Preliminary Suitable Habitat Analysis

Victoria Community Association Network Garry Oak Mapping Project

Phase 2a: Preliminary statistical analysis of environmental characteristics at mapped Garry Oak Tree locations

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Contents

Introduction

Garry Oak (Quercus garryana) ecosystems are among the most ecologically significant yet endangered habitats in British Columbia. These ecosystems support a variety of native species, many of which are rare or at risk due to ongoing urbanization and habitat fragmentation. The Victoria Community Association Network (VCAN) Garry Oak Mapping Project was initiated to aid conservation efforts by identifying and analyzing Garry Oak distribution within the City of Victoria. Community mapping for this study captures only a small fraction of the existing Garry Oak trees in each participating neighborhood and does not represent an exhaustive inventory. This preliminary study aims to assess key environmental and anthropogenic characteristics at mapped Garry Oak locations and compare them to broader landscape conditions. The findings will help identify priority areas for conservation efforts, including potential greenways, conservation parks, or land acquisition initiatives. Using geospatial analysis, elevation, slope, and parcel size values were extracted at mapped Garry Oak locations and compared to the same characteristics across the entire study area. Statistical methods, including the Kolmogorov-Smirnov (KS) test and Wilcoxon rank-sum test, were applied to determine whether Garry Oak trees occupy significantly different environmental conditions than the surrounding landscape. The results provide insights into Garry Oak habitat preferences and serve as a foundation for future conservation planning. This analysis represents an initial phase of research into the habitat conditions that influence Garry Oak distribution. While elevation, slope, and parcel size offer valuable indicators of potential habitat suitability, additional factors such as soil conditions, land cover, historical land use, and proximity to protected areas should be explored in future studies. Furthermore, incorporating Indigenous knowledge will enhance understanding of traditional ecological relationships and inform sustainable conservation practices. A more comprehensive, multi-criteria habitat suitability model could be developed to guide targeted land acquisition, restoration, and management strategies for Garry Oak conservation in Victoria.

Government House Garry Oak Tree Locations

Additional Garry Oak tree locations were mapped in 1998 by Martha Barchyn and her team as part of an advanced cartography course project at the University of Victoria (Barchyn, 1998). Dave Clark, a member of The Friends of Government House Gardens Society, transcribed the coordinates to an Excel file, which was later converted into a shapefile of point locations using a custom-built R script. This script has been uploaded to the VCAN Google Drive for future use.

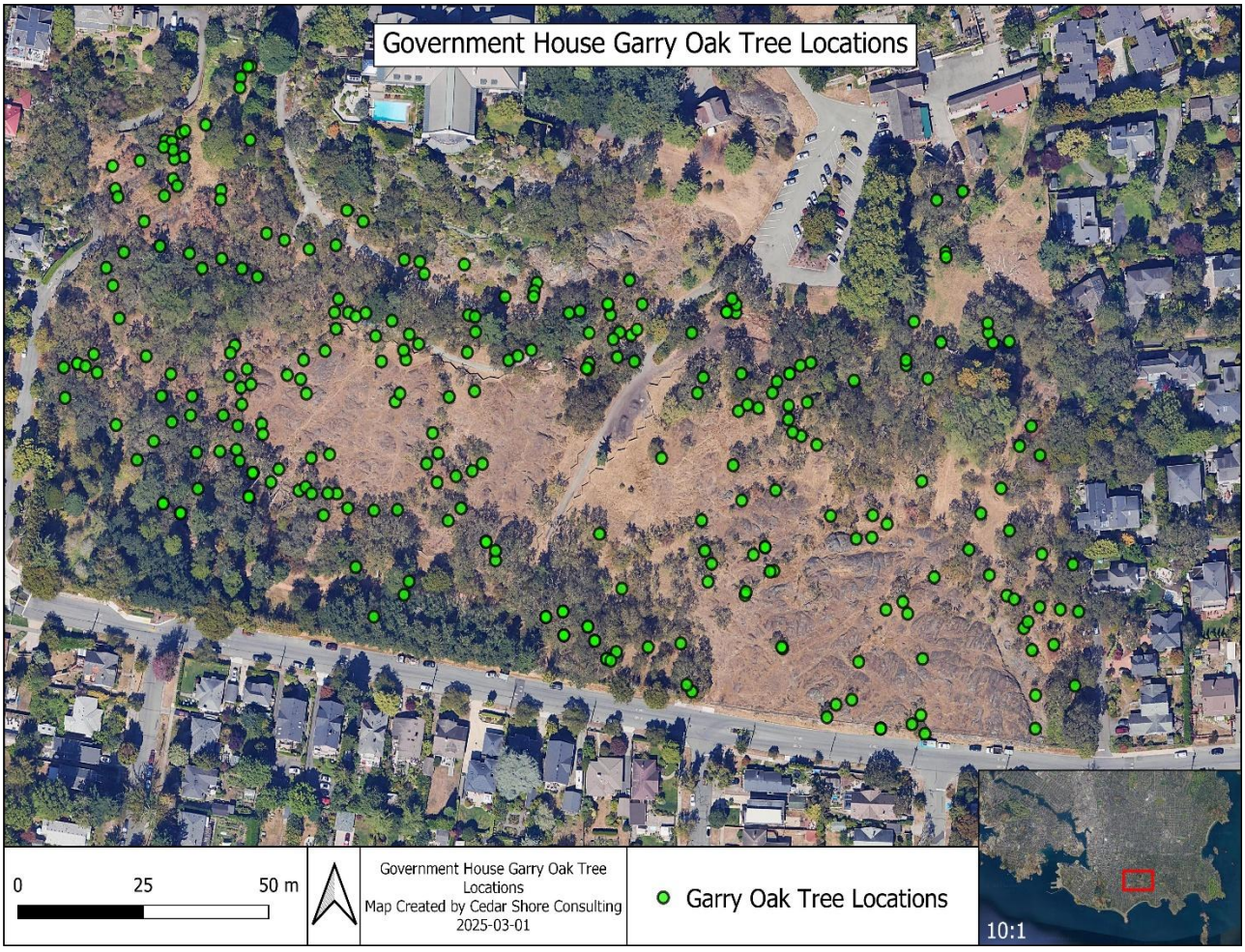

Figure 1: Converted Government House Garry Oak Locations

Results

Garry Oak Locations

Figure 3 includes 5107 Garry Oak locations available through the City of Victoria open data portal (left) and the 1555 Garry Oak locations created by community members throughout the Garry Oak conservation mapping project. Both datasets were combined and used for the analysis in this project. Future analysis could include an analysis of double counted trees, changes in tree location distribution and an analysis of key differences between the two datasets.

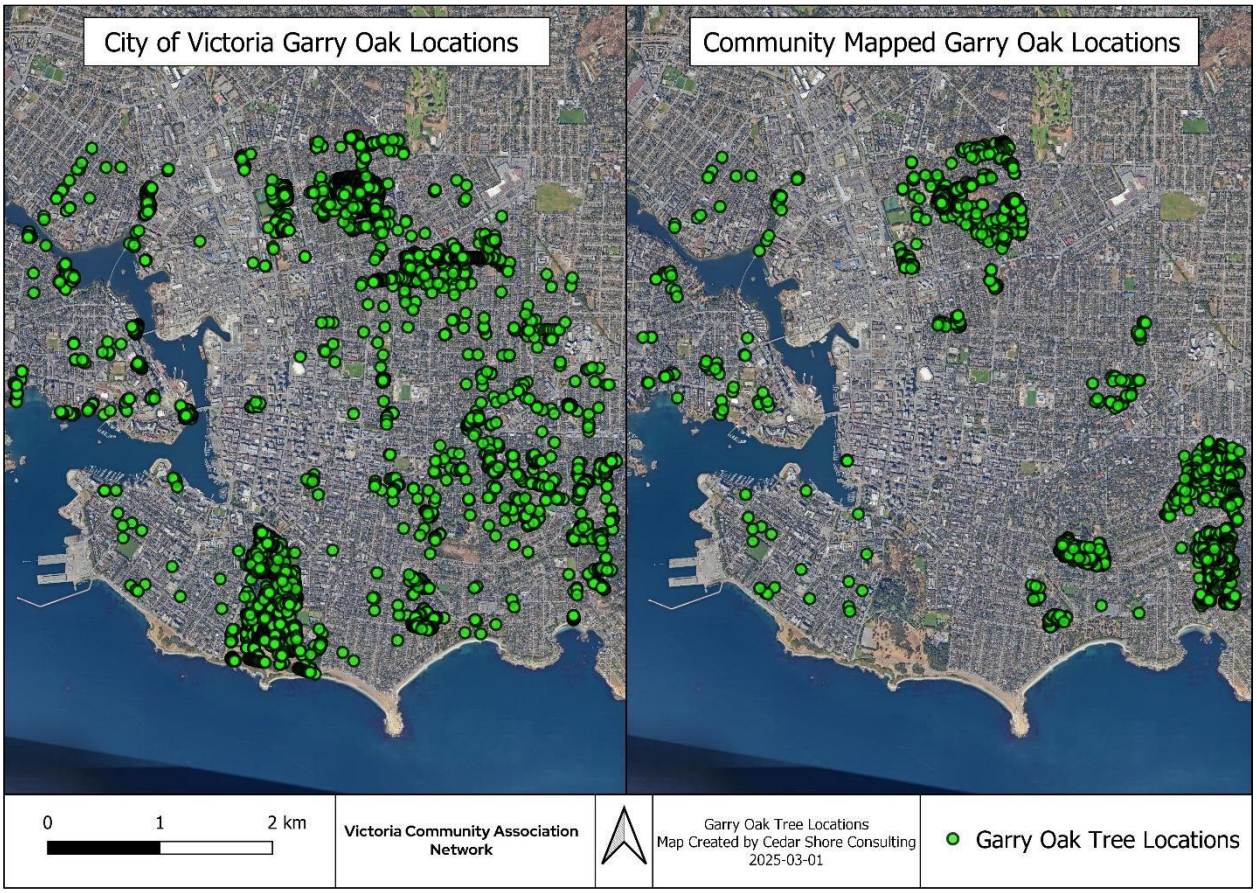

Figure 2: Garry Oak Tree location layer sourced from the City of Victoria (2025) and point locations mapped during the Victoria Community Association Network interactive mapping project

Kernel Density Heat Map

A KDE approach was used to smooth the point distribution of mapped Garry Oak locations, highlighting clusters of trees while accounting for spatial trends. The density scale helps differentiate areas with isolated trees versus those with established stands or groves. The density values range from 1 (lowest, white) to 260 (highest, dark green), allowing for a visual representation of where Garry Oak trees are most abundant. The heat map in Figure 3 reveals two major density hotspots in Beacon Hill Park and Summit Park located in the Hillside/Quadra neighborhood.

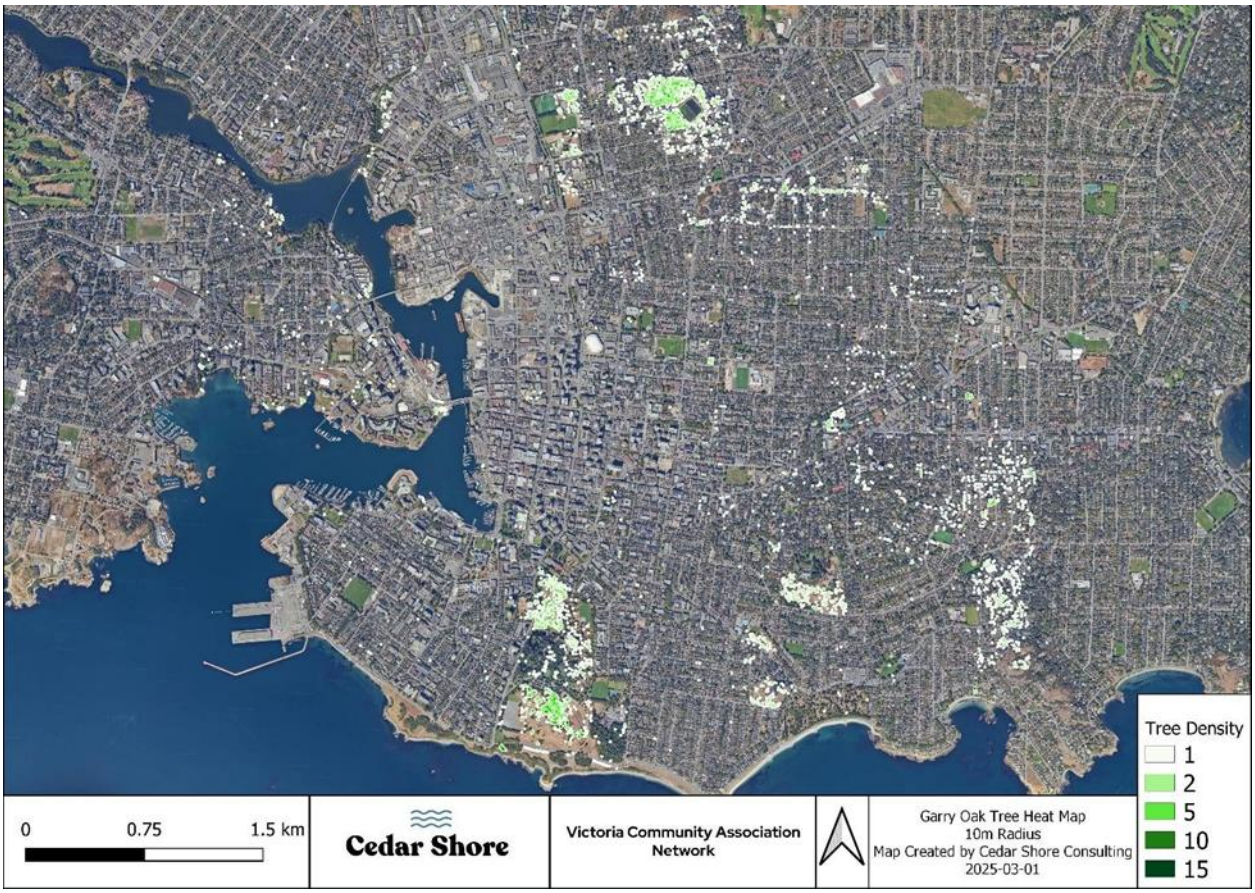

Figure 3: Kernel density heat map with a 10-metre radius around tree locations

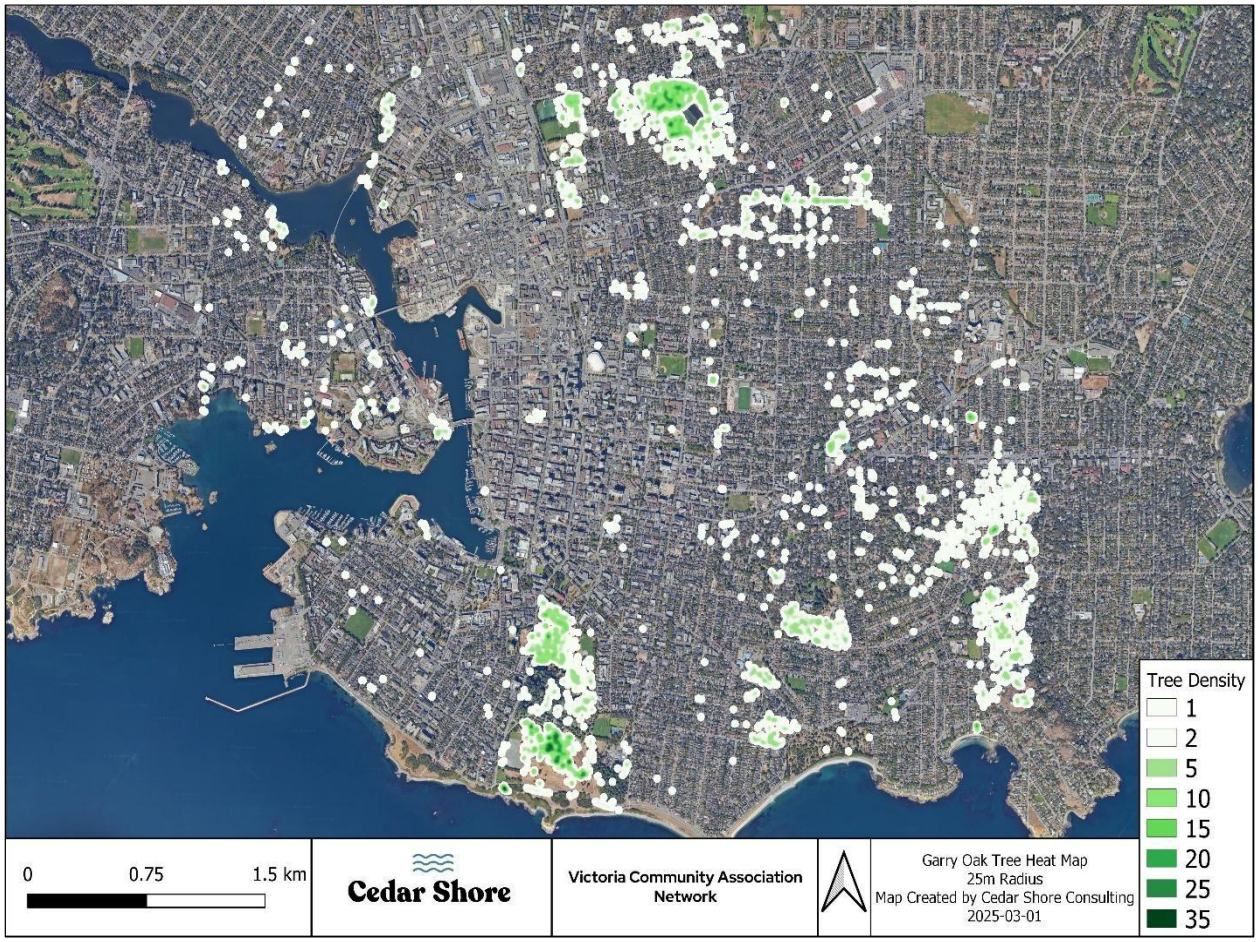

Figure 4: Kernel density heat map with a 25-metre radius around tree locations

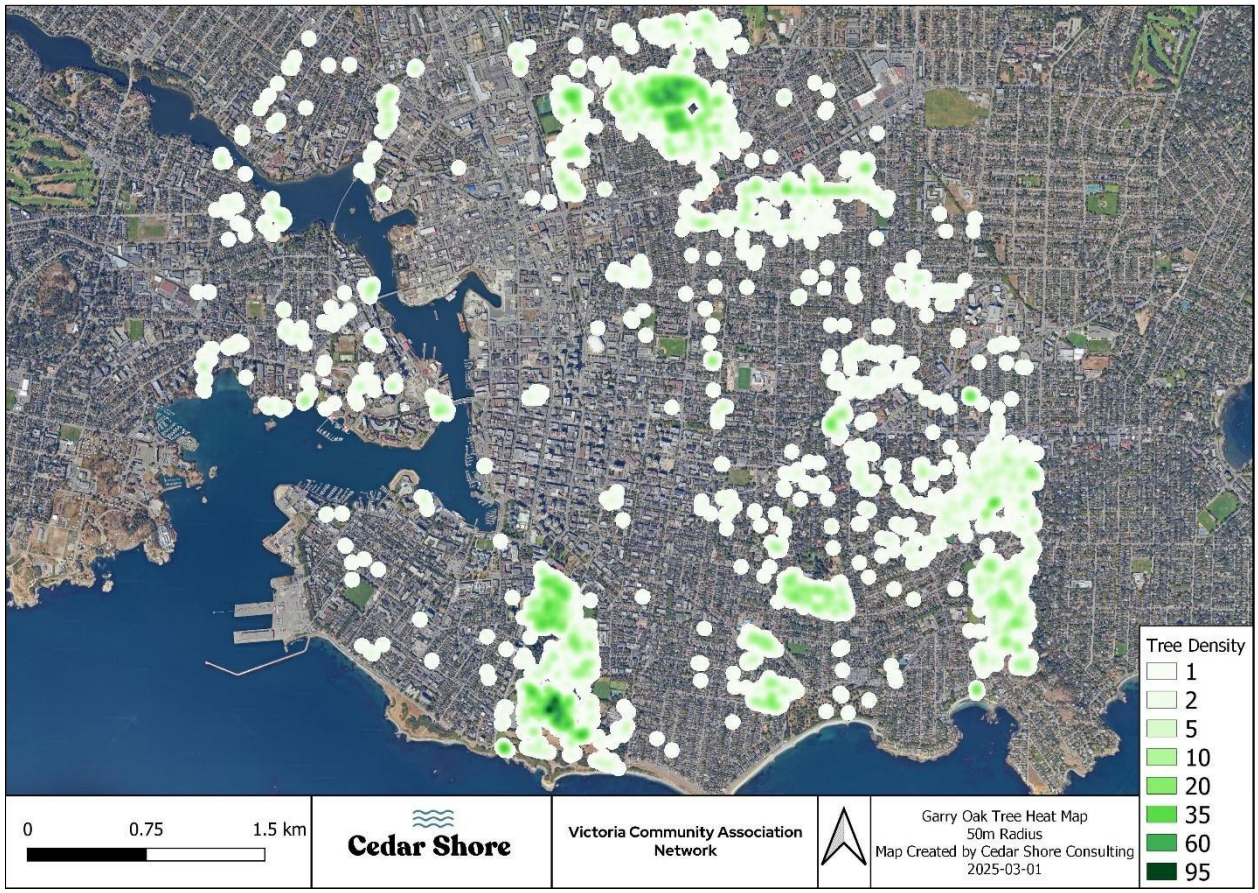

Figure 5: Kernel density heat map with a 50-metre radius around tree locations

Statistical Analysis of Habitat Characteristics

To better understand the environmental conditions that influence Garry Oak distribution in Victoria the elevation and slope values for all mapped tree locations were extracted. These values were then compared against the broader study area's elevation and slope distribution to assess whether Garry Oaks occupy distinct terrain characteristics.

Table 1: Summary Statistics

Statistic	Garry Oak Elevation (m)	Study Area Elevation (m)	Garry Oak Slope (°)	Study Area Slope (°)
Min	0.8	0	0.1	0
Max	67.1	225.3	61.9	83.9
Mean	33	27.5	7.9	5
Median	29.3	23.1	5.7	2.9
SD	15	22.2	7	6.4

The average elevation of Garry Oaks (33 m) is slightly higher than the overall study area average (27.5 m), with a median elevation of 29.3 m compared to 23.1 m for the broader landscape. Garry Oaks tend to occupy low-to-mid elevation areas but are less commonly found at extreme elevations compared to the full study area, which ranges from 0m to 225.3 m. The mean slope at Garry Oak locations (7.9°) is steeper than the study area's mean slope of 5.0°, suggesting that these trees may favor slightly elevated terrain. The median slope at Garry Oak sites (5.7°) is also higher than the study area's (2.9°), reinforcing that Garry Oaks tend to grow on gently sloped terrain rather than completely flat areas. The maximum slope (61.9°) at Garry Oak locations indicates that some trees can persist on steep slopes, though this is less common compared to the study area's maximum slope of 83.9°.

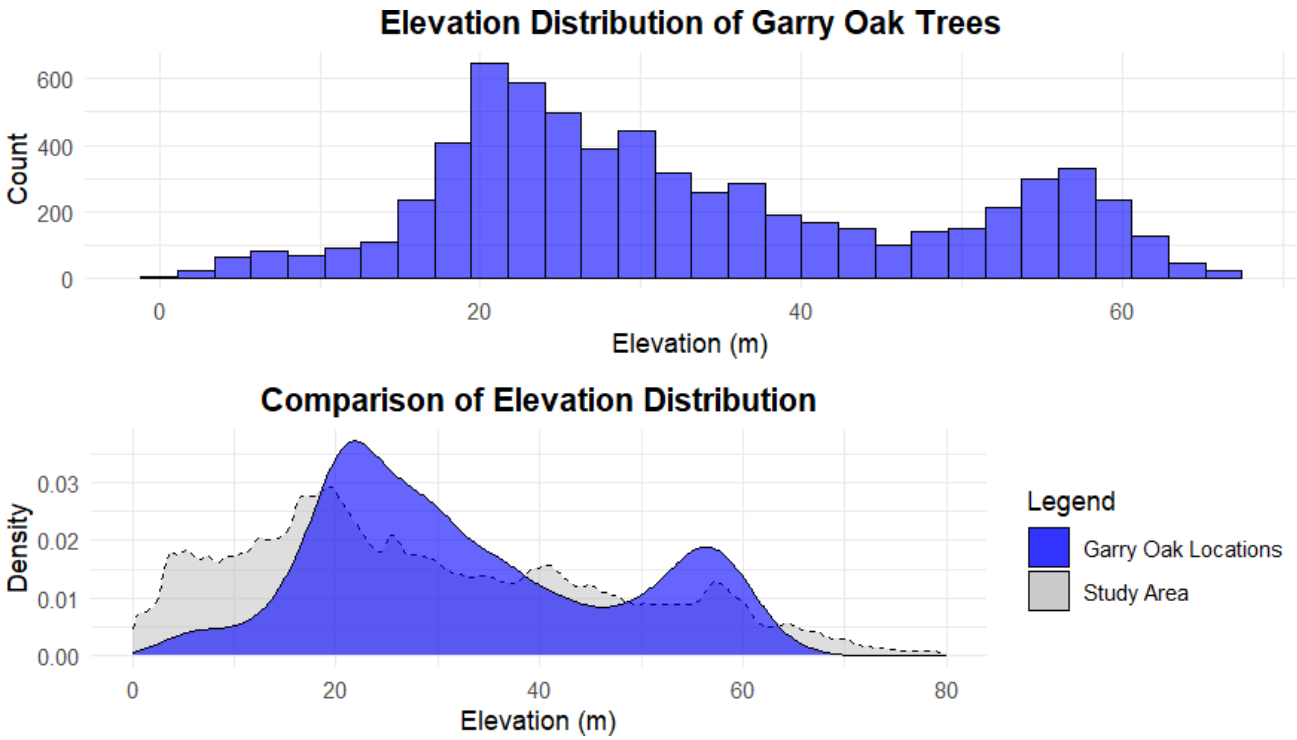

Figure 6:: Distribution of Garry Oak Tree Elevations

In Figure 4, the elevation distribution of Garry Oak locations exhibits a bimodal pattern, with a primary peak between 18m and 23m and a secondary peak around 50m. The primary peak represents the largest concentration of Garry Oak trees, suggesting a preference for relatively low- elevation terrain. The secondary peak at higher elevations could correspond to upland sites. Compared to the study area's elevation distribution, these peaks are statistically significant ($p < 2.2e-16$), as indicated by the Kolmogorov-Smirnov and Wilcoxon tests, confirming that Garry Oaks are not randomly distributed but favor specific elevation ranges. The study area's elevation distribution lacks these distinct peaks, reinforcing that Garry Oaks could occur in specific terrain conditions rather than being evenly spread across the landscape.

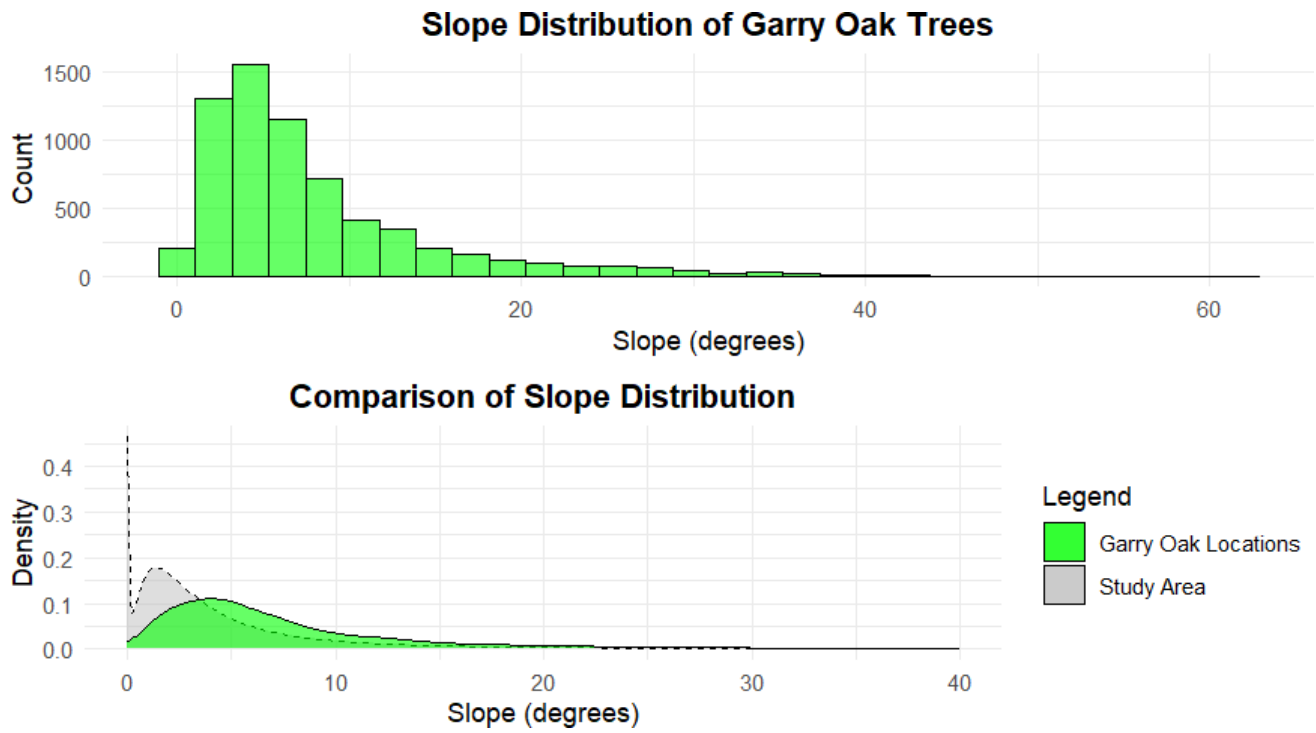

Figure 7: Distribution of Garry Oak Tree Slope Values

In Figure 5, the slope distribution of Garry Oak locations shows a right-skewed pattern, with the majority of trees found on gentle slopes and only a small proportion occurring on steeper terrain. The primary peak is concentrated between 2° and 8°, suggesting that Garry Oaks prefer relatively low-slope environments. However, some trees are found on slopes exceeding 30°, indicating that they can persist in steeper terrain under certain conditions. The comparison between Garry Oak slope distribution and the overall study area slope distribution highlights key differences. The study area (gray) has a higher density of flat terrain (0° - 2°), whereas Garry Oaks (green) are less represented in these extremely flat areas and instead show a shift toward slightly steeper terrain. This trend is statistically significant ($p < 2.2e-16$) based on the Kolmogorov-Smirnov and Wilcoxon tests, confirming that the slope distribution of Garry Oak locations differs significantly from the broader landscape.

Correlation Test of Habitat Characteristics

The Kolmogorov-Smirnov (KS) test and Wilcoxon rank sum test were used to compare the elevation and slope distributions of Garry Oak locations to the overall study area. The KS test measures the maximum distance (D) between two cumulative distributions, with values of D = 0.26929 (elevation) and D = 0.31416 (slope) indicating significant differences between Garry Oak sites and the general landscape. The Wilcoxon test, which evaluates whether two samples have the same median, returned extremely large W values (3.51e+11 for elevation and 3.97e+11 for slope), further confirming that Garry Oaks occur in statistically distinct terrain conditions. The p-values for both tests were < 2.2e-16, meaning the differences are highly significant and we can confidently reject the null hypothesis that Garry Oak trees are randomly distributed across the study area.

Table 2: Correlation Test Results Statistics

Statistic	Elevation	Slope
KS Test D	0.26929	0.31416
KS Test p-value	< 2.2e-16	< 2.2e-16
Wilcoxon W	3.5138e+11	3.9745e+11
Wilcoxon p-value	< 2.2e-16	< 2.2e-16

Statistical Analysis of Anthropogenic Characteristics

Table 3: Summary Statistics of Parcel Size Analysis

Statistic	Garry Oak Parcel Size $m2$	Study Area Parcel Size $m2$
Min	8.3	0
Max	740849.0	740849.0
Mean	263881.5	1025.9
Median	46763.4	557.4
SD	342205.7	7228.0

The distribution of parcel sizes at Garry Oak locations differs significantly from the overall parcel size distribution within the study area. The median parcel size for Garry Oak locations is 46,763.4 m^2, which is substantially larger than the 557.4 m^2 median parcel size for the full study area. This suggests that Garry Oaks are more frequently found on larger parcels, likely within parks, institutional lands, or undeveloped areas, rather than smaller residential lots.

The mean parcel size for Garry Oak locations (263,881.5 m²) is also much higher than the study area's mean of 1,025.9 m², further reinforcing this trend. However, the high standard deviation (SD = 342,205.7 m²) for Garry Oak locations suggests a wide range of parcel sizes, including some very large parcels where Garry Oaks exist. The maximum recorded parcel size (740,849.0 m²) is the same for both Garry Oak locations and the full study area, indicating the presence of Garry Oaks in Beacon Hill Park. The histogram and density plots (Figure 6) show that the study area has many smaller parcels, while Garry Oaks tend to be associated with larger land units. This aligns with ecological expectations, as Garry Oaks often thrive in parklands, remnant woodlands, and less fragmented landscapes. The presence of some Garry Oaks on smaller parcels suggests that they persist in urban residential areas, but they may face constraints due to limited space and potential development pressures.

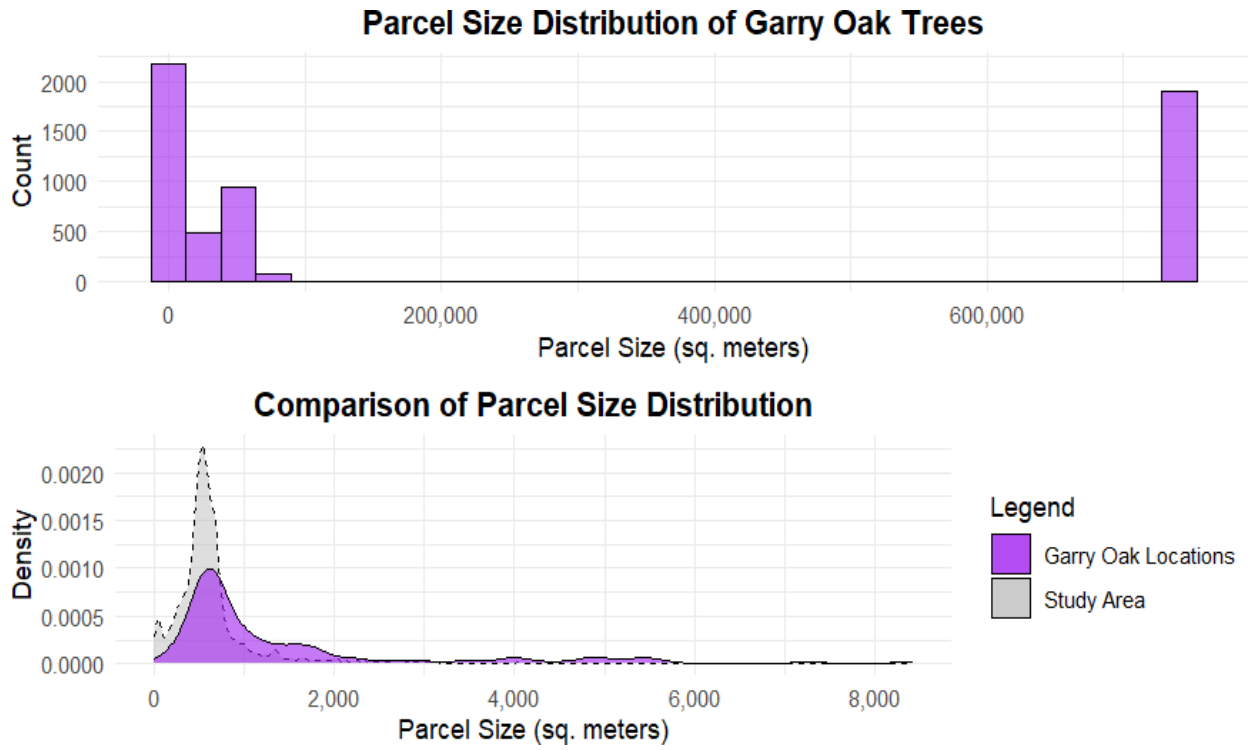

Figure 8: Distribution of Parcel Size at Garry Oak Locations. Top graph the extreme outlier is Beacon Hill Park. Beacon Hill Park was removed from the bottom graph to better visualize the distributions.

Discussion

The results of this analysis indicate that Garry Oaks in Victoria are found on terrain that is significantly different from the broader landscape. The trees tend to occur at moderate elevations (mean: 33 m), with clear peaks at 18–23 m and around 50 m, suggesting a preference for lower- elevation sites and the concentrated areas of Beacon Hill Park and Summit Park. The mean slope at Garry Oak locations (7.9°) is slightly steeper than the study area average (5.0°), indicating that these trees are often found on gentle inclines rather than completely flat terrain. These differences were confirmed through statistical testing, where both the KS and Wilcoxon rank-sum tests returned highly significant p-values (< 2.2e-16), strongly suggesting that Garry Oaks are not randomly distributed across the landscape. In addition to environmental characteristics, parcel size analysis provides insight into the land use context of Garry Oak habitats. The median parcel size at Garry Oak locations (46,763.4 m^2) is much larger than the median parcel size across the study area (557.4 m^2), indicating that Garry Oaks are more commonly found in parks, large institutional lands, or undeveloped areas. However, the presence of Garry Oaks on smaller parcels highlights their ability to persist within urban environments, raising questions about their long-term viability in fragmented landscapes. Future analysis could incorporate additional urban characteristics, such as road proximity, canopy cover, and zoning regulations, to better understand how development pressures influence Garry Oak persistence. While these findings provide valuable insights, they represent only a preliminary assessment of Garry Oak habitat conditions. A key consideration for future research will be the potential biases in data collection. Since the dataset was compiled through community mapping efforts, participation levels may have varied across neighborhoods, leading to underrepresentation or overrepresentation of Garry Oak trees in certain areas. Additionally, double counting of trees may have occurred, particularly in locations where multiple participants mapped the same trees. Future analysis will include a systematic review to identify and remove duplicate points and explore spatial patterns in community reporting to assess whether certain areas have disproportionately influenced the dataset. A more comprehensive habitat suitability model could be developed by incorporating additional environmental (e.g., soil type, moisture availability), anthropogenic (e.g., land use, development intensity), and Indigenous knowledge factors. Such a model could support data-driven conservation planning by identifying high-priority areas for restoration, land acquisition, and long-term protection of Garry Oak ecosystems within Victoria. By refining the dataset, addressing potential biases, and integrating a broader range of ecological and socio-cultural variables, future analyses can provide a more accurate and robust framework for guiding conservation efforts.

References

Barchyn, M**.** (1998). *Mapping an urban woodland: Some guidelines and the woodlands map project at Government House property, Victoria, BC* (Draft, April 27, 1998). [Unpublished manuscript]. University of Victoria.

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