for coniferous trees, deciduous trees, and all trees using time-series variables for pre- and post-fire as inputs. Similarly, maps of post-fire seedling regeneration were produced using random forest for coniferous trees, deciduous trees, and all trees using ecological drivers (soil, climate, fire, and topography) and pre-fire remote sensing predictors. Relationships between ecological drivers of post-fire vegetation trajectories were also evaluated. Additional analyses were conducted to (1) assess whether seedlings could be detected by Landsat or synthetic aperture radar (SAR) time-series analysis (2) assess pre-fire and post-fire Landsat variables against pre-fire and post-fire tree cover estimates to evaluate whether magnitude of forest change can be detected. Understanding variables that influence vegetative recovery, vegetation type conversion, and watershed characteristics will aid forest restoration efforts and water quality management.

Objectives

- **Apply** remotely sensed data to detect post-fire tree canopy cover.
- **Model** suitability for post-fire tree seedling regeneration and evaluate environmental drivers.

Earth Observations



Methodology

Detection models: Detect current tree canopy cover percentage

- Coniferous trees
- Deciduous trees
- All trees

Indicators: Landsat burn and vegetation indices and SAR

Analysis: Random Forest – maps of postfire tree cover percentage

Prediction models: Predict potential forest regeneration using presence/absence data

- Coniferous seedlings
- Deciduous seedlings
- All seedlings

Predictors: Topography, hydrology, climate, soil, fire

Analysis: Random Forest – maps of postfire tree regeneration

Team Members

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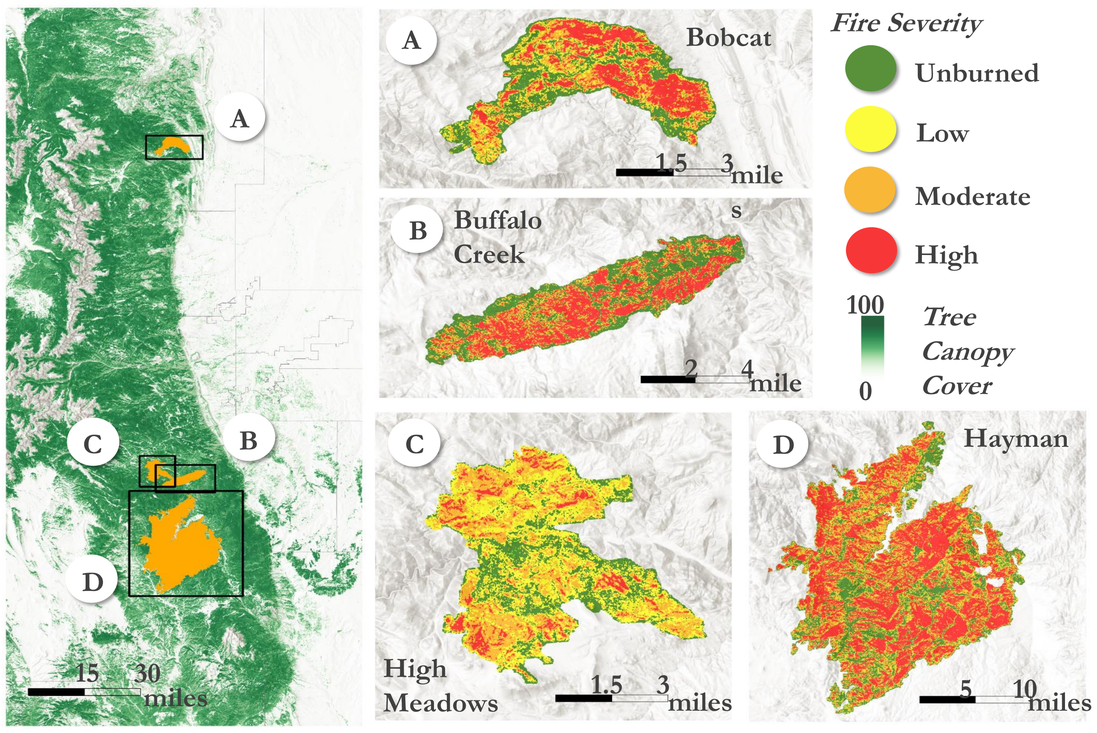
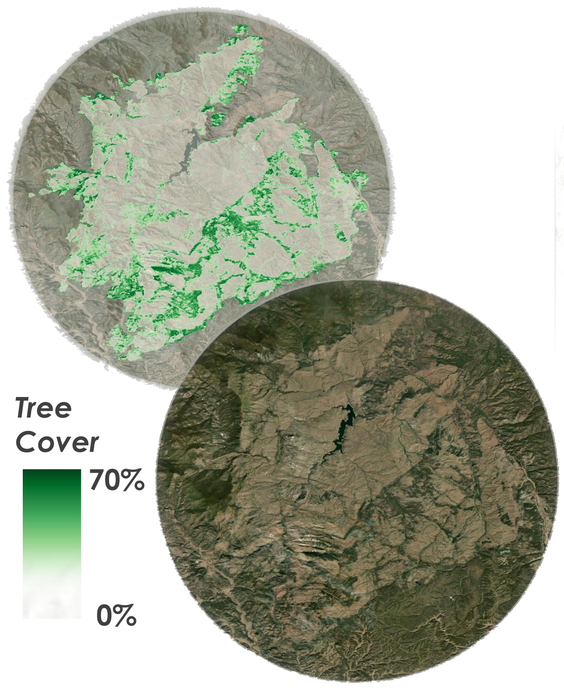
Study Area



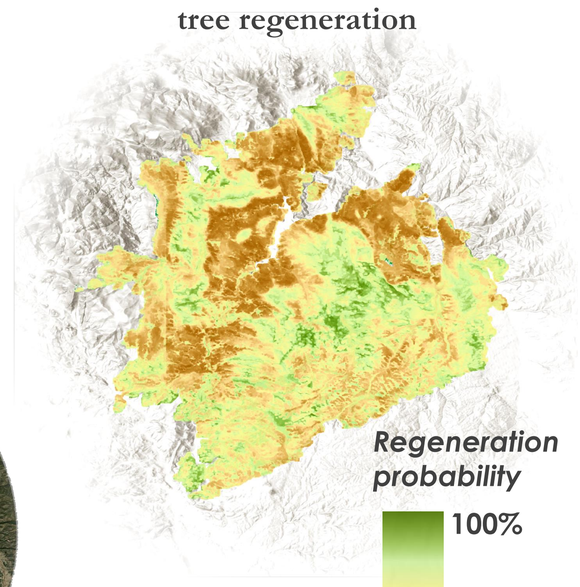
Results

Modeled conifer tree cover percent and actual imagery



Variance explained: 68.19%

Modeled suitability for conifer tree regeneration



AUC: .72

	Abs	Pres	Error
Abs	150	77	33.9%
Pres	49	180	21.4

Conclusions

- Suitability modeling for tree regeneration has promise but needs to be developed further. Ultimately, it may be useful for identifying areas that are likely to have natural post-fire tree regeneration to help prioritize restoration actions.
- Landsat time-series variables and ALOS PALSAR are strong predictors of post-fire conifer tree canopy cover.
- Ocular sampling with high-resolution imagery may be appropriate to supplement field-collected tree cover and seedling data.

Project Partner

- USDA Forest Service, Rocky Mountain Research Station

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Rocky Mountain Disasters

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