Northern Rockies Ecological Conservation

Leveraging Earth Observations to Monitor and Predict Populations of Federally Threatened Whitebark Pine (*Pinus albicaulis*) Across the Intermountain West

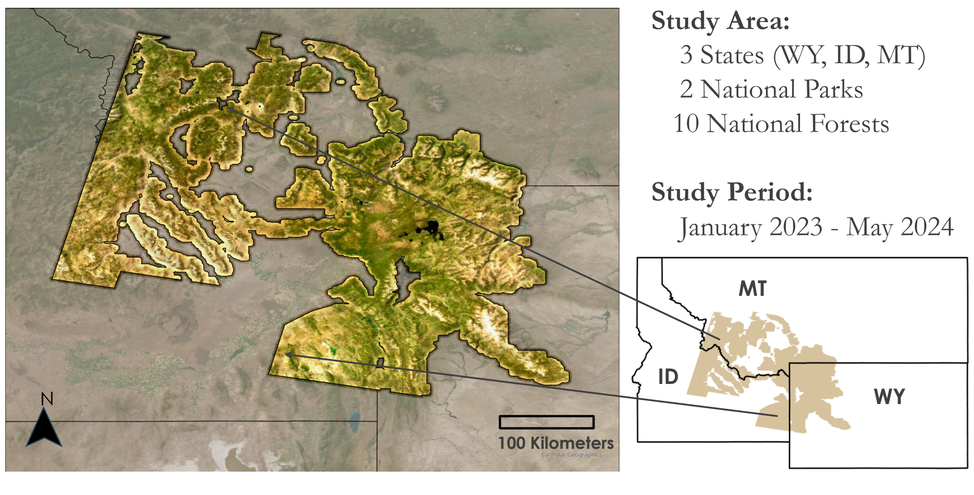
Project Synopsis

Whitebark Pine (*Pinus albicaulis)* is a federally threatened keystone species, found in high elevations. It faces significant threats from blister rust (*Cronartium ribicola),* mountain pine beetle (*Dendroctonus ponderosae),* and climate change. To assist in its conservation, this project aimed to map the habitat suitability and distribution of whitebark pine using remote sensing methods and geographic information systems. First, we used a generalized logistic model to develop a habitat suitability at 30m resolution. Next, to develop our distribution model, we extracted spectral signatures from high-resolution satellite imagery pixels containing known whitebark pine locations. These findings demonstrated the feasibility of using remote sensing, geographic information systems (GIS), and field data collection to further inform whitebark pine conservation efforts and research.

Objectives

- **Investigate** whitebark pine spectral signatures
- **Create** distribution models utilizing spectral signatures
- **Generate** a whitebark pine habitat suitability model
- **Develop** accessibility model to whitebark pine utilizing roads and trails

Study Area

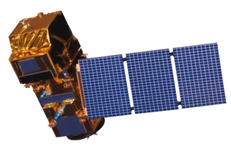


Study Area:
3 States (WY, ID, MT)
2 National Parks
10 National Forests

Study Period:
January 2023 - May 2024

Earth Observations

Landsat 9 OLI-2



Sentinel-2 MSI

Project Partners

- USDA, US Forest Service, Region 1
- Bureau of Land Management, Salmon Idaho Field Office
- US Fish and Wildlife Service, Montana Ecological Services Field Office
- US Fish and Wildlife Service, Wyoming Ecological Services Field Office
- National Park Service, Yellowstone Inventory & Monitoring Network
- Whitebark Pine Ecosystem Foundation

Team Members

Hannah Rogers
Project Lead

Josh Carrell

A H M Mainul Islam

Dustin Corbridge

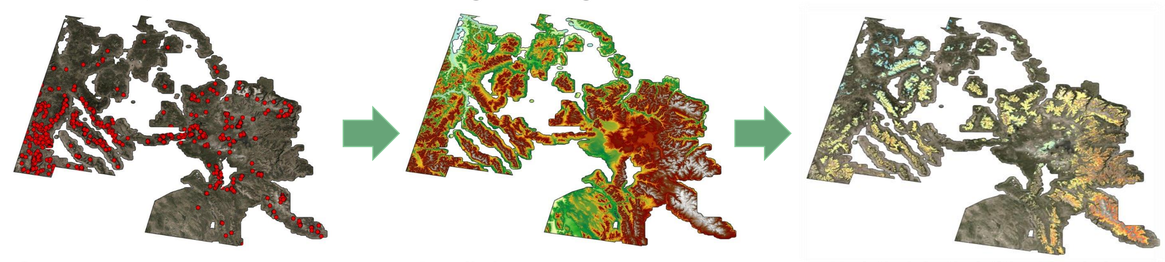
Acknowledgements

Advisors: **Dr. Keith Weber** - Idaho State University, GIS Director & NASA DEVELOP Science Advisor | **Joe Spruce** - NASA DEVELOP Science Advisor | **Partners:** **Julee Shumhart** - Whitebark Pine Ecosystem Foundation, Executive Director, **Contributors:** **Dr. Chris Earle** - The Gymnosperm Database, Wildlife Biologist | **Diana Tomback -** University of Colorado, Department of Integrative Biology | **Jim Strickland –** Idaho Fish and Wildlife, Botany Director | **Lead:** **Kait Lemon** - NASA DEVELOP, ID Lead

This material contains modified Copernicus Sentinel data (2023,2024), processed by ESA

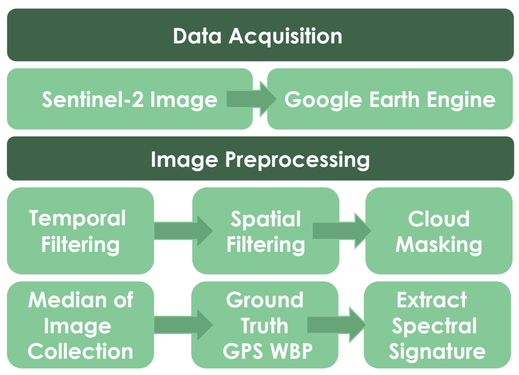
Methodology

Habitat Suitability Model: Generalized Logistic Regression

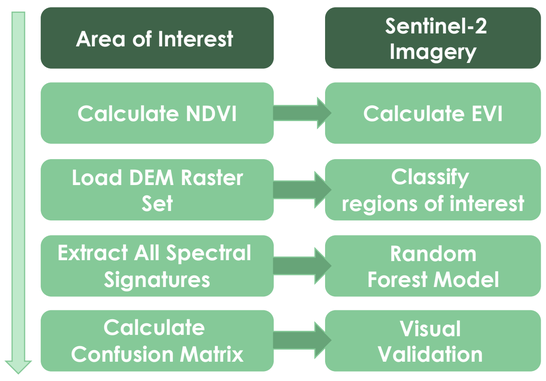


Accessibility Model

Spectral Signature Image & Data Processing



Preliminary Distribution Model

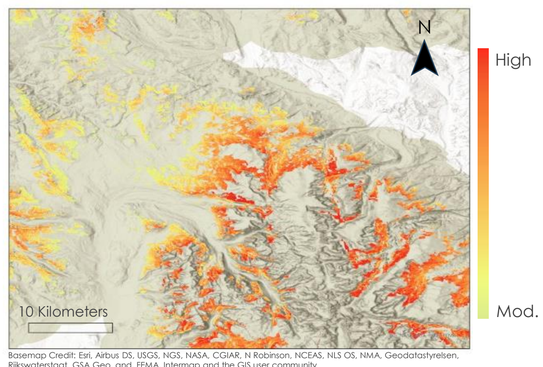


Results

Habitat Suitability Model

Performance Metrics

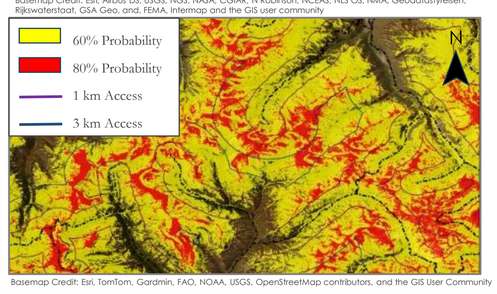
- **Sensitivity:** 0.719 (ability to model true positives)
- **Specificity:** 0.689 (ability to model true negatives)
- **Area Under the Curve (AUC):** 0.754 (overall model performance)
- **True Skill Statistic (TSS):** 0.408 (combined Sensitivity and Specificity)



Basemap Credit: Esri, Airbus DS, USGS, NGS, NASA, CGIAR, N Robinson, NCEAS, NLS OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA Geo, and, FEMA, Intermap and the GIS user community

Accessibility Model

WBP high probability zones can be accessed within 1 kilometers and 3 kilometers of trails and roads

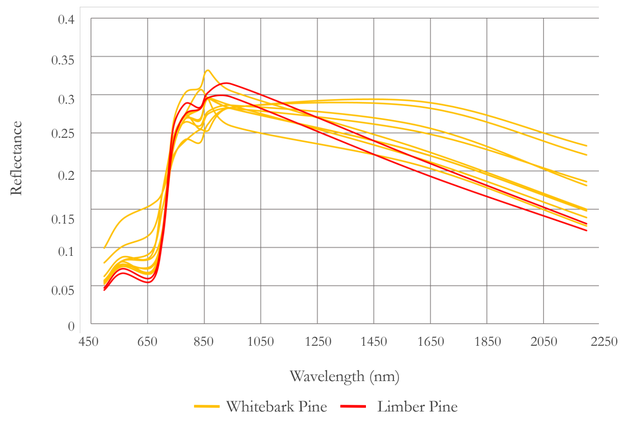


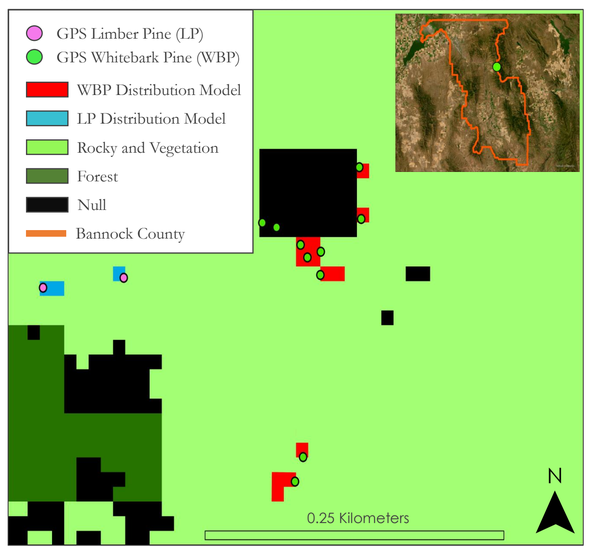
Basemap Credit: Esri, TomTom, Garmin, FAO, NOAA, USGS, OpenStreetMap contributors, and the GIS User Community

Spectral Signature & Distribution Model

Spectral reflectance of whitebark pine is higher than limber pine in VIS and SWIR region but lower in NIR region.

Classification performed better for the trees with verified accurate coordinates than sourced data with approximate locations.





Conclusions

- The differences between spectral signatures of whitebark pine and limber pine shows the feasibility of classifying tree species using remote sensing.
- To ensure the distribution model's accuracy and achieve higher classification precision, we need a more substantial number of ground truth observations.
- Additional models such as Random Forest, Gradient Boosting Machine, etc., working in conjunction (mean average) with the generalized linear model may provide further insights into whitebark pine habitat suitability.
- Future development of downscaled climate, soil, and topographic predictor variables and the addition of new occurrence records will improve habitat suitability model's predictive power.

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