Global Warming: Changing Growth in the Desert?

Erin Fragoso and David Charlet
College of Southern Nevada
Department of Biological Sciences

Overview:

I wanted to determine if local climate warming influences the creosote bush's (*Larrea tridentata*) increased height at higher elevations. I reviewed, calculated, and graphed the pre-existing data collected by Dr. Charlet and his team, on the vegetation in the Mojave Desert. I performed a correlation analysis on all variables in the data and looked for relationships between these variables and *Larrea* height, finding that elevation had the strongest relationship. I then performed linear regressions to quantify this influence. The results were consistent with the hypothesis that the zone of optimal climate for *Larrea* is rising upslope with elevation. I wish to continue to study the changes that global warming has on local patterns of vegetation and if other species exhibit similar changes in their growth patterns.

Introduction

Larrea tridentata (LATR) is probably the most abundant and widespread of all woody species in North American deserts (Benson and Darrow 1981). LATR is emblematic of the Mojave Desert and clones can persist at sites for more than 11,000 years (Vasek 1980). While Charlet and his team surveyed Nevada's Mojave Desert from 2007-2014, they observed that LATR appeared to be taller at the upper end of its distribution than elsewhere. This is unusual, because plants are usually more abundant and robust near the middle of their elevation ranges. Due to environmental stresses, the upper and lower ends tend to be reduced in both abundance and height as a species nears the limits of its environmental tolerance.

A possible explanation for LATR having this growth pattern is that as local climate warms, the optimum conditions for the species shift upward in elevation, leading to those individuals at the upper end of their distribution to have enhanced growth and greater height relative to those lower in elevation.

Methods

We took a pre-existing data set (Charlet et al. 2014) with 2797 vegetation plots and removed all plots in which LATR height was not measured, either because it was not there, or it was not a dominant or codominant plant in the plot, leaving 669 plots. We performed a correlation analysis on these data that revealed that LATR height tended to increase with elevation.

We performed a series of linear regressions on the 669 plots, while culling the data further by removing plots that were associated with other variables that interacted with LATR height. Ultimately, we used plots only on mountain slopes and their associated fans. We further divided these into 14 individual mountain ranges, upon which we did more regressions.

Creosote Bush (*Larrea tridentata)* in 669 plots in Nevada's Mojave Desert

Figure 1. Location of sample locations ($n = 400$) in the mountains used in this study .

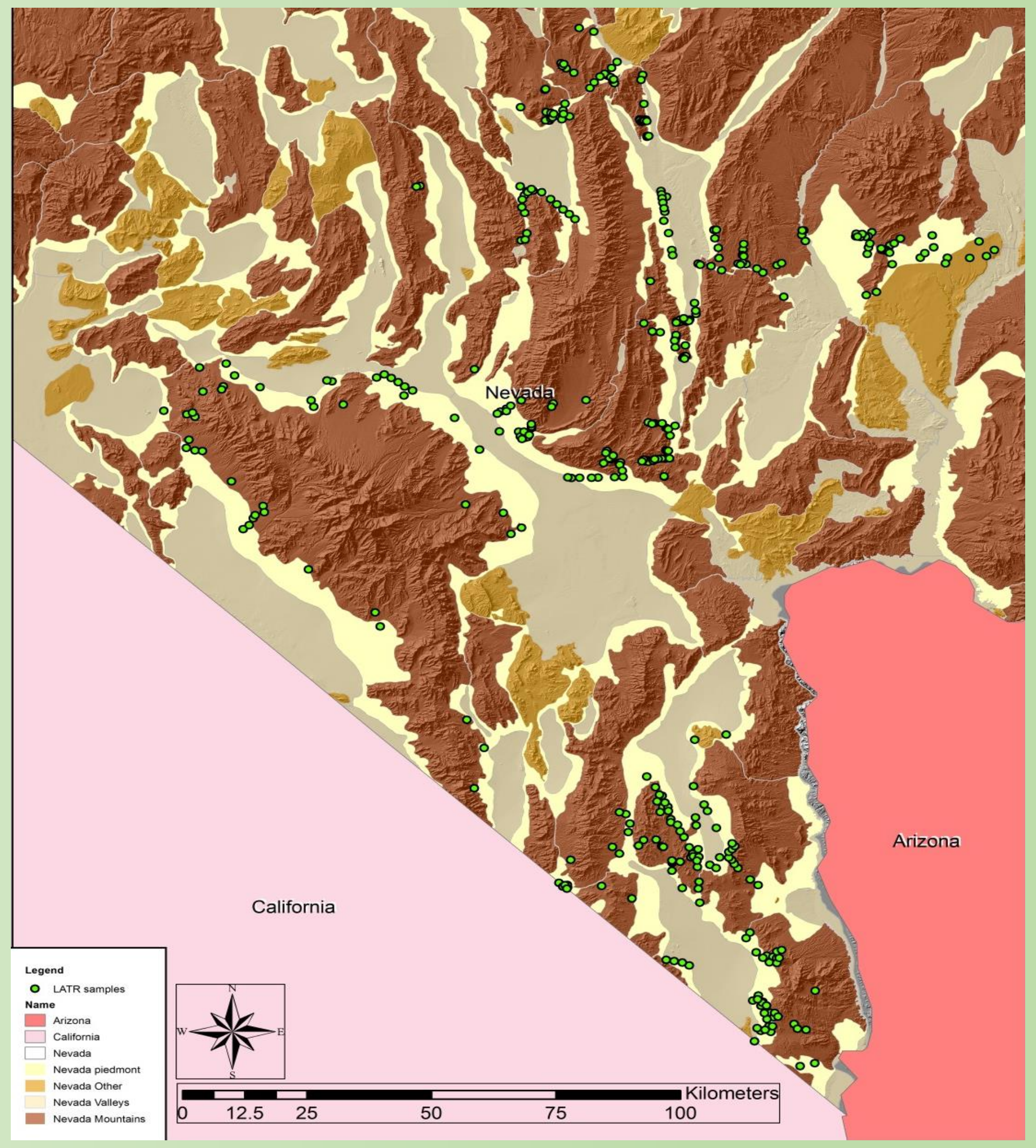

Table 1. Compiled results of linear regressions in mountain ranges. Significant results indicated with *.

Mountain Range	R^2	*p*	*n*
Coyote Spring Range	0.12	0.2	15
East Desert Range	0.49	0.005*	14
East Pahranagat Range	0.03	0.56	13
Elbow Range	0.03	0.4	27
Highland Range	0.23	0.003*	36
Las Vegas Range	0.10	0.03*	49
McCullough Range	0.78	0.0001*	12
Meadow Valley Range	0.39	0.002*	22
Mormon Mountains	0.11	0.1	26
Newberry Mountains	0.01	0.53	38
Opal Mountains	0.25	0.01*	23
Pahranagat Range	0.89	<0.0001*	14
Sheep Range	0.33	<0.0001*	44
Spring Mountains	0.34	<0.0001*	40
All Mountain Ranges (14)	0.09	<0.0001*	400

Figures 2-4. Linear regression of *Larrea tridentata* height by elevation. Fig. 1: all mountain ranges, Fig. 2: Spring Mountains. Fig. 3.: Sheep Range.

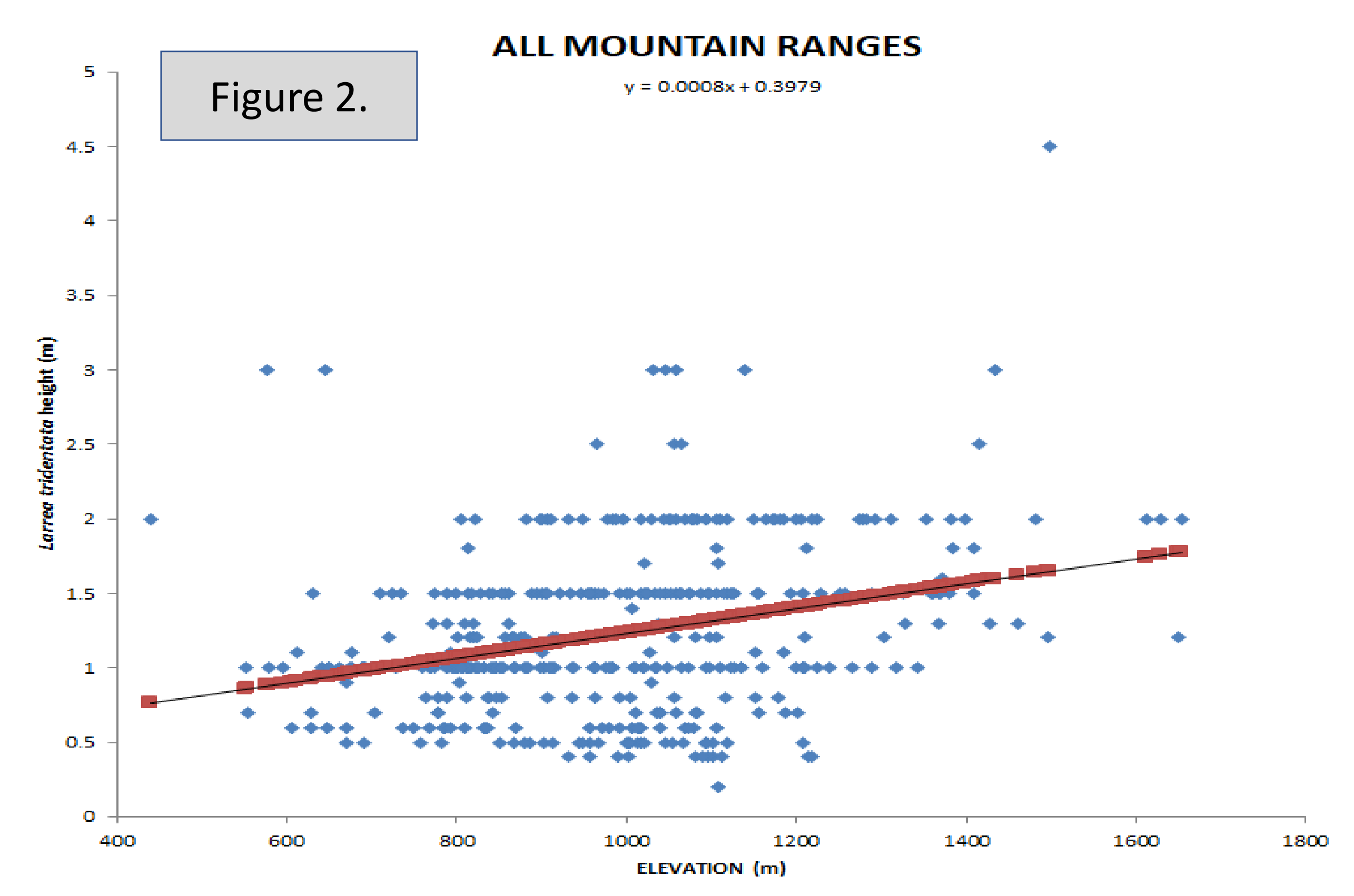
Figure 2.

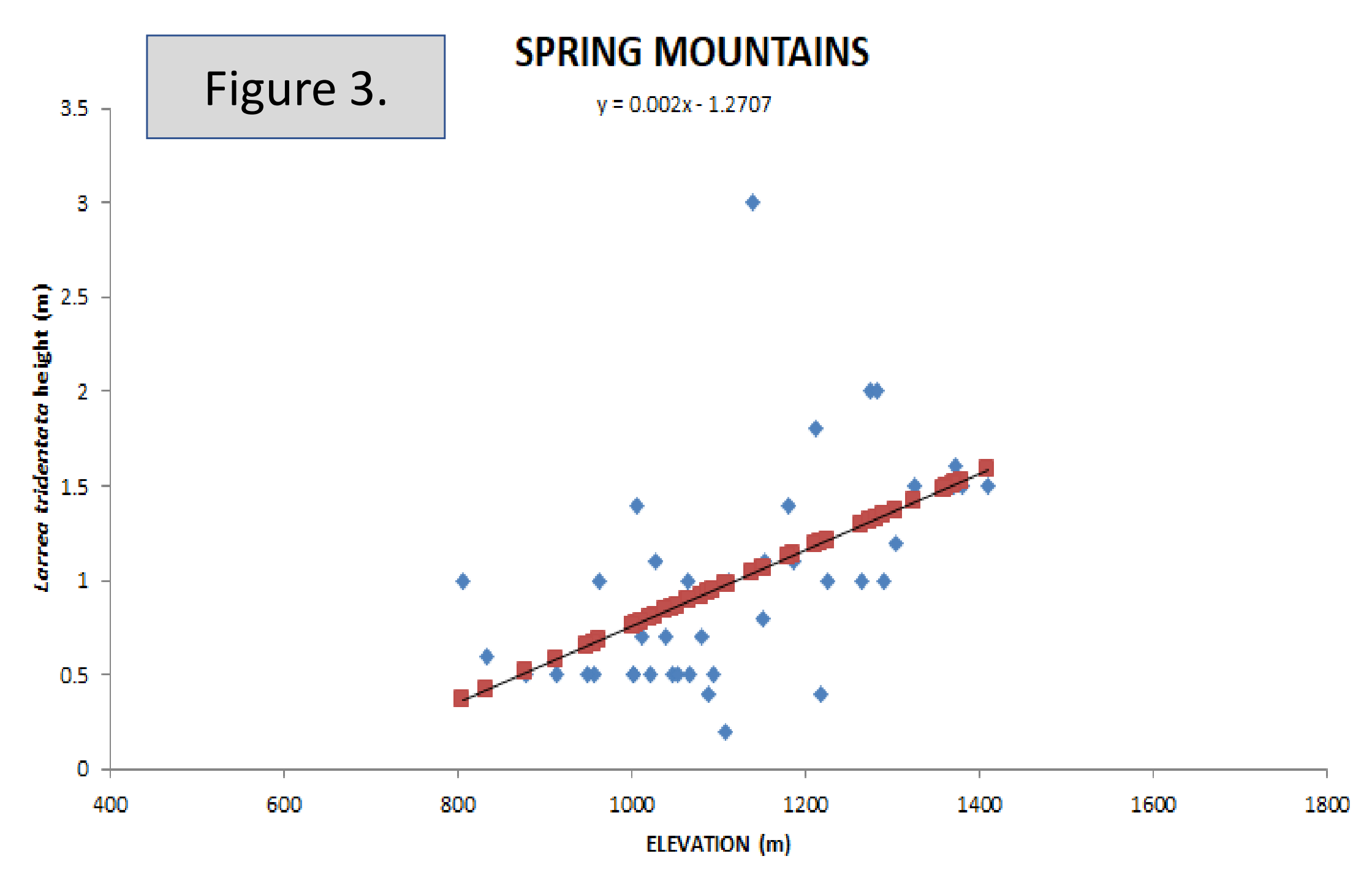
Figure 3.

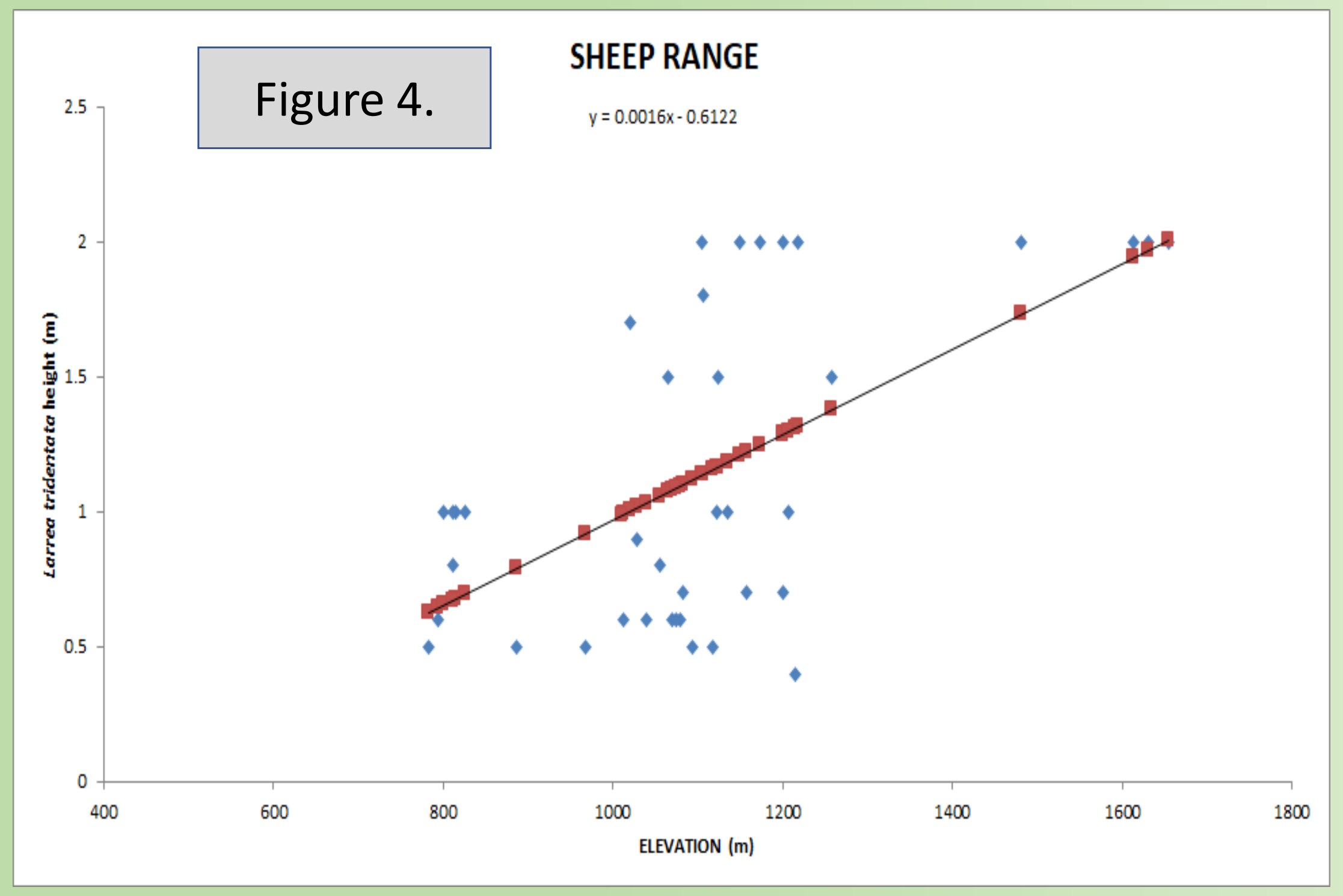
Figure 4.

Results

Regression of LATR height by elevation in the entire data set ($n = 669$) resulted in an R^2 value of 0.08. Several variables in the correlation analysis were weakly tied to LATR height. To remove this noise from the data, we removed all plots from dunes, washes, and valleys. Regression of LATR height by elevation on all of these ($n = 400$) yielded an R^2 value of 0.09, so not much improvement (Fig. 2).

Correlation analysis revealed that latitude was negatively tied to LATR height, and so we divided the data into 14 individual mountain ranges (e.g., Fig. 3-4) and regressed LATR height by elevation on these. Of the 14 regressions, 9 were highly significant ($p < 0.01$), and explained from 25 – 89% of the variation in LATR height ($R^2 = 0.25 – 0.89$)(Table 1).

Conclusion

The results are consistent with the prediction of the hypothesis that the zone of optimal climate for LATR is rising upslope. As global temperatures increase and warmer temperatures move upslope, LATR at higher elevations appears to respond with greater stature.

Other possible causes for this may include an increase in precipitation, rather than, or in concert with, warming temperatures at these elevations. This study can be improved by revisiting the sites and focusing on greater precision in the height measurements. For the original purpose of the data collection, such precision was not required, but this lack of precision in measuring LATR height resulted in additional noise in the data.

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