Sensitivity of chaparral obligate seeders in Los Angeles and Ventura Counties

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Introduction

Chaparral, the dominant vegetative community in Southern California, is characterized by sclerophyllous, evergreen shrubs. These shrubs can be categorized into three main reproductive strategies based on their responses to the infrequent fire regime characteristic for the region: obligate seeding, obligate resprouting, and facultative resprouting. Obligate seeders typically occur in more xeric and nutrient-poor sites, where obligate resprouters are generally less likely to succeed. However, obligate seeders are predicted to be negatively affected by the shortened fire return intervals that are occurring as a result of human caused fire within chaparral settings.

Fire typically stimulates abundant germination of obligate seeding shrub species. However, as fire return intervals become shorter than obligate seeders' maturation period, obligate seeders are unable to replenish their seed bank in between fires. Despite fire frequency's obvious role in the decline of obligate seeders, there are a myriad of other state factors (e.g. precipitation, min/max temperatures, elevation, etc.) that could also play a role in the loss of obligate seeders. Therefore, identifying which environmental factors are most influential in the loss of obligate seeder dominated chaparral is essential in directing conservation and restoration efforts.

Questions

1. How has the range of obligate seeder dominated chaparral in Los Angeles and Ventura Counties changed between 1934 and 2001?
2. Which state factors are most strongly correlated with this change?

Methods

1. Obtain the 1934 Vegetation Type Map (VTM) from UC Berkeley Kelly Lab and 2010 Cal VEG map from USGS; both for Los Angeles and Ventura Counties.
2. For the two counties, obtain fire history data from FRAP, precipitation data and temperature normals from PRISM, elevation data from USGS National Map Viewer, and coast and road shapefiles from US Census Bureau.
3. Upload data to ArcGIS, create slope and aspect data from the elevation data, and classify polygons that are dominated by obligate seeders in the VTM dataset.
4. Compare the obligate seeder dominated areas in 1934 to areas still classified as chaparral in the 2010 CalVEG dataset and classify as either points that remained chaparral or did not remain chaparral.
5. Use Create Random Points tool to convert polygons to point features, then upload all state features into new point features' attribute table.
6. Run a Random Forest analysis in R on those points to determine which environmental variable was strongest in determining loss of obligate seeder dominated chaparral

Results

Vegetation type:	1934 area (ha):	2010 area (ha):	Percent of area remaining of chaparral
Chaparral	24,070,918	18,730,422	77.8%
Obligate Seeders	1,292,099	440,746	34.1%
Obligate Resprouters	6,318,874	2,643,269	41.8%

Table 1: Percent of area remaining for chaparral, obligate seeder dominated chaparral, and obligate resprouter dominated chaparral in Los Angeles and Ventura counties.

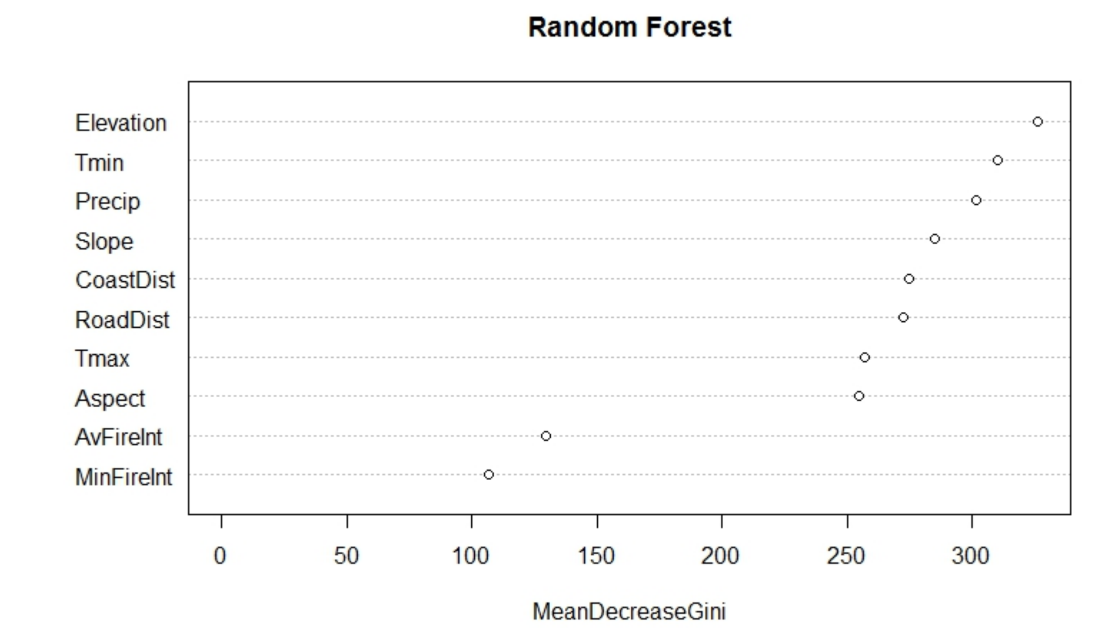

Figure 1: Random Forest results, with a larger Mean Decrease Gini meaning the state factor had a larger influence on determining whether or not the polygon remained obligate seeder dominated chaparral.

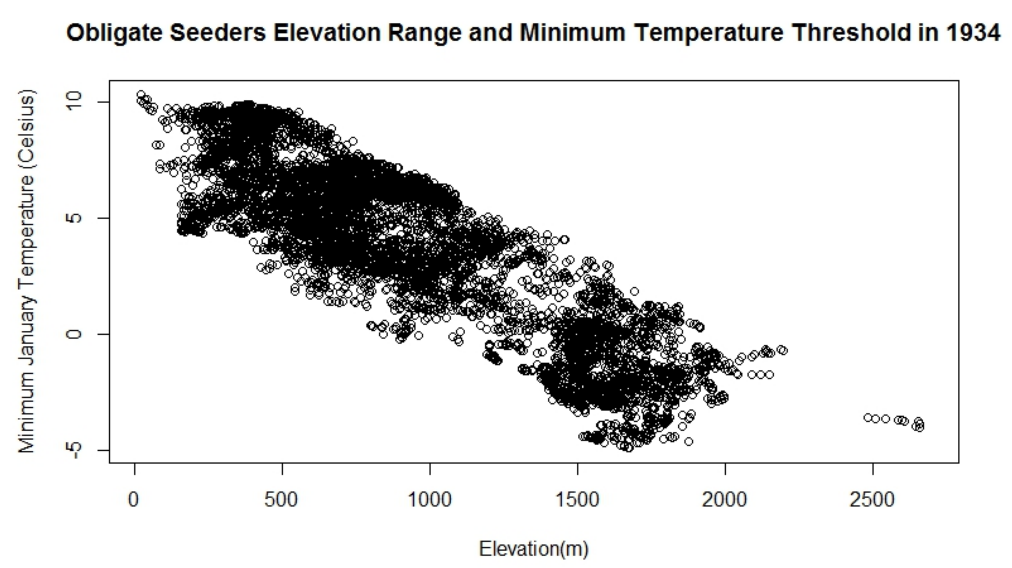

Figure 2: Defining Obligate Seeders' Niche in relation to Elevation and Minimum January Temperature in 1934.

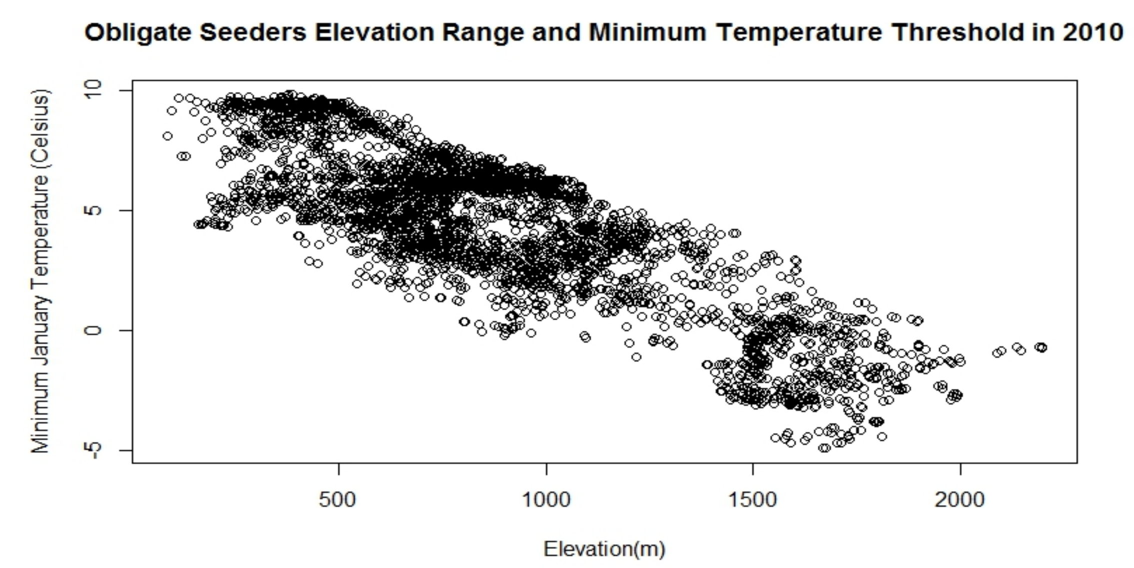

Figure 3: Defining Obligate Seeders' Niche in relation to Elevation and Minimum January Temperature in 2010.

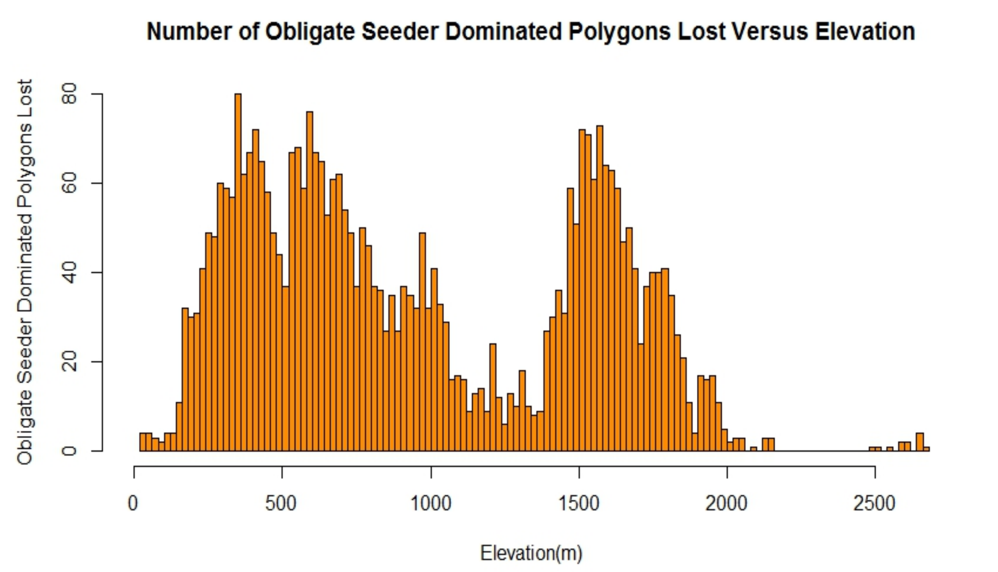

Figure 4: Histogram portraying the number of obligate seeder dominated polygons lost at different elevations.

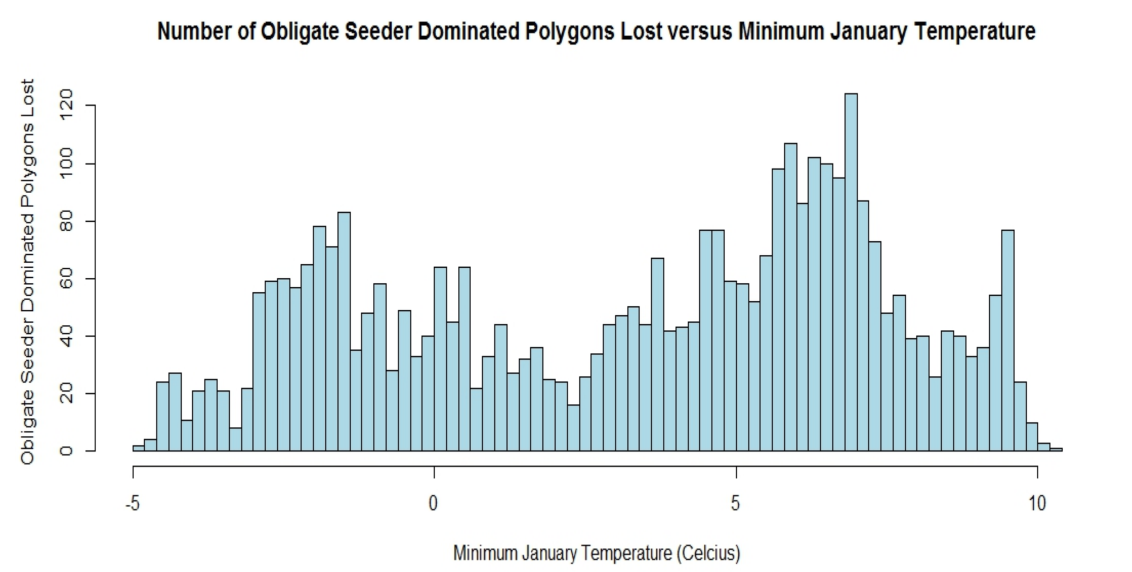

Figure 5: Histogram portraying the number of obligate seeder dominated polygons lost at different minimum January Temperatures.

Discussion:

The results of the Random Forest Analysis reveal that elevation and minimum average January temperature had the largest influence on whether or not a given area converted from obligate seeder dominated chaparral from 1934 – 2010. It can also be seen that the elevation range obligate seeder dominated chaparral occupies has been reduced on its upper end, while obligate seeder dominated chaparral's occupied minimum average January temperature has not had an observable change. Analysis of the number of polygons lost at different elevations and minimum January temperatures reveal that obligate seeder dominated chaparral appears to be most vulnerable at elevations of approximately 250 – 750m and 1500 – 1600m, and areas that experience minimum temperatures of approximately 7°C.

While elevation is a geographic feature, and the mechanisms that cause the observed vulnerability at specific elevations require further investigation, I hypothesize the vulnerability of obligate seeders at 7°C is a result of obligate seeders being drought tolerators, and not being equipped to survive in low temperatures. While the apparent increased resistance at lower temperatures requires further investigation in regards to this hypothesis, one potential explanation is populations that have persisted in areas with severely lower temperatures than their norm have better adapted than those existing in areas just below their standard threshold.

Most Vulnerable Areas:

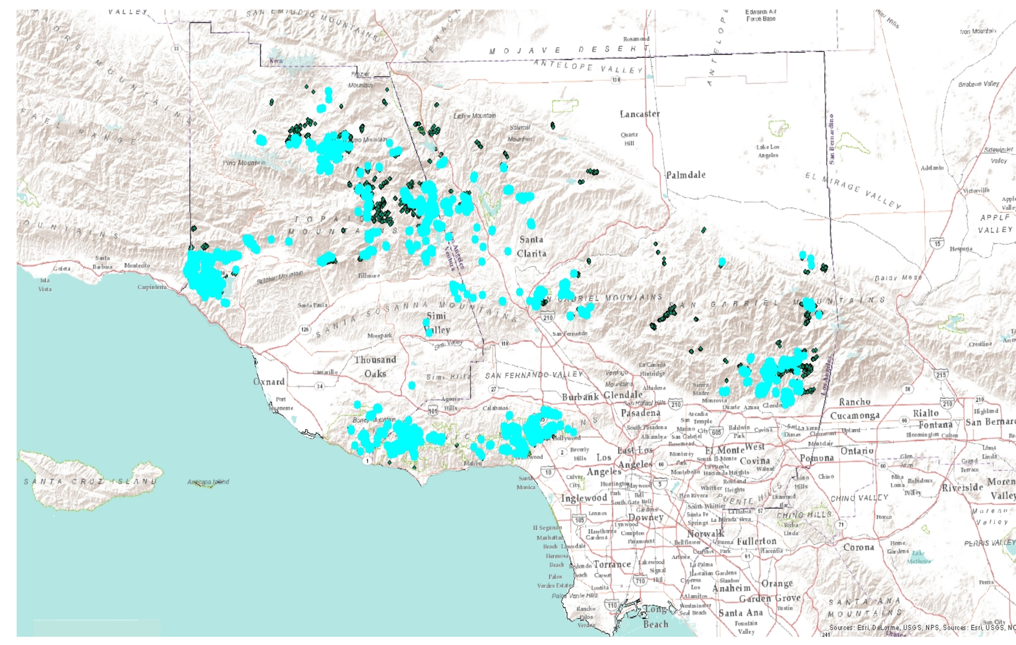

Figure 6: Obligate seeder dominated chaparral (highlighted in blue) currently most at risk based off elevation and minimum January temperature. This area consists of 225,461.63ha of the remaining 440,746.01ha. Therefore, 51.15% of the remaining obligate seeder dominated chaparral is currently at high risk for conversion.

Future Analysis

Future investigation should be focused on what biotic and abiotic mechanisms cause the observed vulnerability of obligate seeders at the specified elevations and temperature. Further analysis of what these areas have most commonly been converted to and what obligate seeding species have been most severely impacted is also required. Finally, additional environmental factors, such as soil type and solar insolation could also be included in the Random Forest analysis. This could potentially create a more robust model, and give a deeper insight to the environmental mechanisms causing the loss of obligate seeder dominated chaparral.

Literature Cited

Keeley, J.E. (1986). Resilience of Mediterranean Shrub Communities to Fire. *Resilience in Mediterranean-Type Ecosystems Tasks for Vegetation Science*, 95-112.

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