Elevation and Latitude as Predictors for Alpine Plant Life History Traits

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INTRODUCTION

High elevation alpine zones in mountainous regions create harsh climates through extreme temperatures, short growing seasons, and unshielded wind exposure, formulating an environment unsuitable for most plant species. The alpine zone therefore acts as a filter, where only a limited number species occur above the treeline. While many of these species simultaneously occur at lower elevations (alpine generalists), some exclusively live in alpine zones (alpine specialists). Thus, the alpine peaks can be considered biological islands. We investigate the community composition of the peaks' species pools, with regard to species life history traits.

METHODS

We recorded all species in the alpine zones of 23 peaks in the Washington Cascades (Figure 1), and scored them as either alpine generalists or alpine specialists. We then categorized the growth form for each species using the methods outlined in Harguindeguy et al. 2016 (Table 1), and referencing online and local floras, digitized collection databases and Google images. We used simple linear regression models to determine if the species growth habit or ecological specialty is correlated with, or predicted by, peak elevation or latitude.

DISCUSSION

We found no significant relationship between peak latitude or elevation and growth habit. We conclude that no single alpine growth form provides an advantage for survival in our study area. Observed growth form distributions (Figure 4) may be due to phylogenetic relatedness of taxa observed. Higher counts of alpine specialists at higher elevations may be due to long-standing evolutionary selection for advantageous traits, which fit outside of our tested parameters. More specialists found at higher latitudes may be due to generalists in warmer southern Washington climates being less adapted to alpine conditions. This study provides baseline data for alpine communities. As the climate continues to warm, reduced snowpack and higher alpine temperatures may increase dwarf tree abundance and decrease specialist abundance, relative to generalist abundance in the alpine zones.
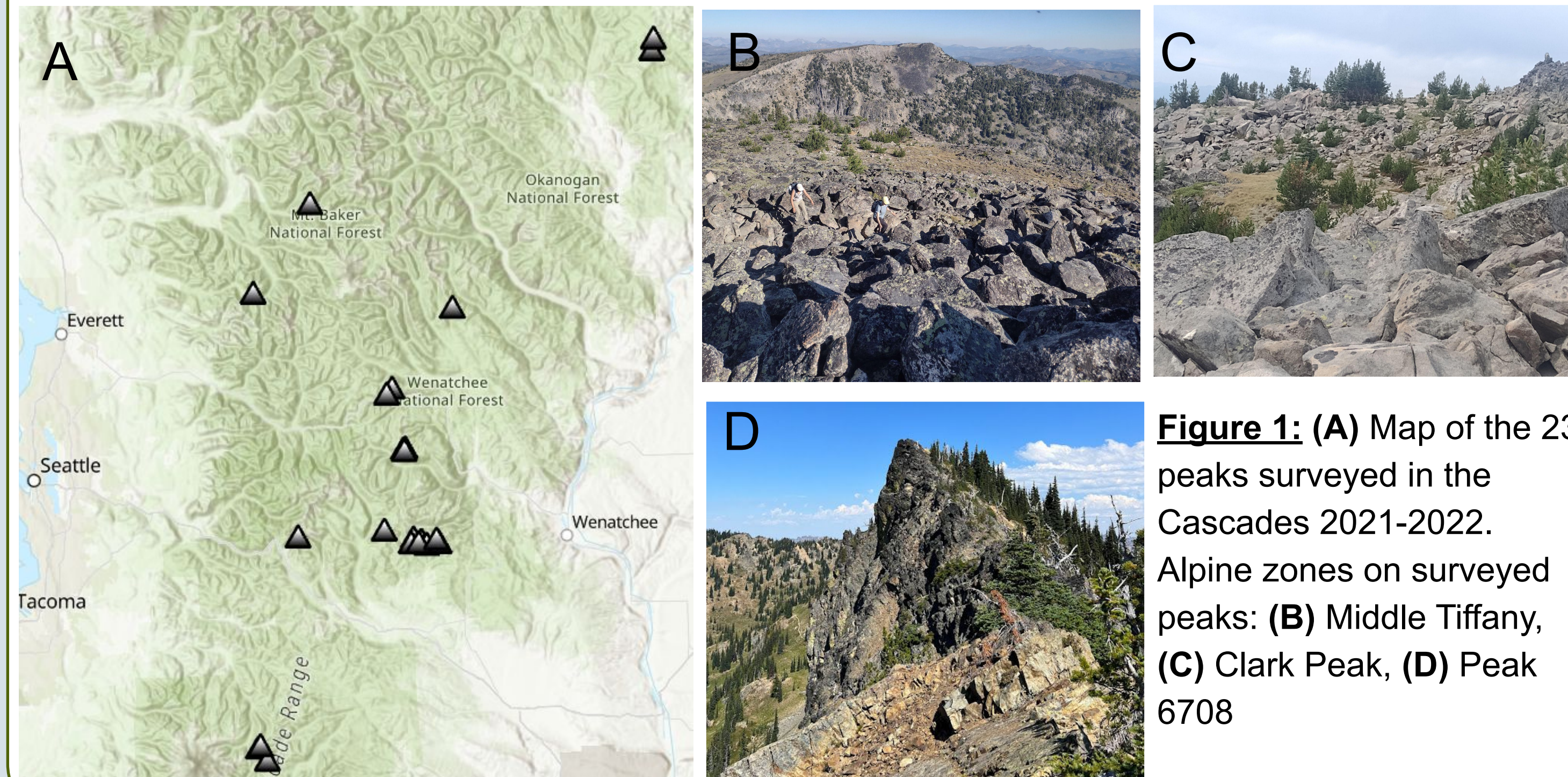
SAMPLING LOCATIONS

Figure 1: (A) Map of the 23 peaks surveyed in the Cascades 2021-2022. Alpine zones on surveyed peaks: **(B)** Middle Tiffany, **(C)** Clark Peak, **(D)** Peak 6708

COMMUNITY COMPOSITION DATA

Average Alpine Plant Growth Form Across All Peaks

Woody 14.4%
Semi-woody 6.9%
Herbaceous 78.7%

Ecological Specialty Distribution of All Species Recorded

Specialist 11.1% (30)
Generalist 88.9% (241)

Average Alpine Plant Growth Habit Distribution

Dwarf tree 5.3%
Prostrate s. 10.0%
Subshrub 2.5%
Rosette 21.9%
Leaf-bearin. 4.3%
Cushion 16.7%
Extensive-s. 39.4%

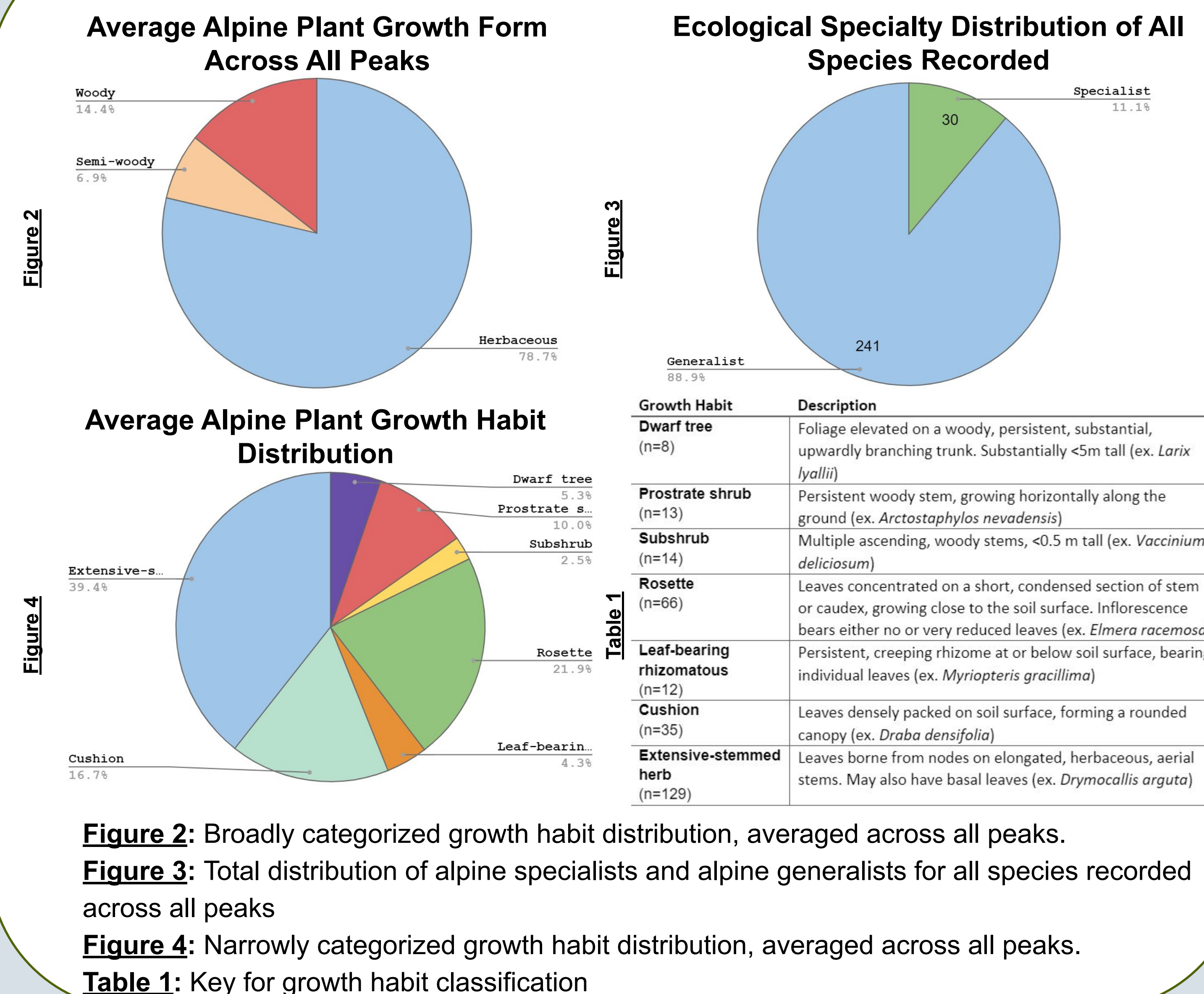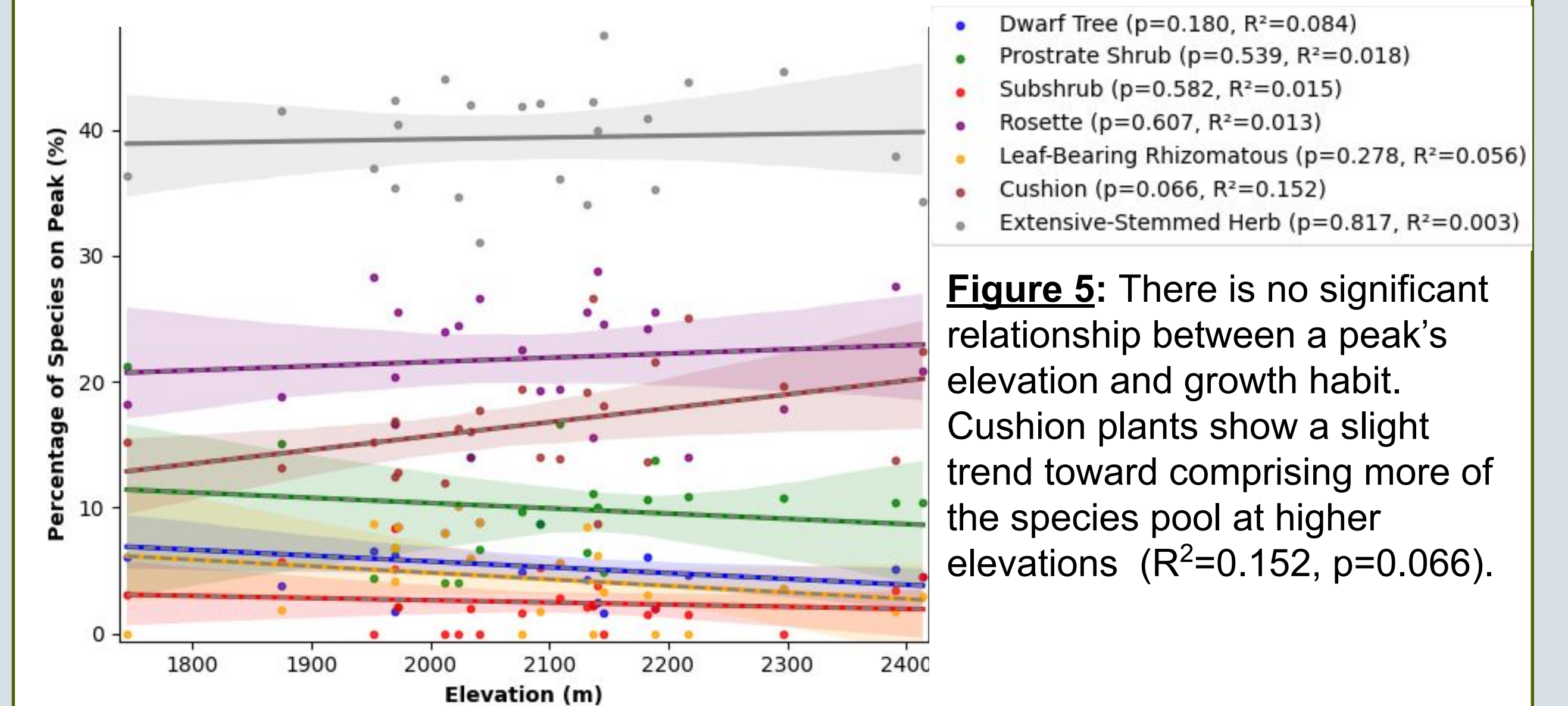| Growth Habit	Description
Dwarf tree (n=8)	Foliage elevated on a woody, persistent, substantial, upwardly branching trunk. Substantially <5m tall (ex. *Larix lyallii*)
Prostrate shrub (n=13)	Persistent woody stem, growing horizontally along the ground (ex. *Arctostaphylos nevadensis*)
Subshrub (n=14)	Multiple ascending, woody stems, <0.5 m tall (ex. *Vaccinium deliciosum*)
Rosette (n=66)	Leaves concentrated on a short, condensed section of stem or caudex, growing close to the soil surface. Inflorescence bears either no or very reduced leaves (ex. *Elmera racemosa*)
Leaf-bearing rhizomatous (n=12)	Persistent, creeping rhizome at or below soil surface, bearing individual leaves (ex. *Myriopteris gracillima*)
Cushion (n=35)	Leaves densely packed on soil surface, forming a rounded canopy (ex. *Draba densifolia*)
Extensive-stemmed herb (n=129)	Leaves borne from nodes on elongated, herbaceous, aerial stems. May also have basal leaves (ex. *Drymocallis arguta*)

Figure 2: Broadly categorized growth habit distribution, averaged across all peaks.
Figure 3: Total distribution of alpine specialists and alpine generalists for all species recorded across all peaks
Figure 4: Narrowly categorized growth habit distribution, averaged across all peaks.
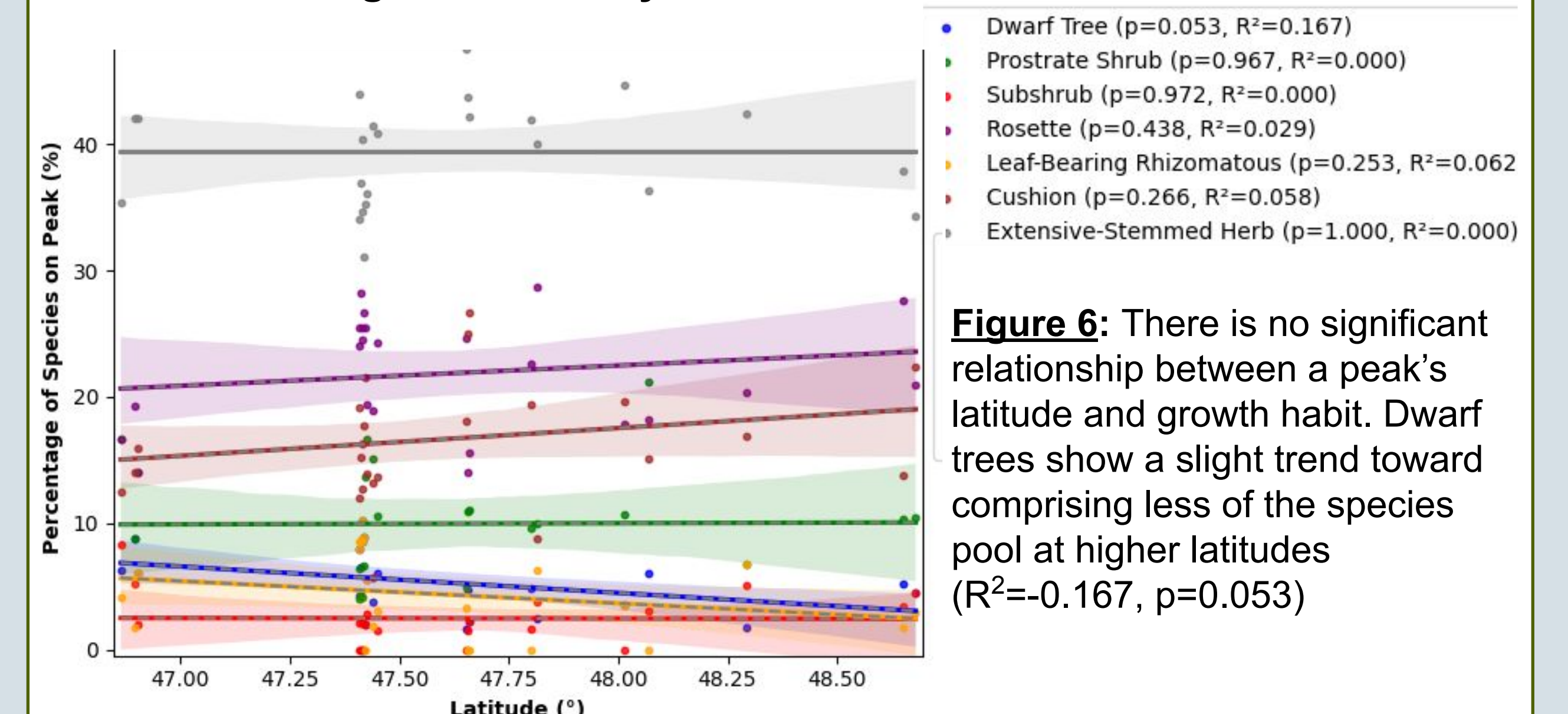**Table 1:** Key for growth habit classification

REFERENCES

Flora of North America. FNA. (2022); Flora of the Pacific Northwest, 2nd edition (2018); iDigBio Specimen Portal (2023); Pérez-Harguindeguy et al. (2016). Corrigendum to: New Handbook for Standardised Measurement of plant functional traits worldwide. Australian Journal of Botany, 64(8), 173–174; SEINet Data Portal (2023); Jepson eFlora (2023).
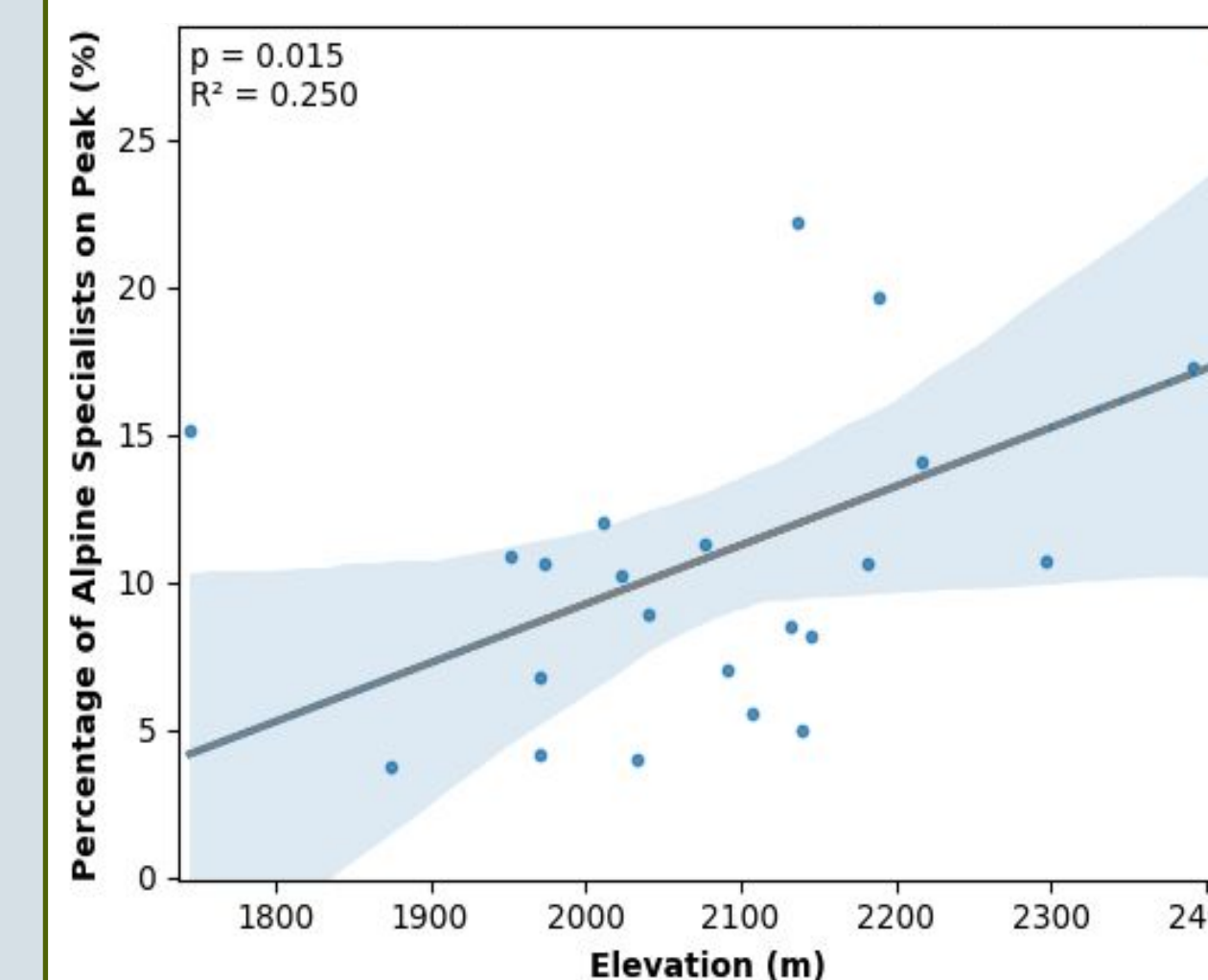
RESULTS

Linear Regression Analysis between Growth Habit and Elevation

Dwarf Tree (p=0.180, R^2=0.084)
Prostrate Shrub (p=0.539, R^2=0.018)
Subshrub (p=0.582, R^2=0.015)
Rosette (p=0.607, R^2=0.013)
Leaf-Bearing Rhizomatous (p=0.278, R^2=0.056)
Cushion (p=0.066, R^2=0.152)
Extensive-Stemmed Herb (p=0.817, R^2=0.003)

Figure 5: There is no significant relationship between a peak's elevation and growth habit. Cushion plants show a slight trend toward comprising more of the species pool at higher elevations (R^2=0.152, p=0.066).

Linear Regression Analysis between Growth Habit and Latitude

Dwarf Tree (p=0.053, R^2=0.167)
Prostrate Shrub (p=0.967, R^2=0.000)
Subshrub (p=0.972, R^2=0.000)
Rosette (p=0.438, R^2=0.029)
Leaf-Bearing Rhizomatous (p=0.253, R^2=0.062)
Cushion (p=0.266, R^2=0.058)
Extensive-Stemmed Herb (p=1.000, R^2=0.000)

Figure 6: There is no significant relationship between a peak's latitude and growth habit. Dwarf trees show a slight trend toward comprising less of the species pool at higher latitudes (R^2=-0.167, p=0.053)

Linear Regression Analysis between Ecological Specialty and Elevation

p = 0.015
R^2 = 0.250

Linear Regression Analysis between Ecological Specialty and Latitude

p = 0.004
R^2 = 0.339

Figure 7: The percentage of alpine specialists is positively correlated with a peak's elevation (R^2=0.250, p=0.015). There are more alpine specialists at higher elevations, relative to alpine generalists.

Figure 8: The percentage of alpine specialists is positively correlated with a peak's latitude (R^2=0.339, p=0.004). There are more alpine specialists at peaks located further north in Washington, relative to alpine generalists.