Whitebark Pine Community Mapping at Crater Lake National Park

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Introduction:

A collaborative project between the Institute for Natural Resources (INR) at Portland State University, and the National Park Service (NPS) was undertaken between 2008 and 2012 to assess the current distribution of whitebark pine (*Pinus albicaulis*) at Crater Lake National Park. Mapping methods included distribution modeling, remote sensing, GIS and expert knowledge.. For future management decision support it is necessary to first identify the baseline distribution of whitebark pine. Prior efforts to map whitebark pine in Crater Lake were at a resolution too coarse to effectively measure changes in whitebark pine distribution and were unable to differentiate mountain hemlock (*Tsuga mertensiana*) from whitebark pine.

Methods:

A Random Forest (RF) model was run to predict the distribution of whitebark occurrences throughout the park. This relied on digitized polygons from field observations as training data. RF uses a Classification and Regression Tree (CART; Breiman et al 1984) methodology to combine multiple replicate tree classifiers, each generated from a randomly selected subsample of the original predictor dataset. RF has the capability to utilize both categorical and continuous predictor variables and to incorporate complex relationships between variables (Garzon et al. 2006, Phillips et al. 2006). The RF regression model produced a continuous probability estimate of whitebark pine occurrence at 5 meter pixel resolution. This whitebark pine prediction raster was then grouped into 5 classes to ease interpretation. The classes are:

1. No whitebark pine;
2. Trace occurrences only;
3. Interspersed, if present a minor component;
4. A codominant species; or
5. The dominant tree.

For use in the modeling, one meter resolution LiDAR (Light Detection and Ranging) data flown in 2010 was obtained from the NPS. The LiDAR tiles were mosaicked, then the base elevation layer and the highest hit layer were differenced, resulting in a vegetation height layer. Both the heights and elevation were used as predictor variables. 1 meter resolution, 4 band National Agricultural Imagery Program (NAIP) imagery from 2011 was obtained and used as a predictor variable (Table 1) as well.

Positive whitebark pine training samples were created from random points located within the digitized whitebark pine training polygons, and predictor variable values were sampled. Any training point with a LiDAR height of less than 4 feet was deemed a negative occurrence. If the

point landed on vegetation with a height over 65 feet it was also deemed as a negative occurrence. Additional negative occurrence points were visually interpreted and manually placed in areas which were clearly not whitebark pine, such as lower elevation tall forests, pumice areas or water.

A field crew from INR spent 3 days at Crater Lake ground truthing the map, evaluating it for commission and omission errors. Notes were taken and drawn on the initial predictive map for later revisions back in the lab. Additionally, GPS points were taken where occurrences of whitebark pine were not mapped or incorrectly mapped. These points were then added to the existing positive occurrence and negative occurrence training data; so the RF model could be further refined.

Once the predictive model was refined the map was submitted for review by NPS staff. Comments and recommendations by NPS staff were then incorporated into the final map. Recommendations included the addition of several whitebark pine populations throughout the park and changing the probability of occurrence in particular areas based upon elevation. The final edits and recommendations were manually fixed.

Table 1. Predictor variables used in RF model:

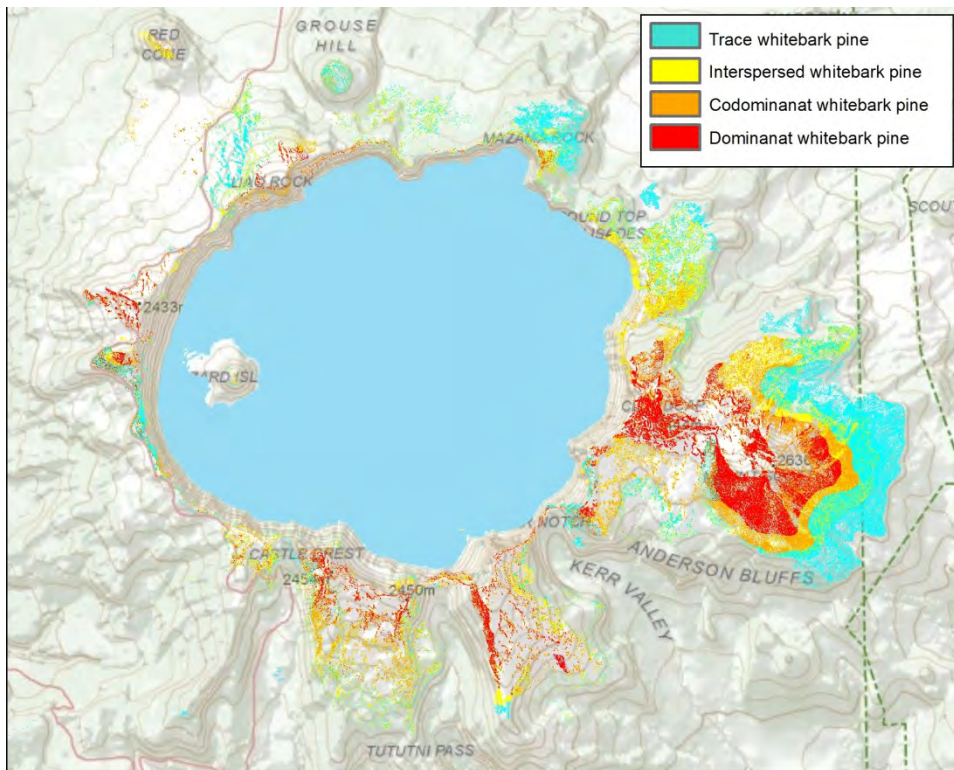| LiDAR Vegetation height |
| --- |
| LiDAR Elevation |
| NAIP red band |
| NAIP green band |
| NAIP blue band |
| NAIP infrared band |
| NAIP Normalized Difference Vegetation Index |

Results:

Four whitebark pine prevalence classes were mapped, trace, interspersed, codominant, and dominant. The trace class typically represents areas that are generally dominate by lodgepole pine (*Pinus contorta*) with scattered whitebark pines, these areas are particularly present on the east side of the park at elevations between 6,600 and 6,800 feet. An increase in elevation represents the interspersed class that has a whitebark pine presence but a greater prevalence in the canopy of mountain hemlock (*Tsuga mertensiana*) and shasta red fir (*Abies magnifica*). Increasing in elevation further, with higher winds and lower temperatures, is the codominant class represented only by whitebark pine and mountain hemlock. Depending upon geographic location in the park at elevations whitepark pine dominates as low as 6,900 feet elevation; this class is represented by the dominant class. Table 2 contains a summary of the acreage present of

each of the whitebark pine classes in the park. Figure 1 shows the whitebark pine distribution map.

Table 2. Predicted acreage of whitebark pine classes

Class	Acres
Trace	1,699
Interspersed	1,387
Codominant	1,181
Dominant	950
Total Acres	5,217

Figure 1. Whitebark pine prevalence community map

Summary:

Whitebark pine is a very valuable species to wildlife, plants, soil stabilization, visitors and hydrology. Prior to the current mapping effort very little information about whitebark pine communities throughout the park had been digitally documented. Our mapping effort provides new and useful baseline information. Given the many perils whitebark pine is facing it is essential to document such conditions in order to better ensure its survival or mitigate for its potential losses.

References

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