Whitebark pine mapping in the Northern Region of the US Forest Service
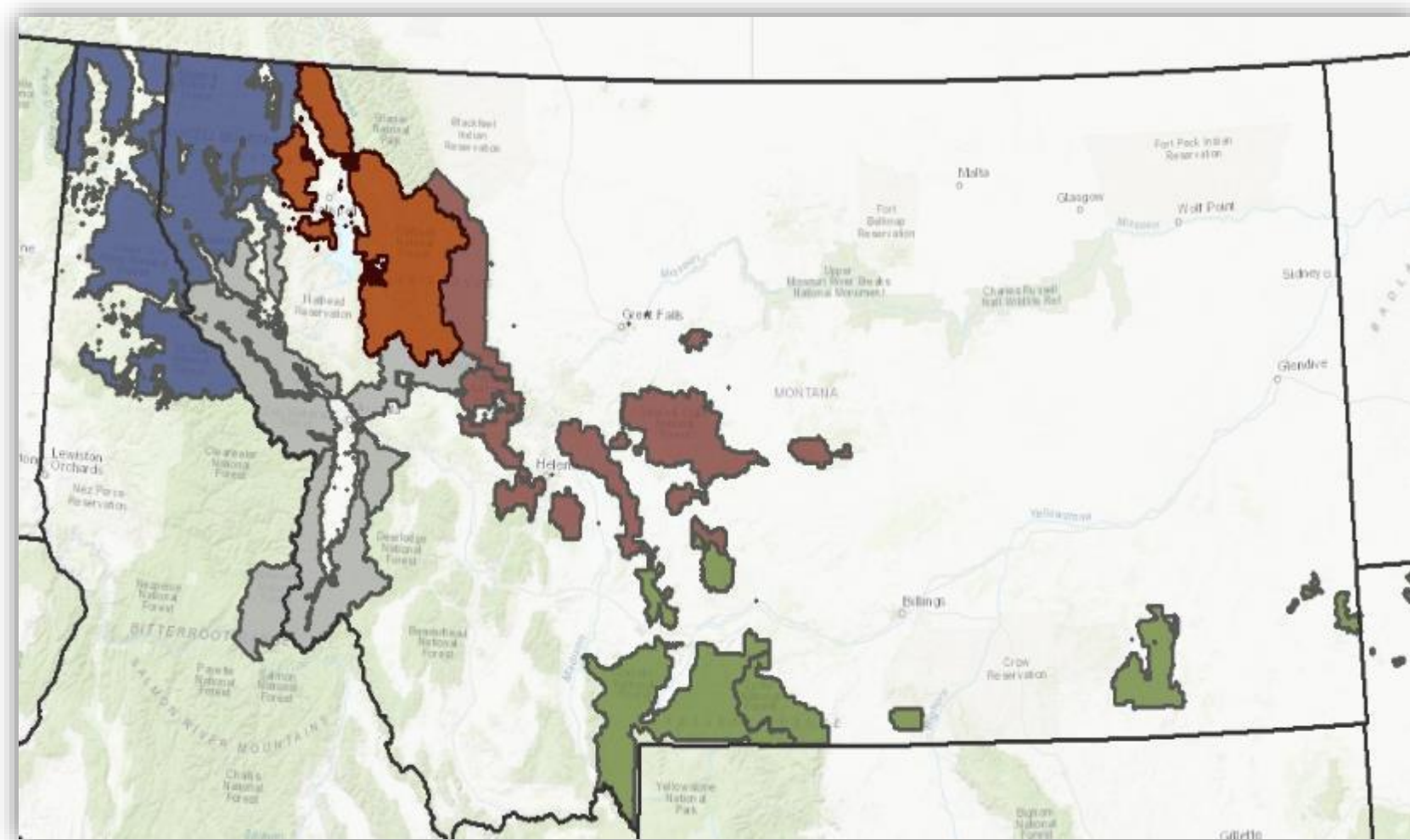
Steve Brown – USDA Forest Service

Joe Fortier – MT Natural Heritage Program

- **Process Developed by RSAC, 2013**
  - Flathead National Forest

- **Re-Applied by MTNHP**
  - Helena Lewis and Clark
  - Custer Gallatin
  - Bitterroot Lolo
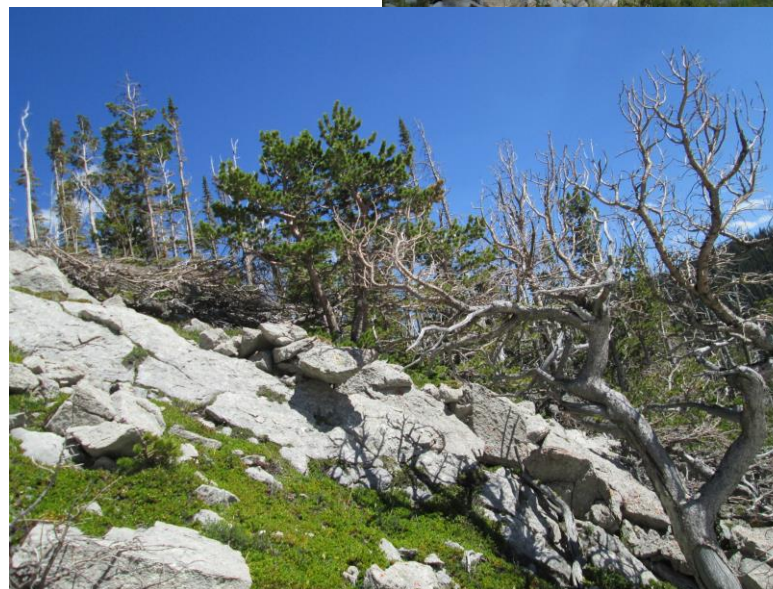 - Idaho Panhandle & Kootenai

Field Data Collection

- **USFS**
  - 2012 – Flathead NF
  - 2017 – Beaverhead-Deerlodge NF
- **Montana Natural Heritage Program**
  - 2013 – Custer Gallatin NF
  - 2014 – Helena Lewis and Clark NF
  - 2015 – Bitterroot Lolo NF
  - 2016 – Idaho Panhandle and Kootenai NF

Region One, U.S. Forest Service

- **Objective 1 – Model Whitebark Pine potential range**

- **Objective 2 – Identify areas of historical forest disturbance and recovery to direct potential WBP restoration projects**

- **Objective 3 – Generate WBP occurrence maps**
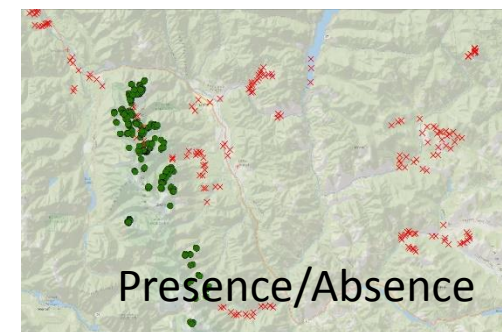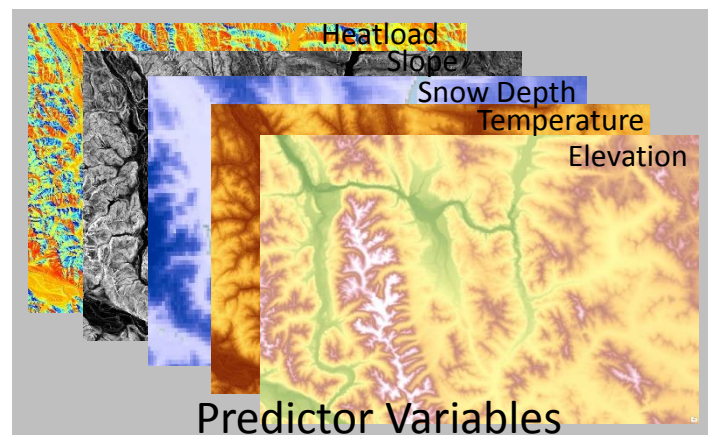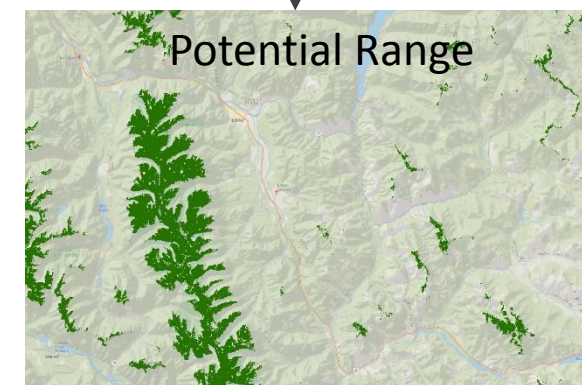 - Presence
  - Relative % of canopy cover

Objective 1- Model Whitebark Pine potential range:

- **Predictive habitat distribution model**
  - Presence/Absence locations compared against topographic and climatic independent variables
  - Random Forest binary classification in R

Presence/Absence

Predictor Variables

Random Forest model

Potential Range

Northern Region, Regional Office

Whitebark Pine Potential Habitat Mapping

Dependent Predictor:

Presence/Absence locations

- MTNHP field inventory 2013-2016
- High resolution image photointerpretation
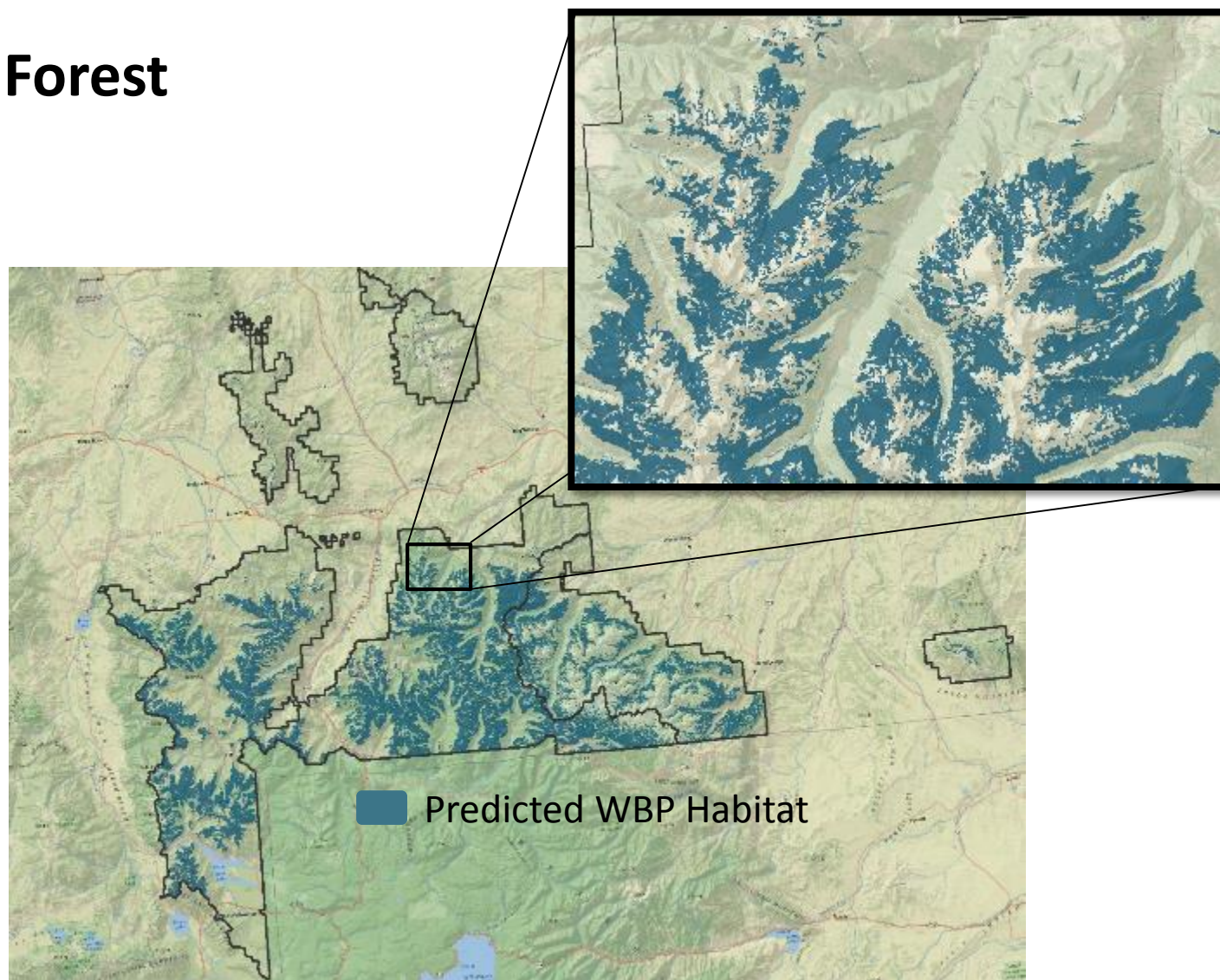- Vmap
- Montana Gap Analysis

Independent Predictor Variable	Source
Topography	
Elevation (DEM)	US Geological Survey
Slope (radians)	Transformed DEM
Aspect (radians)	"
Hillshade	"
Potential Annual Incoming Heatload	McCune and Keon (2002)
Euclidian Distance from Ridgeline	Jenness *et al.* (2013)
Euclidian Distance from Valley Bottom	Housman *et al.* (2012)
Modeled Probability of Valley Bottom	"
Height Above DEM Derived Drainage	"
Climate	
Average Annual Maximum Temperature	PRISM climate group; Daly *et al.* (2007)
Average Annual Minimum Temperature	"
Average Annual Precipitation	"
Mean Snow Depth March 1 (2004-2014)	National Operational Hydrologic Remote Sensing Center (2004)
Mean Snow Depth April 1 (2004-2014)	"
Mean Snow Depth May 1 (2004-2014)	"
Mean Snow Depth June 1 (2004-2014)	"
Mean Snow Depth July 1 (2004-2014)	"

Example: Custer Gallatin National Forest

- **Training Data**
  - 4,307 presence locations
  - 3,404 absence locations
- **Modeled Potential Habitat results**
  - 801,044 acres of WBP suitable habitat
  - 23% of Custer Gallatin forested area
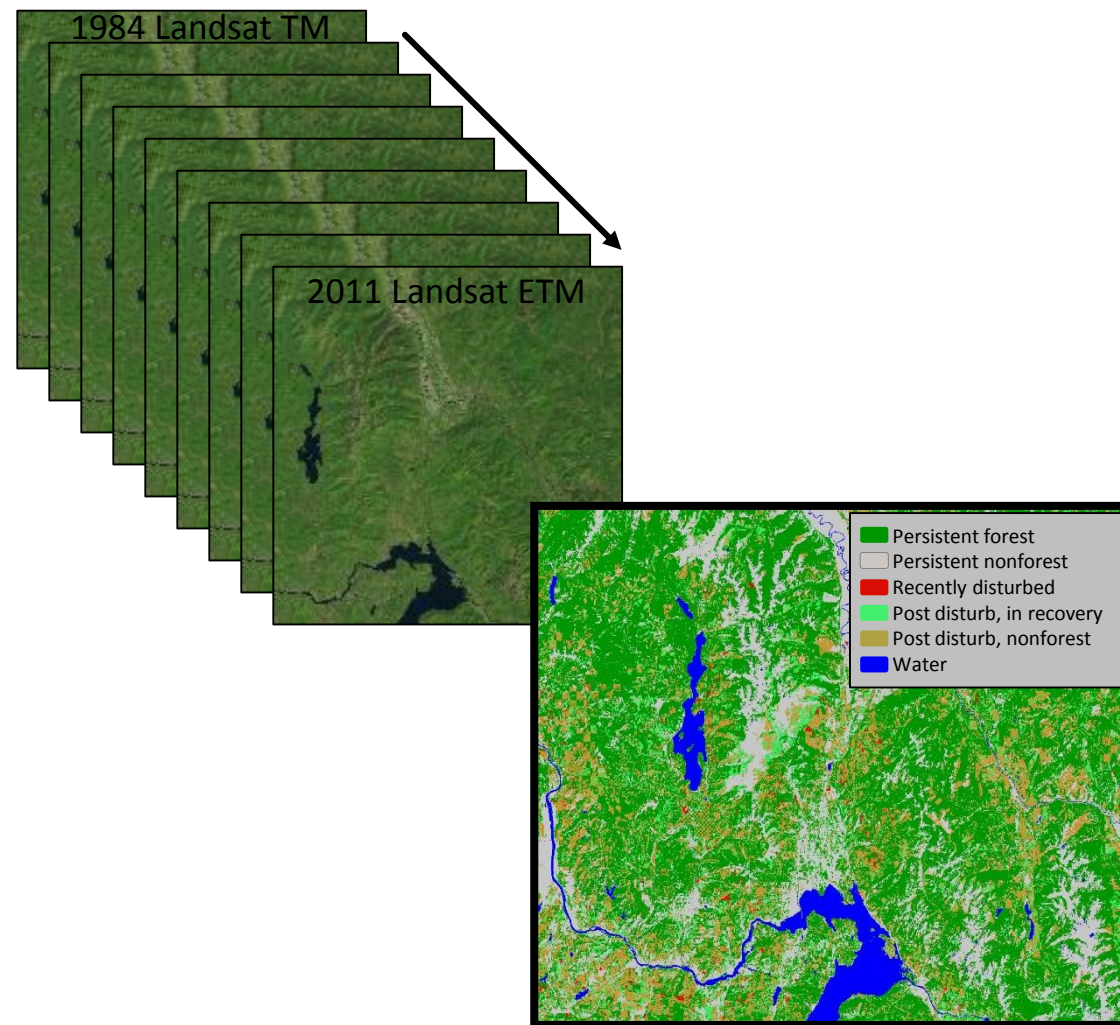- **Model accuracy -- 93%**

Predicted WBP Habitat

Objective 2 – Identify areas of historical forest disturbance and recovery:

- **Spectral differencing between 27 year Landsat time-series stack**
  - Date and extent of disturbance
  - Severity of disturbance
  - Post disturbance rate of recovery
  - Date of stand recovery (return to forest)
- **Products can inform WBP restoration projects**
  - ex. Recent stand clearing disturbance with recovery potential within WBP suitable habitat = candidate for reintroduction
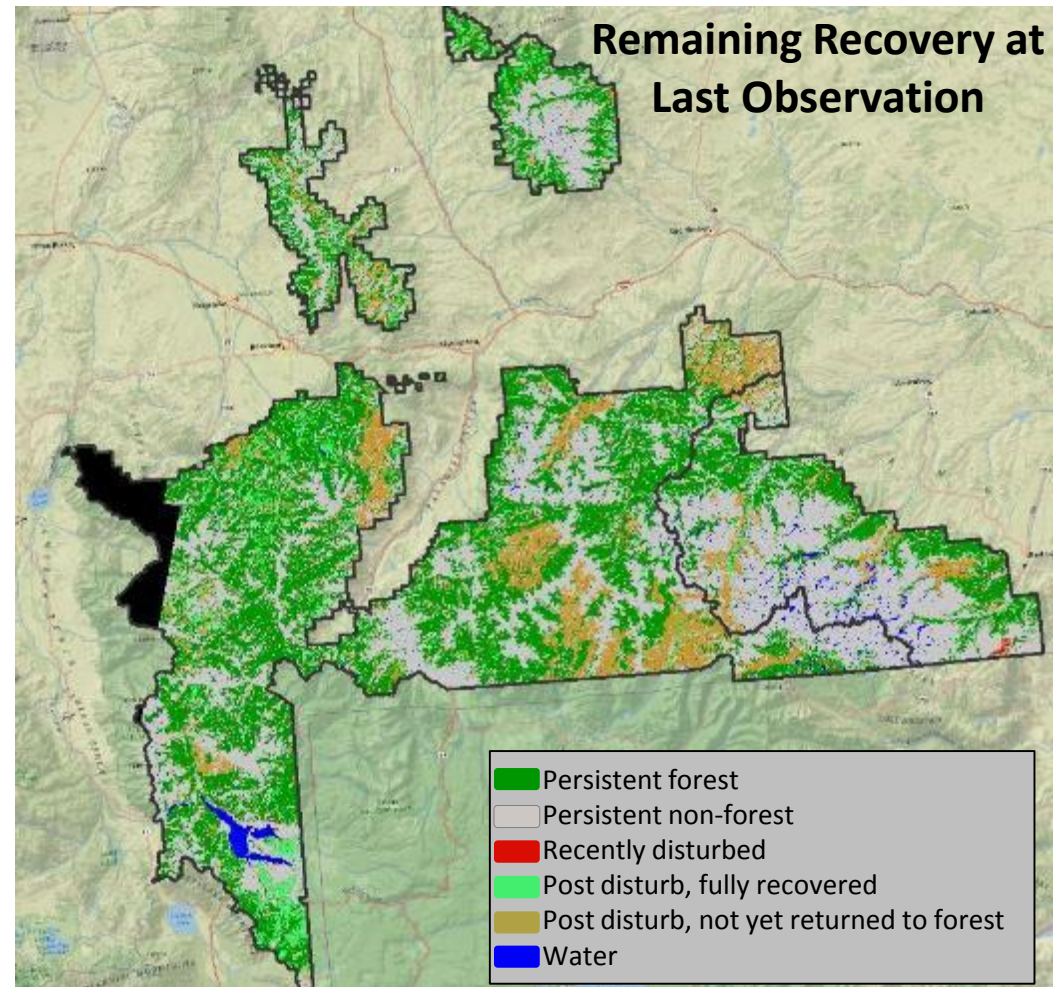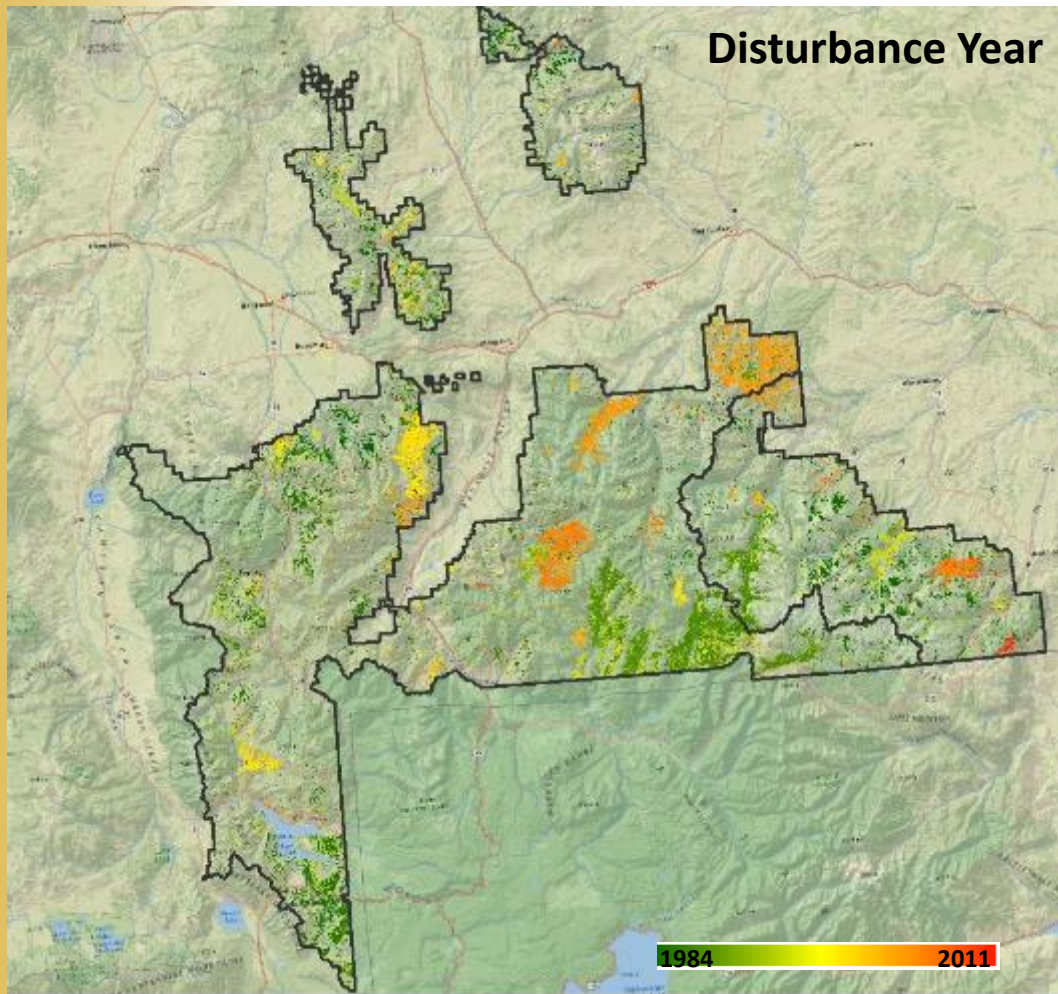
1984 Landsat TM

2011 Landsat ETM

Legend:
- Persistent forest
- Persistent nonforest
- Recently disturbed
- Post disturb, in recovery
- Post disturb, nonforest
- Water

Northern Region, Regional Office

Post Disturbance Restoration Suitability

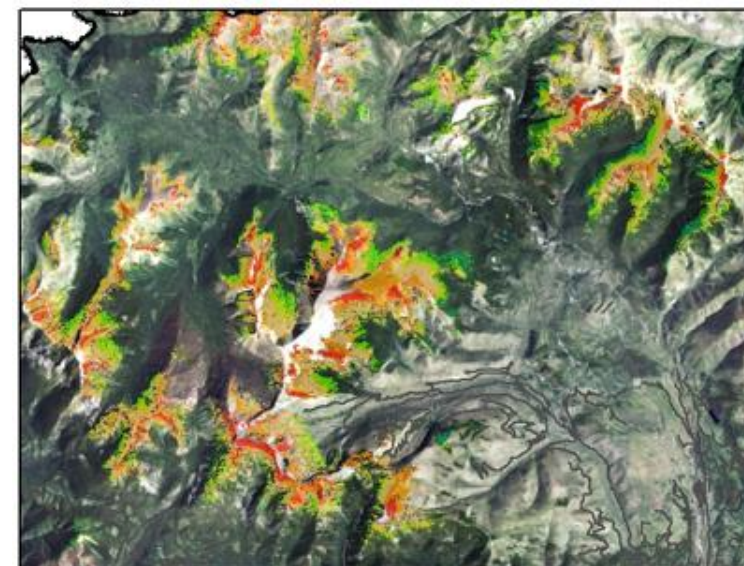## Example: Custer Gallatin National Forest

Disturbance Year

1984 — 2011

Remaining Recovery at Last Observation

Legend:
- Persistent forest
- Persistent non-forest
- Recently disturbed
- Post disturb, fully recovered
- Post disturb, not yet returned to forest
- Water

Northern Region, Regional Office

Objective 3 – Generate Whitebark Pine Occurrence Maps:

- **Whitebark Pine presence**
  - 30 meter resolution
  - Landsat spectral imagery
  - 1991 pre-blister rust die off
  - 2013-2015 post die off

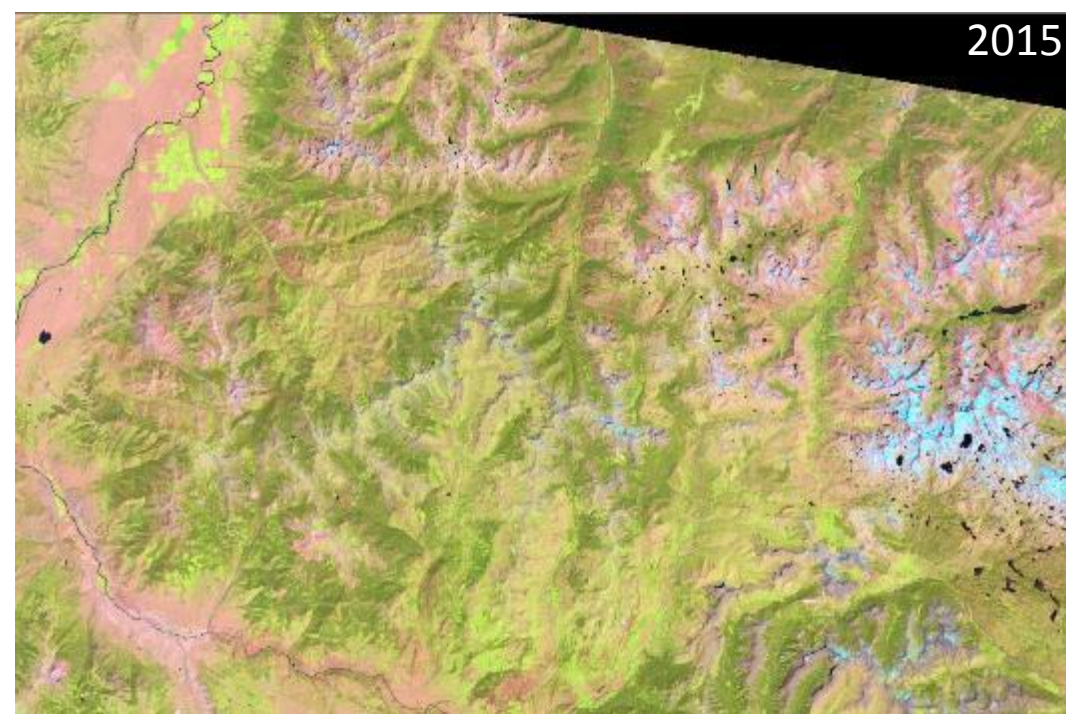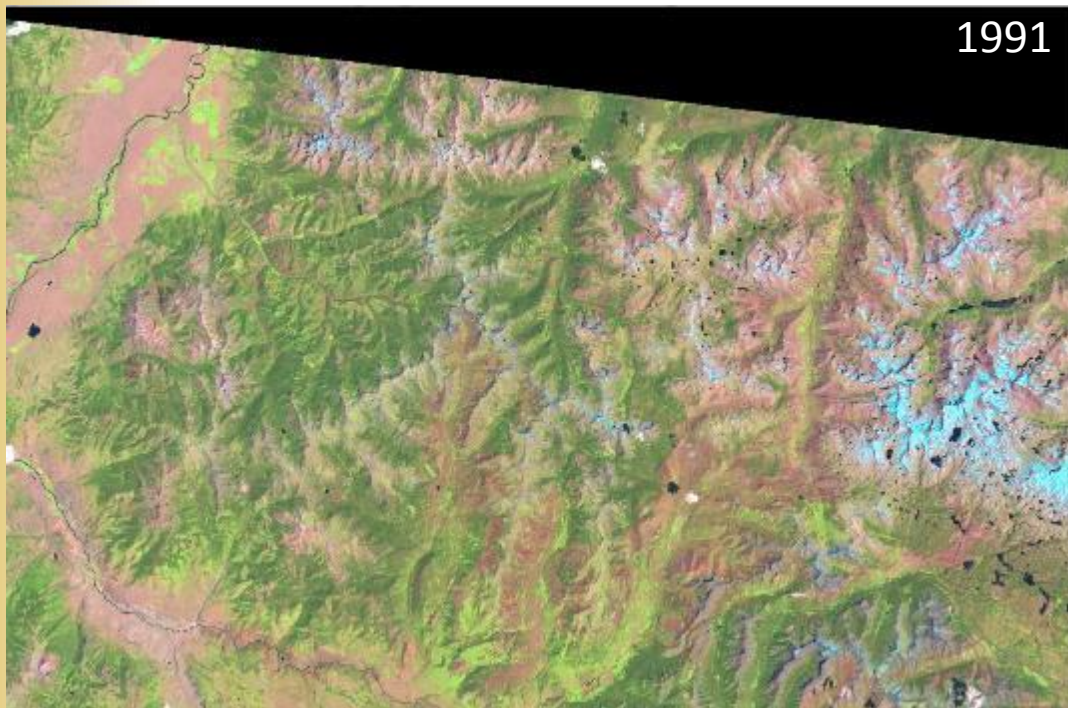- **Whitebark Pine Relative % of Canopy Cover**
  - 10 meter resolution
  - 2013 NAIP CIR aerial photography

Relative % Whitebark Pine

25% 35% 45% 55% 65% 75% 85% 94%

Mapping WBP occurrence pre- and post- blister rust die off
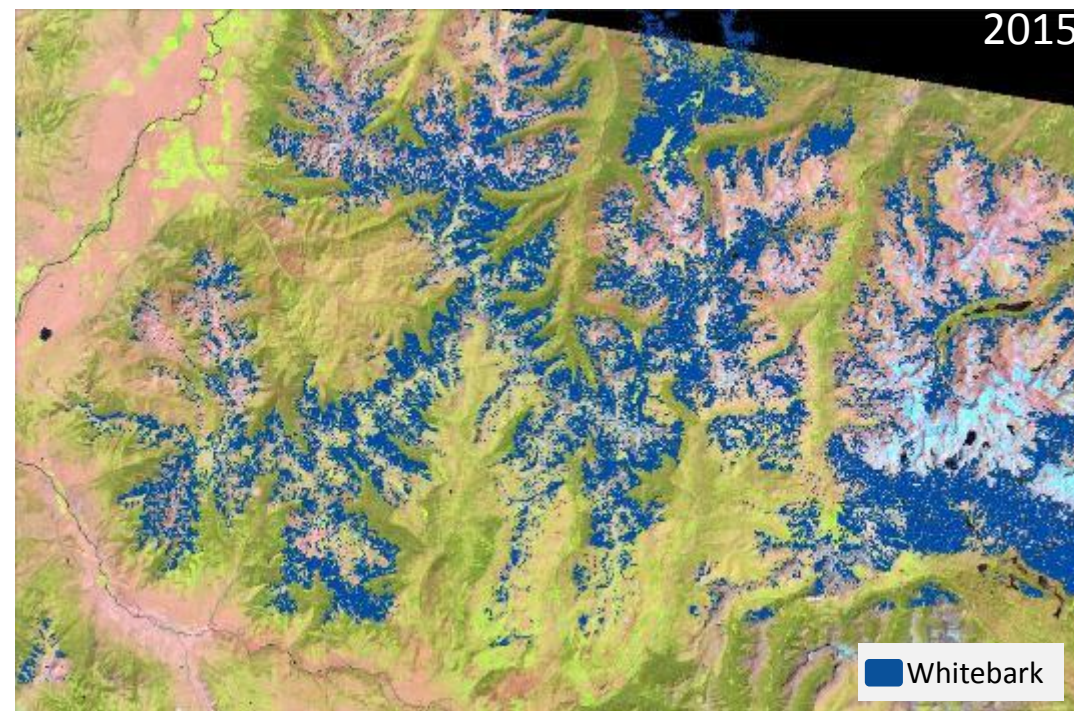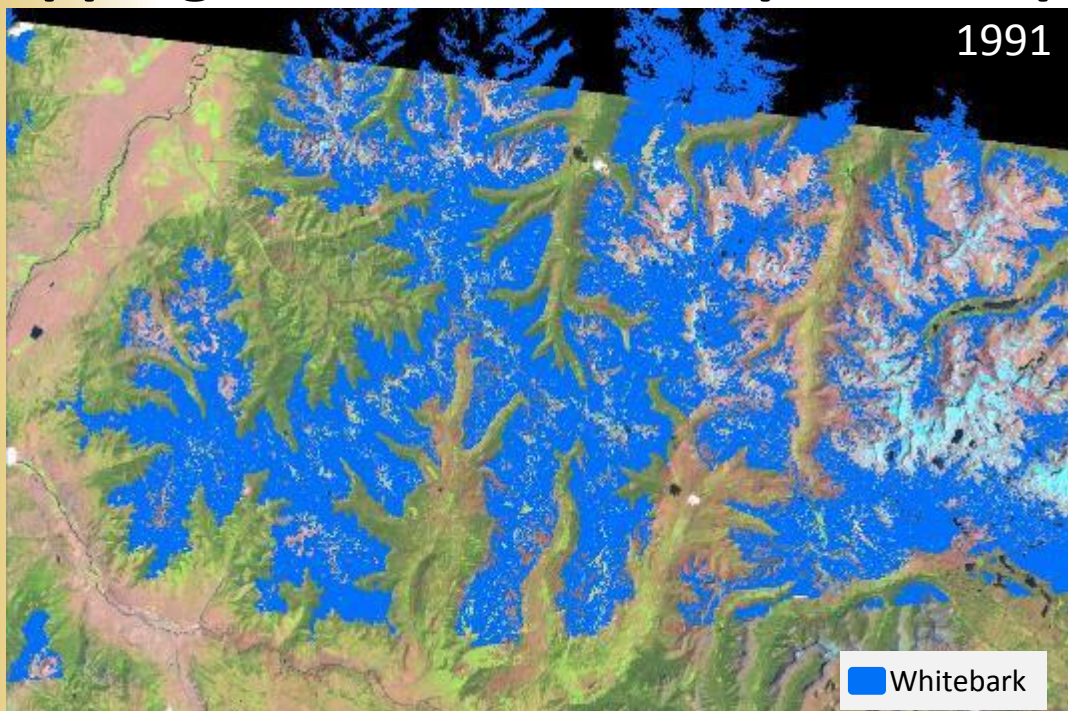

- **Training data:** Field work, Vmap, GAP, Landfire, Photointerpretation
- **Inputs:** Landsat imagery, spectral transformations, Slope, Elevation, Precipitation
- **Classification Algorithm:** Random Forest in R

Mapping WBP occurrence pre- and post- blister rust die off

1991

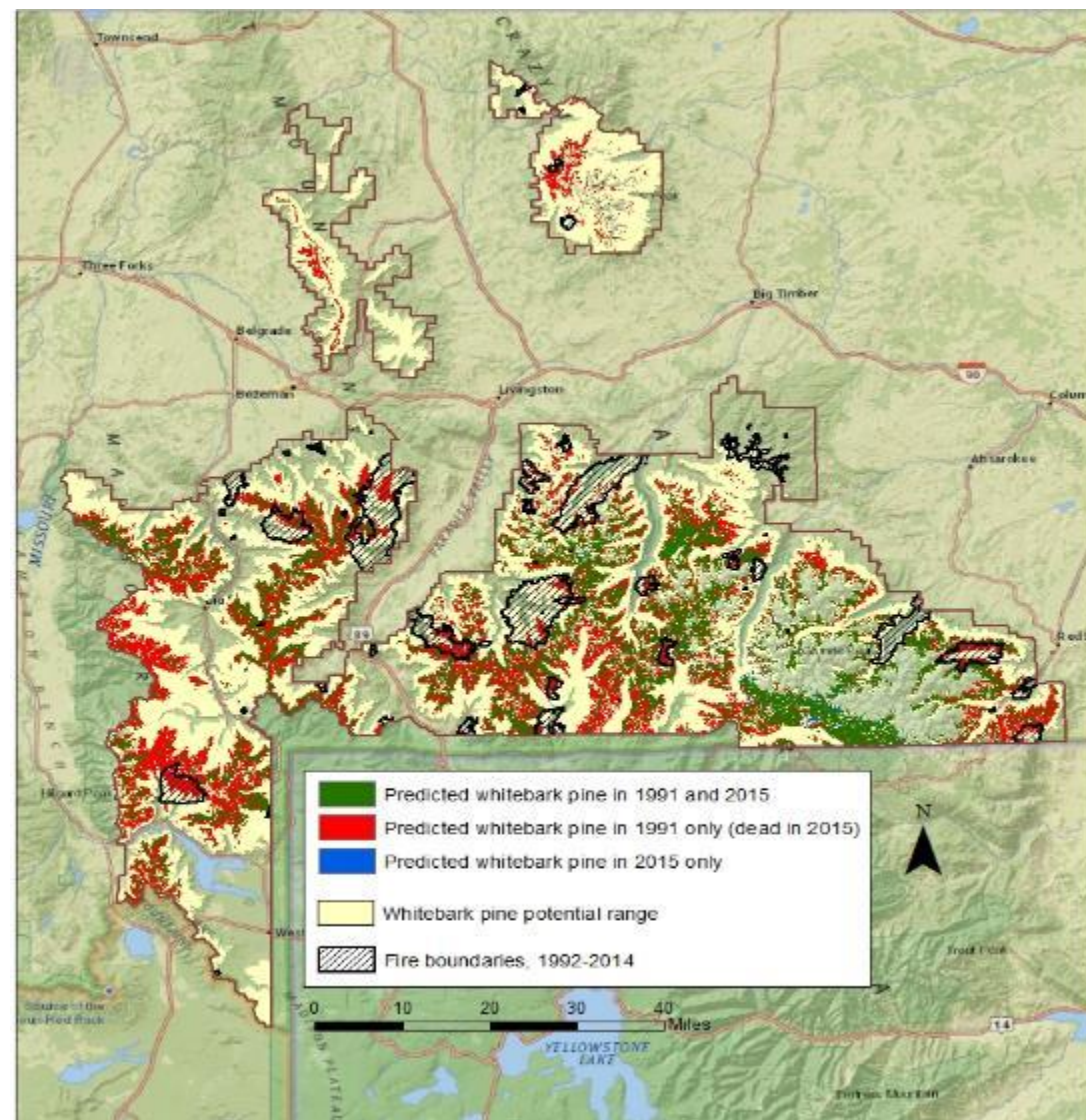2015

Whitebark

Whitebark

- **Classification accuracies range from 87% to 95%**
- **Die off rates ranged from 15% to 61% loss of WBP due to blister rust or fire within the different National Forests.**

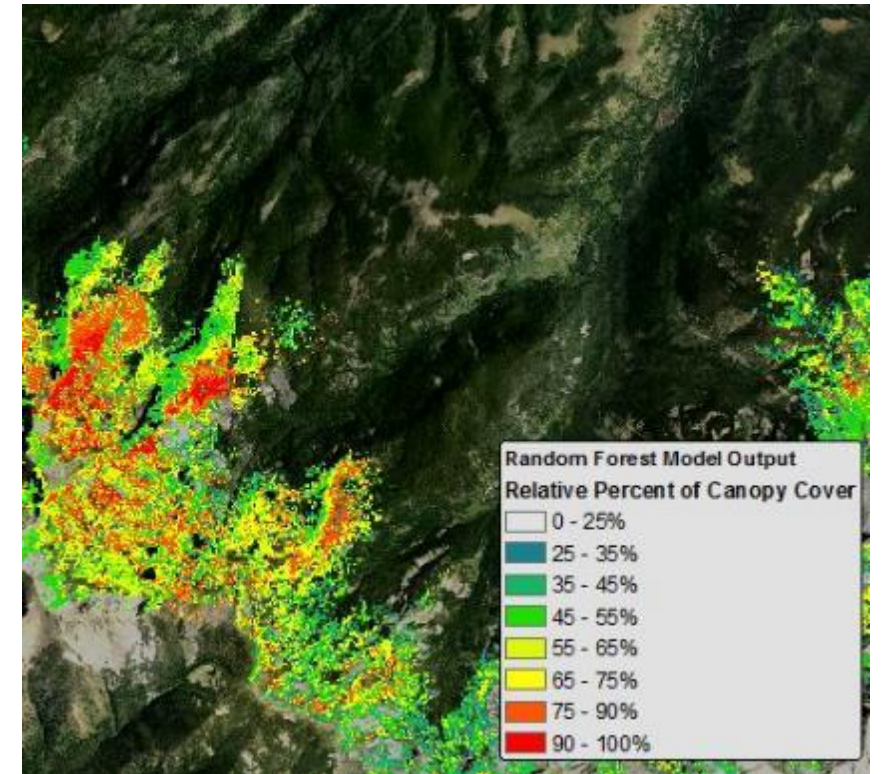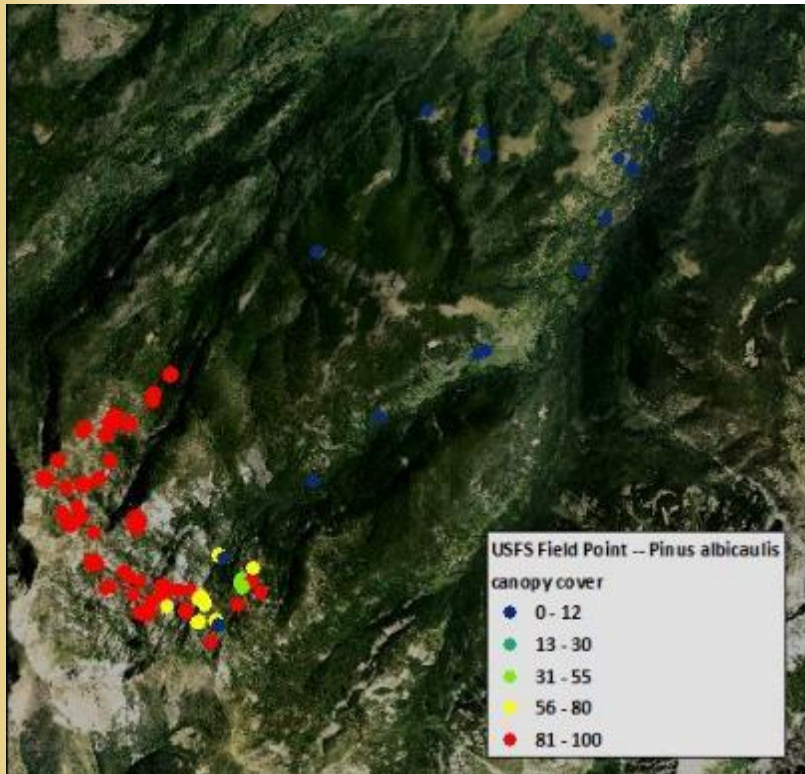## Example: Custer Gallatin National Forest

- **732,621 ha of WBP in 1991**
- **340,647 ha of WBP in 2015**
- **53% mortality rate**
  - 44,200 ha within fire boundaries
  - 350,000 ha likely due to blister rust

Legend:
- Predicted whitebark pine in 1991 and 2015
- Predicted whitebark pine in 1991 only (dead in 2015)
- Predicted whitebark pine in 2015 only
- Whitebark pine potential range
- Fire boundaries, 1992-2014

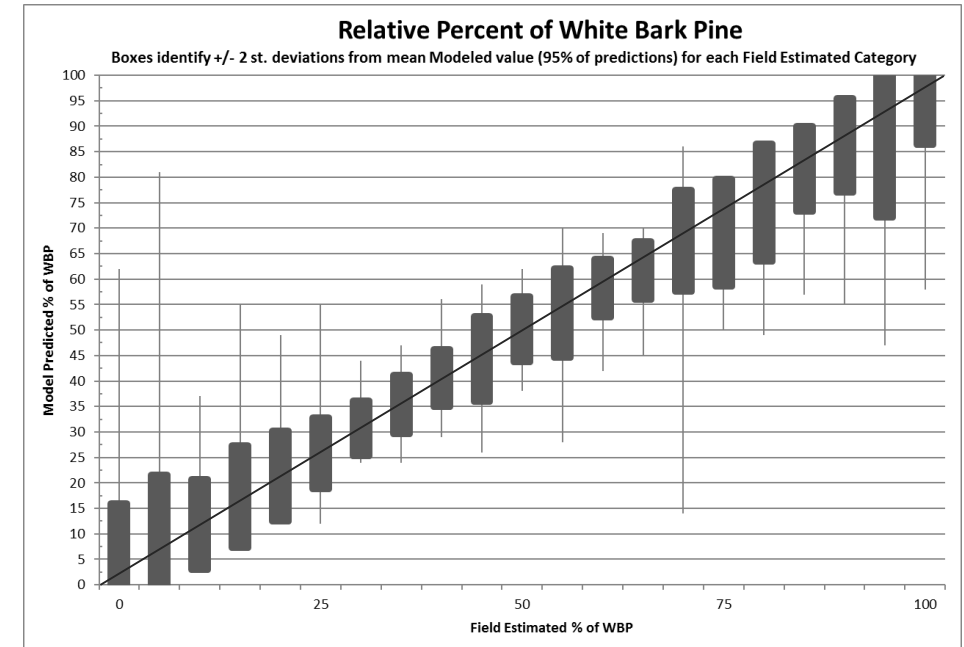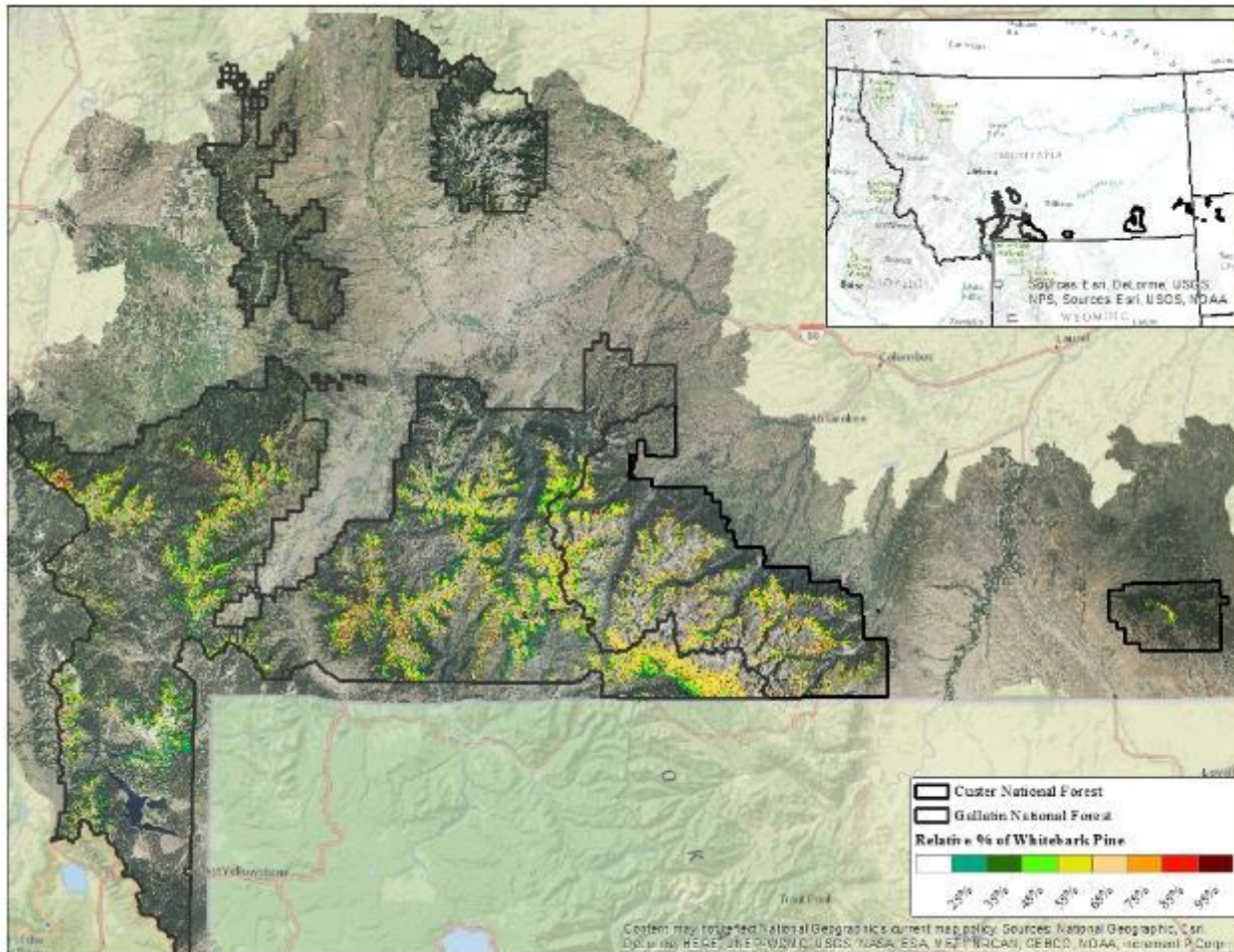## Modeling WBP relative percent of canopy cover

- **Training data:** Field based stand assessments (30% set aside for independent validation)
- **Inputs:** NAIP CIR, spectral transformations, slope, elevation, aspect, heatload, precipitation
- **Regression Algorithm:** Random Forest in R

Example: Custer Gallatin National Forest

- **95% of all model predicted WBP canopy cover calls were within ±17 points from the field assessed value**

- **31,000 ha PIAL dominant stands (>60% cc)**

Questions?

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