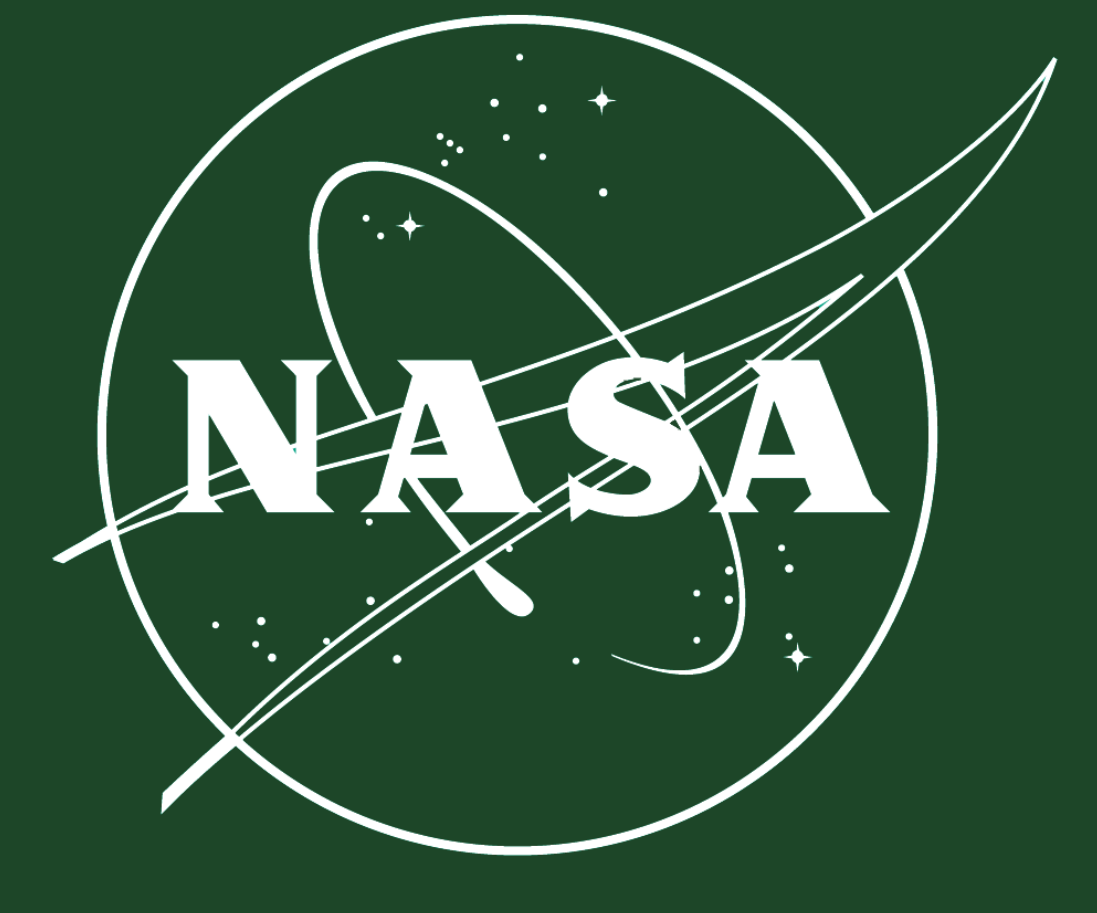




Modeling the Effects of Climate Change on Whitebark Pine along the Pacific Crest Trail



Ryan Anderson^{1,2}, Andrew Nguyen^{1,3}, Nathan Gill^{1,4}, Soumya Kannan^{1,5}, Neeshi Patadia^{1,6}, Marc Meyer⁷, Cindy Schmidt^{1,8}

¹NASA DEVELOP National Program, Ames Research Center, ²University of Wyoming, ³San Jose State University, ⁴Brigham Young University, ⁵California Institute of Technology, ⁶St. Francis High School, ⁷USDA Forest Service Pacific Southwest Region, ⁸Bay Area Environmental Research Institute

Abstract

The Pacific Crest Trail (PCT), one of eight National Scenic Trails, and stretches over 4,000 km from Mexico to the Canadian border. At high elevations along this trail, within the Inyo and Sierra National Forests, populations of whitebark pine (*Pinus albicaulis*) have been diminishing due to infestation of the mountain pine beetle (*Dendroctonus ponderosae*) and are threatened due to a changing climate. Understanding the current and future condition of whitebark pine is a primary goal of forest managers due to its high ecological and economic importance, and it is currently a candidate for protection under the Endangered Species Act (ESA). Using satellite imagery, we analyzed the rate and spatial extent of whitebark pine tree mortality from 1984 to 2011 using the Landsat-based Detection of Trends in Disturbance and Recovery (LandTrendr) program. Climate data, soil properties, and biological features of the whitebark pine were incorporated in the Physiological Principles to Predict Growth (3-PG) model to predict future rates of growth and assess its applicability in modeling natural whitebark pine processes. Finally, the Random Forest algorithm was used with topographic data alongside recent and future climate data from the IPCC A2 and B1 climate scenarios for the years 2030, 2060, and 2090 to model the future distribution of whitebark pine. LandTrendr results indicate beetle related mortality covering 14,940 km² of forest, 2,880 km² of which are within whitebark pine forest. By 2090, our results show that under the A2 climate scenario, whitebark pine suitable habitat may be reduced by as much as 99.97% by the year 2090 within our study area. Under the B1 climate scenario, which has decreased CO₂ emissions, 13.54% more habitat would be preserved in 2090.

Objectives

- Map current locations of whitebark mortality due to mountain pine beetle infestation
- Identify the environmental conditions contributing to mountain pine beetle outbreaks
- Map the future distribution of whitebark pine under changing climate conditions

Study Area

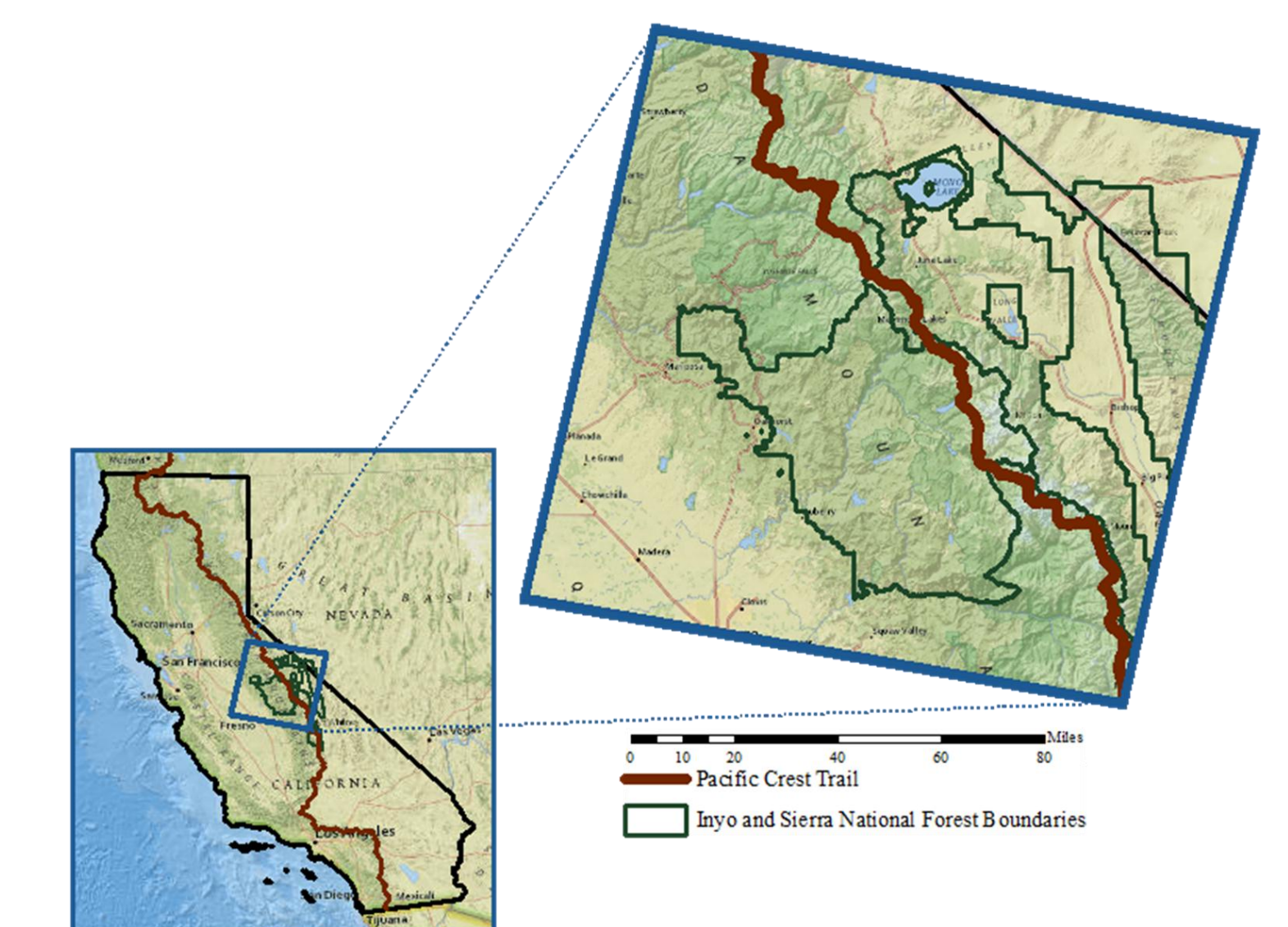


Figure 1: The study was conducted along the Pacific Crest Trail in Sierra and Inyo National Forests, located in California. The area encompasses one Landsat TM 5 scene.

Methods

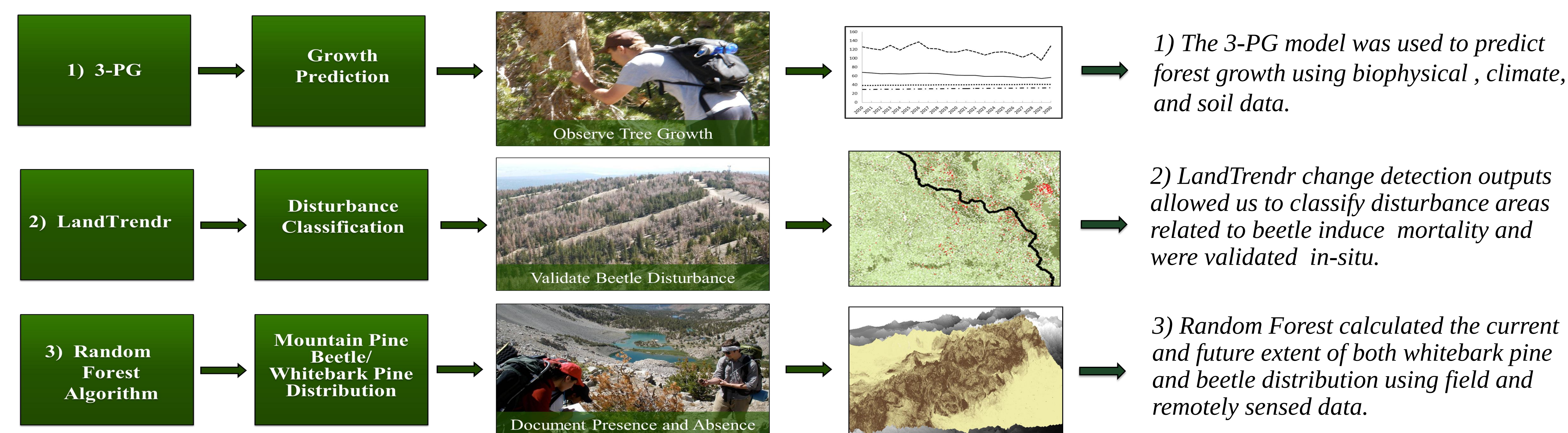


Figure 2: Flowchart of methodology

NASA EOS



Team Members



Left to right:
Neeshi Patadia,
Andrew Nguyen,
Ryan Anderson,
Nathan Gill
Soumya Kannan

Results

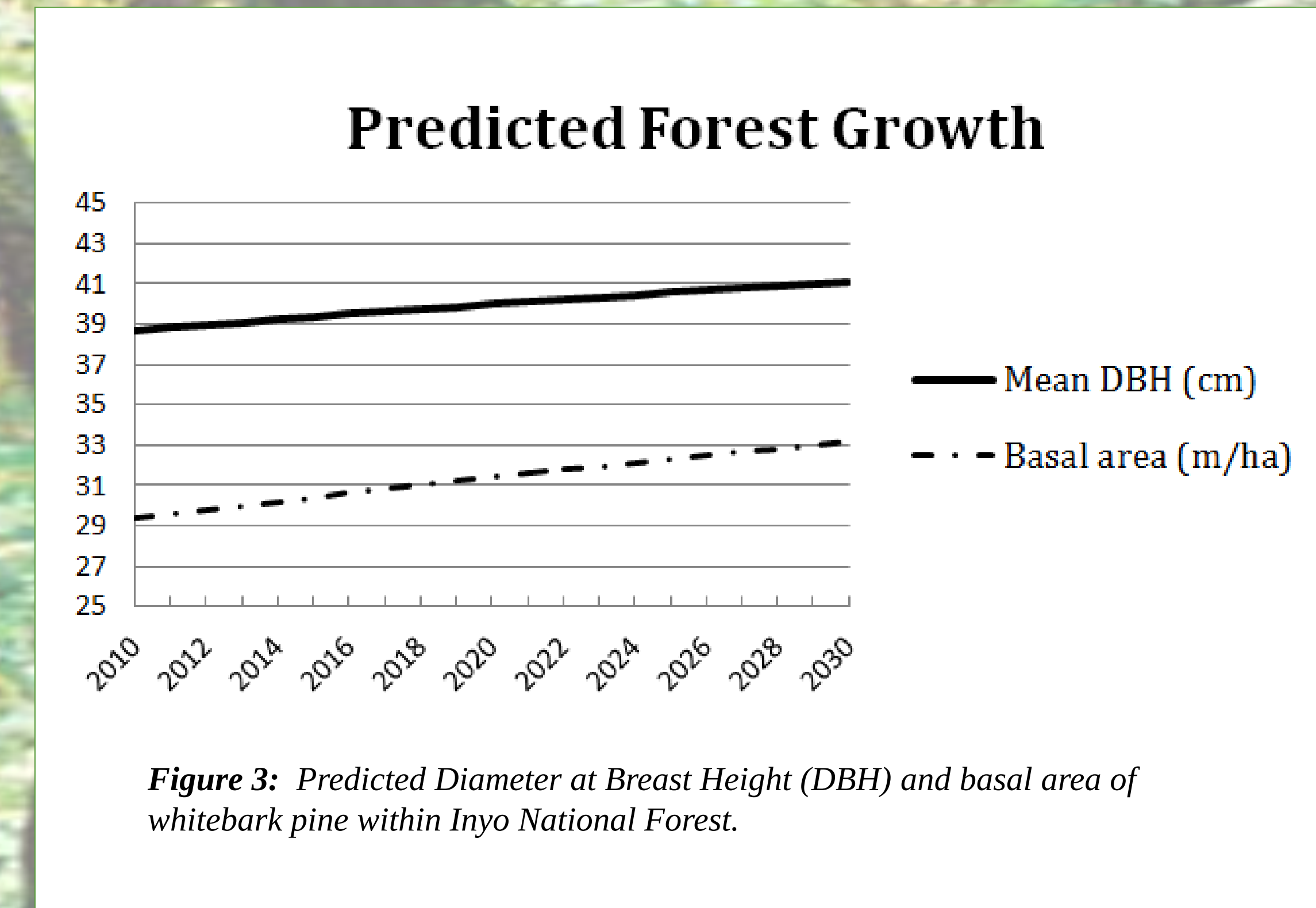


Figure 3: Predicted Diameter at Breast Height (DBH) and basal area of whitebark pine within Inyo National Forest.

Results

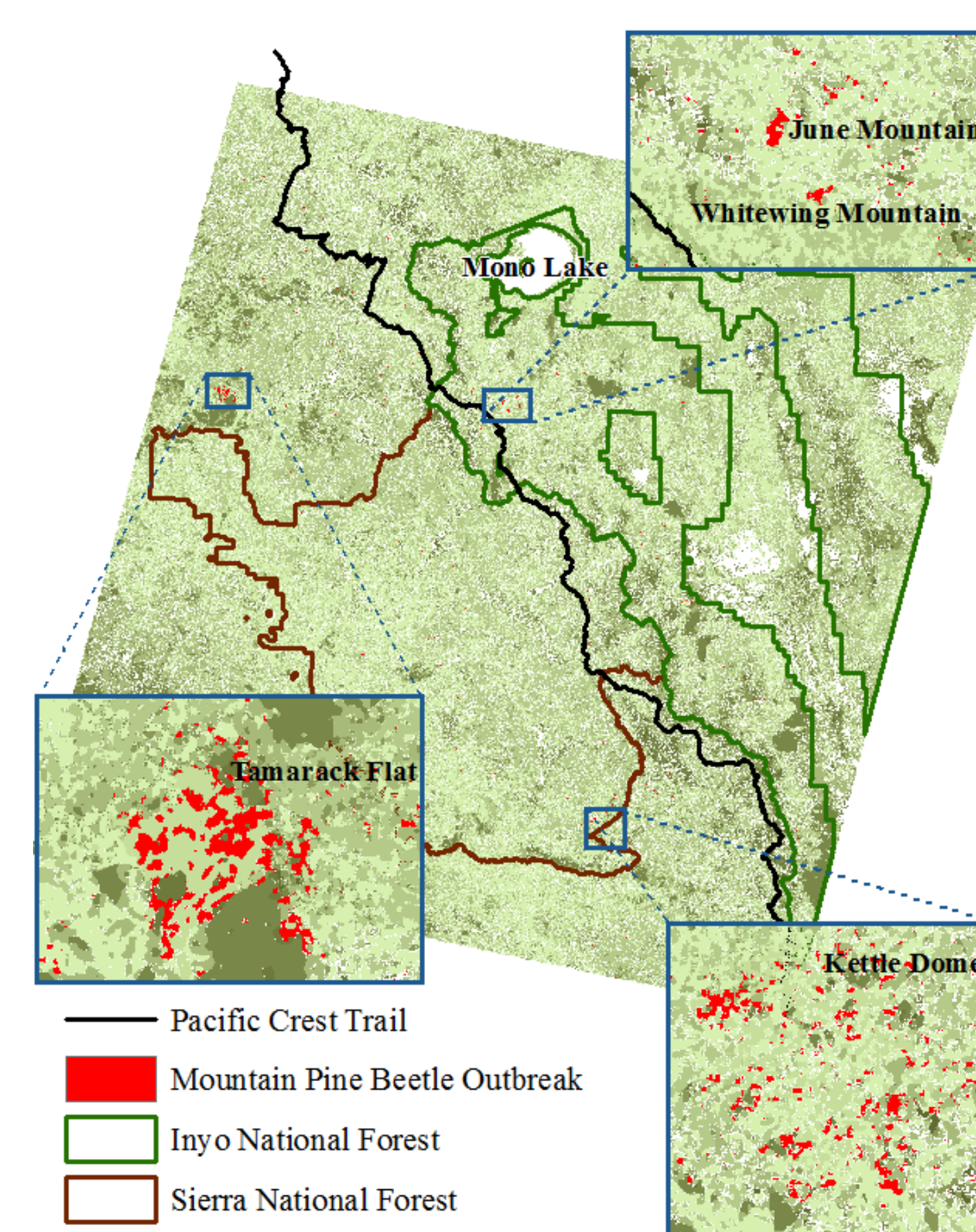


Figure 4: Mountain pine beetle outbreaks as identified by LandTrendr. Within our study area, 14,940 km² of forest have been affected by mountain pine beetle outbreaks.

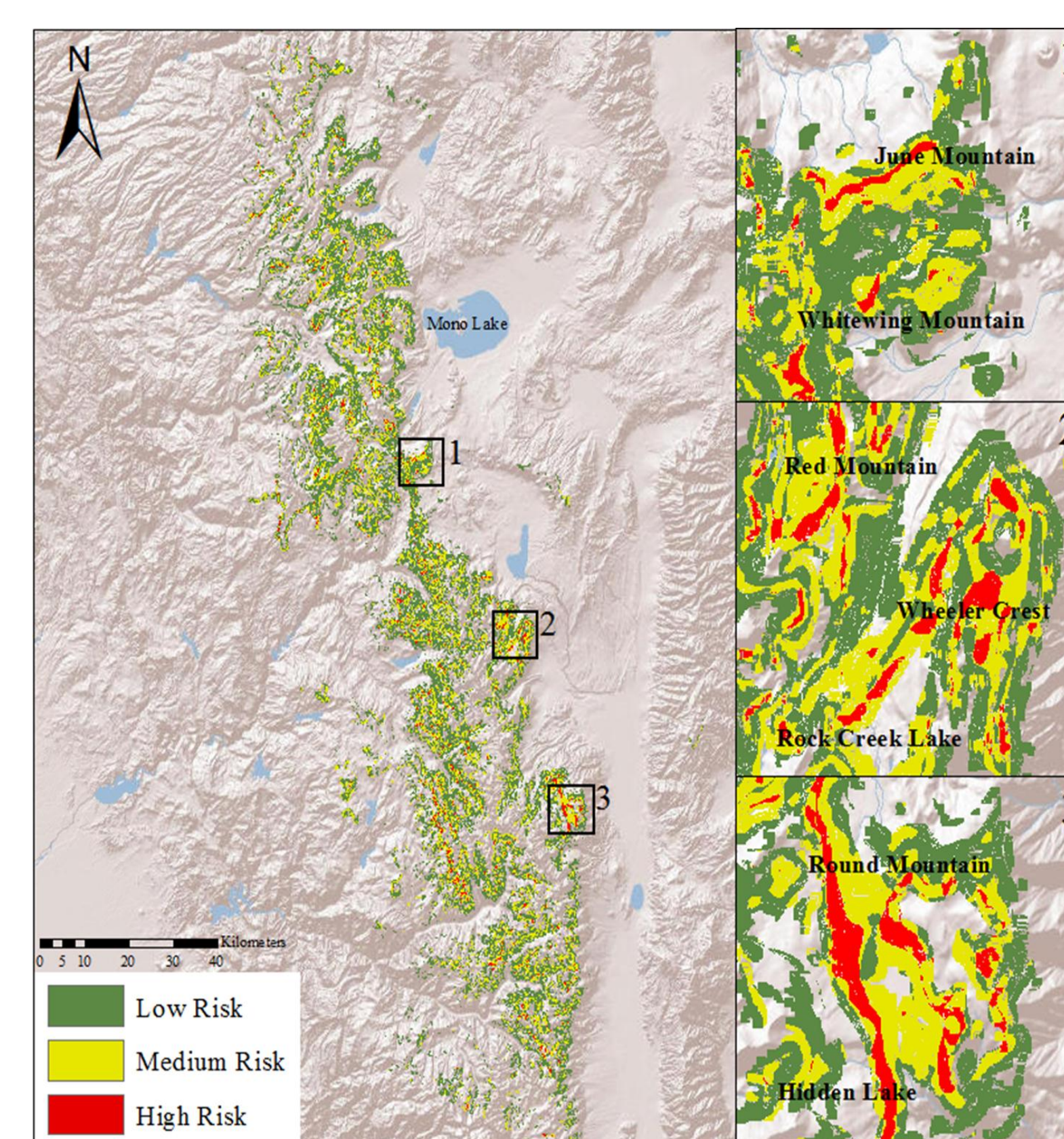


Figure 5: According to Random Forest Whitebark pine forests at risk of or currently experiencing mountain pine beetle outbreak under recent climate conditions.

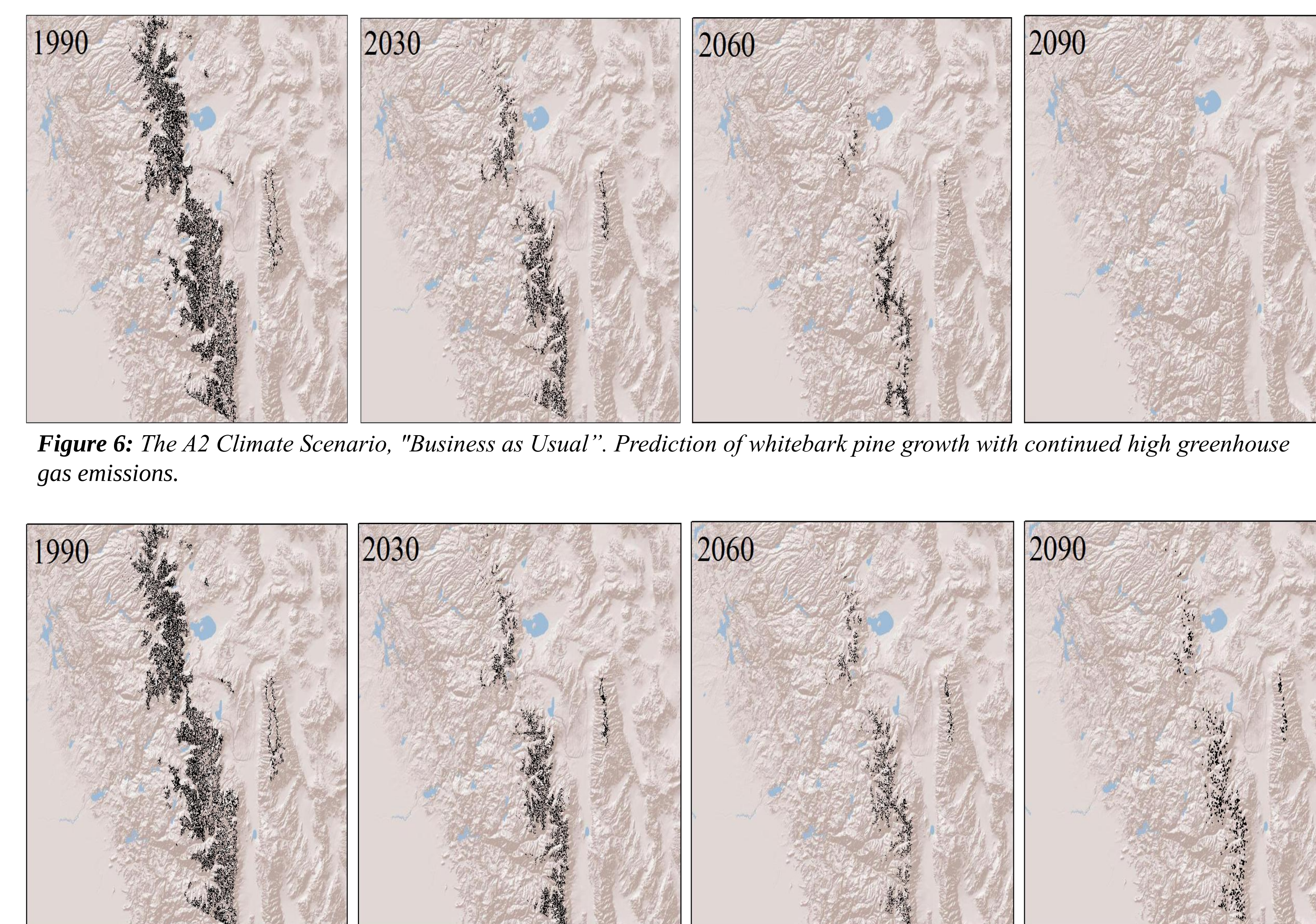


Figure 6: The A2 Climate Scenario, "Business as Usual". Prediction of whitebark pine growth with continued high greenhouse gas emissions.

Figure 7: The B1 Climate Scenario, "Focus on Sustainability". Prediction of whitebark pine growth with reduced greenhouse gas emissions and focus on cleaner technology.

Conclusions

- The strongest predictor variables of whitebark pine and mountain pine beetle habitat suitability include length and severity of winter and mean precipitation.
- 14,940 km² of trees have experienced mortality due to mountain pine beetle outbreaks, 2,880 km² of which were whitebark pine.
- 85,136 km² (6.41%) of whitebark pine forest are currently at high risk of mountain pine beetle attack.
- By 2090, assuming current climate trends continue, suitable habitat for whitebark pine in our study site will reduce by 99.97%. With reduced greenhouse gas emissions, 13.54% less habitat will be lost by 2090.

Collaborators

- Dr. Robert Kennedy, Oregon State University
- Dr. Jeffrey Evans, The Nature Conservancy
- Dr. Nicholas C. Coops, University of British Columbia



Links

Project Video



About DEVELOP

