Elevational Distribution of Insecta Species Richness in Costa Rica

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What is species richness?

- A quantification of the species in a given area, usually measured as either *alpha, beta,* or *gamma* diversity

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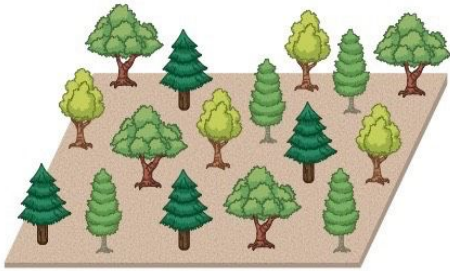
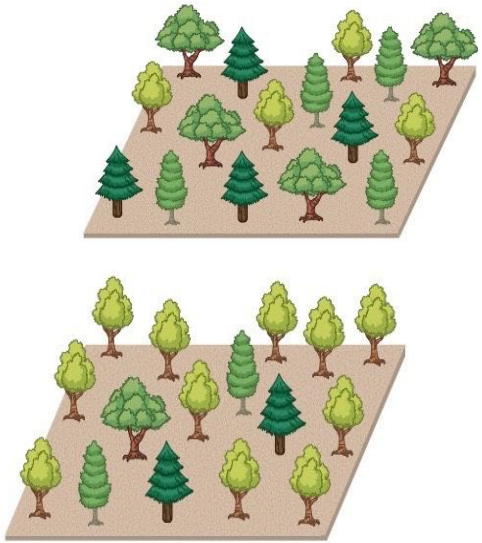
Alpha diversity

The richness of species within a community in an ecosystem



Beta diversity

The diversity of species between communities in an ecosystem

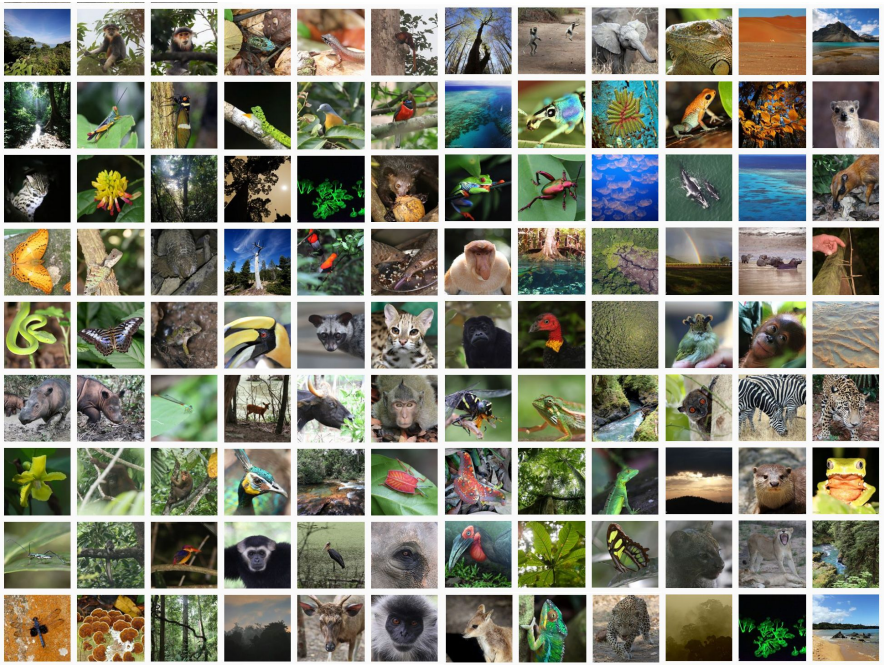


Gamma diversity

The diversity of species across geographic regions

Species richness is an ecosystem indicator

- Ecosystem health
- Ecosystem functioning
- Food web stability



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Species richness is affected by space and time

- Spatially
  - Latitudinally
  - Longitudinally
  - Altitudinally
- Temporally
  - Land development
  - Environmental conditions

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Species respond to climate change by adapting or moving

- Morphological/physiological/ behavioral responses
  - Radmacher and Strohm (2011)
- Range shifts
  - Musolin et al. (2007)

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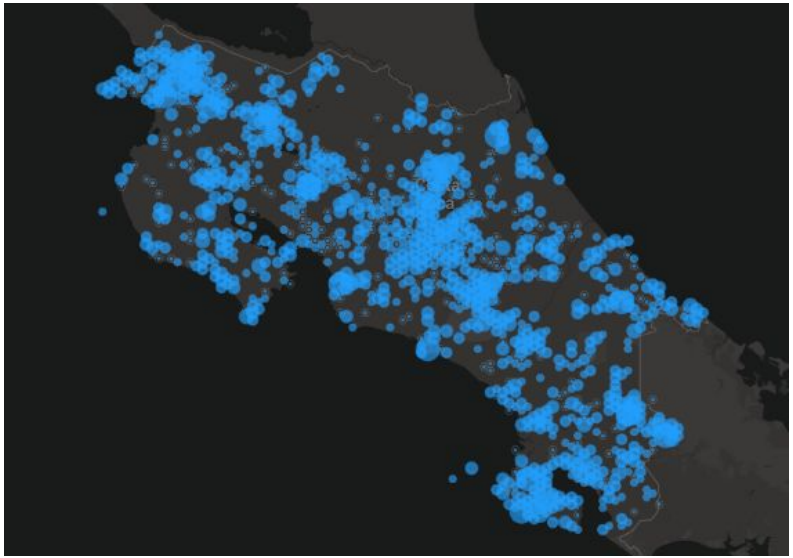
How do insects respond to changes in time and space?

How species richness changes with elevation

How maximum species richness changes by elevation and over year



Methods - Dataset used

- Occurrence data for insecta of Costa Rica
- Instituto Nacional de Biodiversidad (INBio)
- Retrieved from GBIF online repository

Methods - Data collected

Taxonomic Classification Order Family Genus Species
Spatial Factors Site of data collection (locality) Province Elevation Longitude Latitude
Temporal Factors Year

Table 1 – Variables included in the *Insecta* of Costa Rica dataset.

Methods - Analysis: Species richness by elevation and time

- Plotted species richness by elevation, year, and province
- Constructed linear models to see the relationship between species richness (response) and two predictor variables (year & elevation)
- Fitted linear models to plots to see how the model predicts changes in species richness

Methods- Analysis: Maximum species richness

- Plotted maximum species richness by year, elevation, and province
- Constructed linear models to see the relationship between maximum species richness (response) and two predictor variables (year & elevation)
- Fitted linear models to plots to see how the model predicts changes in maximum species richness

Most of the insect orders are shared across provinces

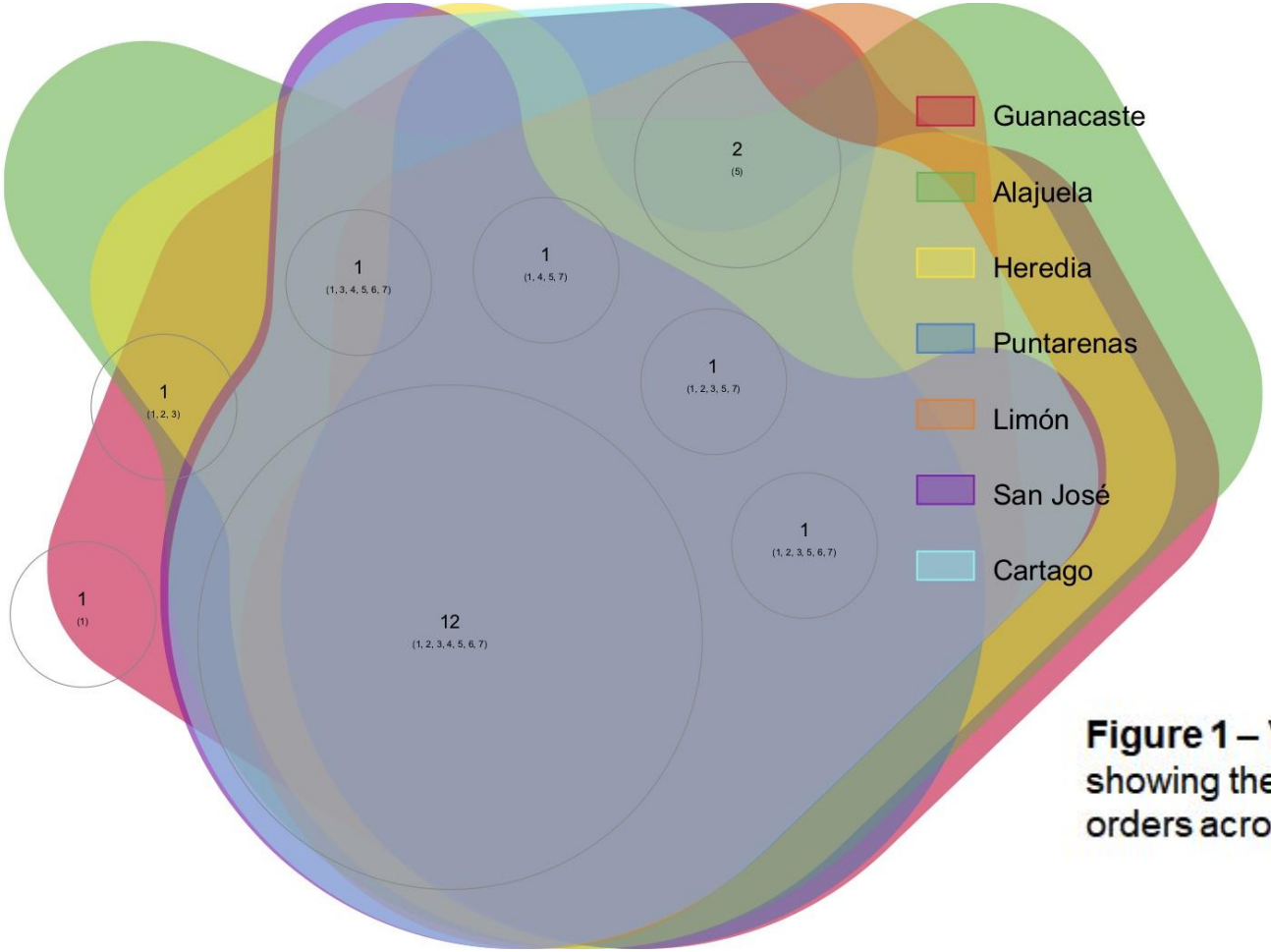


Figure 1 – Venn diagram showing the spread of insect orders across provinces.

Species richness varies across elevation and by province

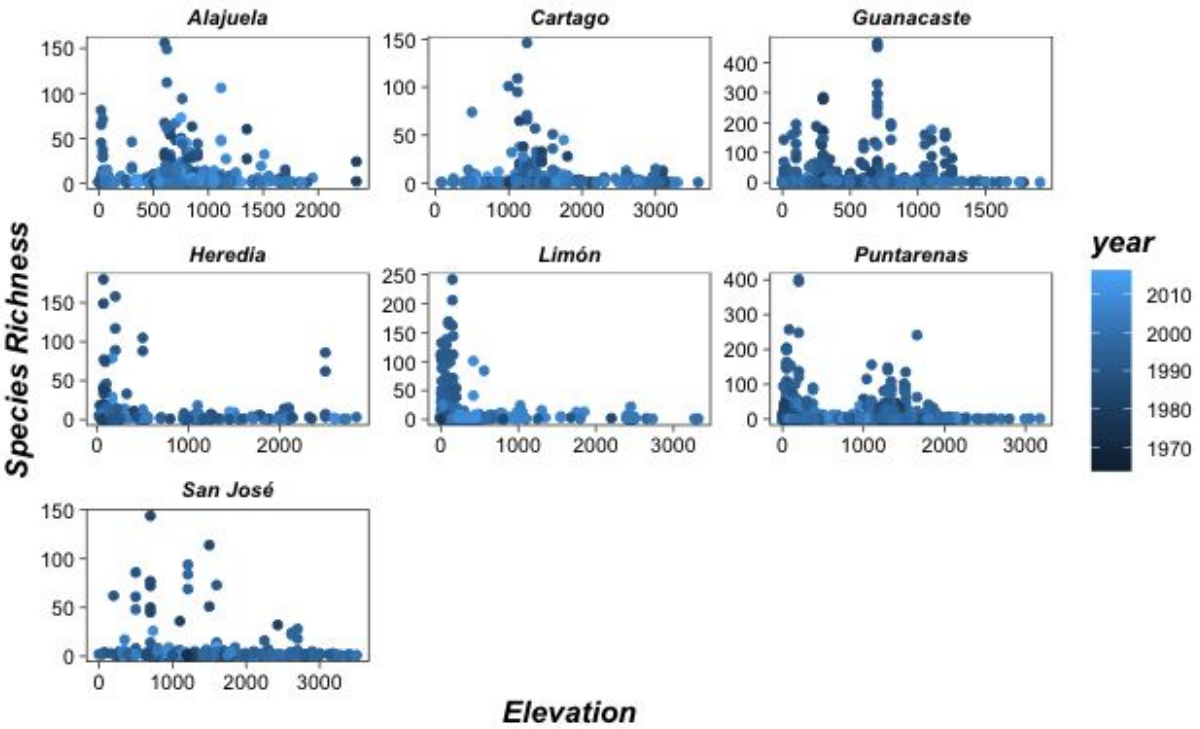


Figure 3 – Scatterplots of species richness by elevation and province.

Figure 4 – Map showing the altitudes of regions across Costa Rica.

Species richness decreases with elevation and with year

	species richness	
	(1)	(2)
elevation	-0.004***	-0.003***
	(0.001)	(0.001)
year	-0.874***	-0.650***
	(0.069)	(0.072)
Constant	1,759.946***	1,310.182***
	(137.520)	(142.994)
N	3,524	3,522
Log Likelihood	-17,113.910	-16,812.230
Akaike Inf. Crit.	34,237.820	33,636.460
Bayesian Inf. Crit.	34,268.650	33,673.460
Notes:	***Significant at the 0.1 percent level.	
	**Significant at the 1 percent level.	
	*Significant at the 5 percent level.	

Figure 5 – Mixed effects models for the effects of elevation and year on species richness.

Fixed effects model (year and elevation) indicates a decrease in species richness

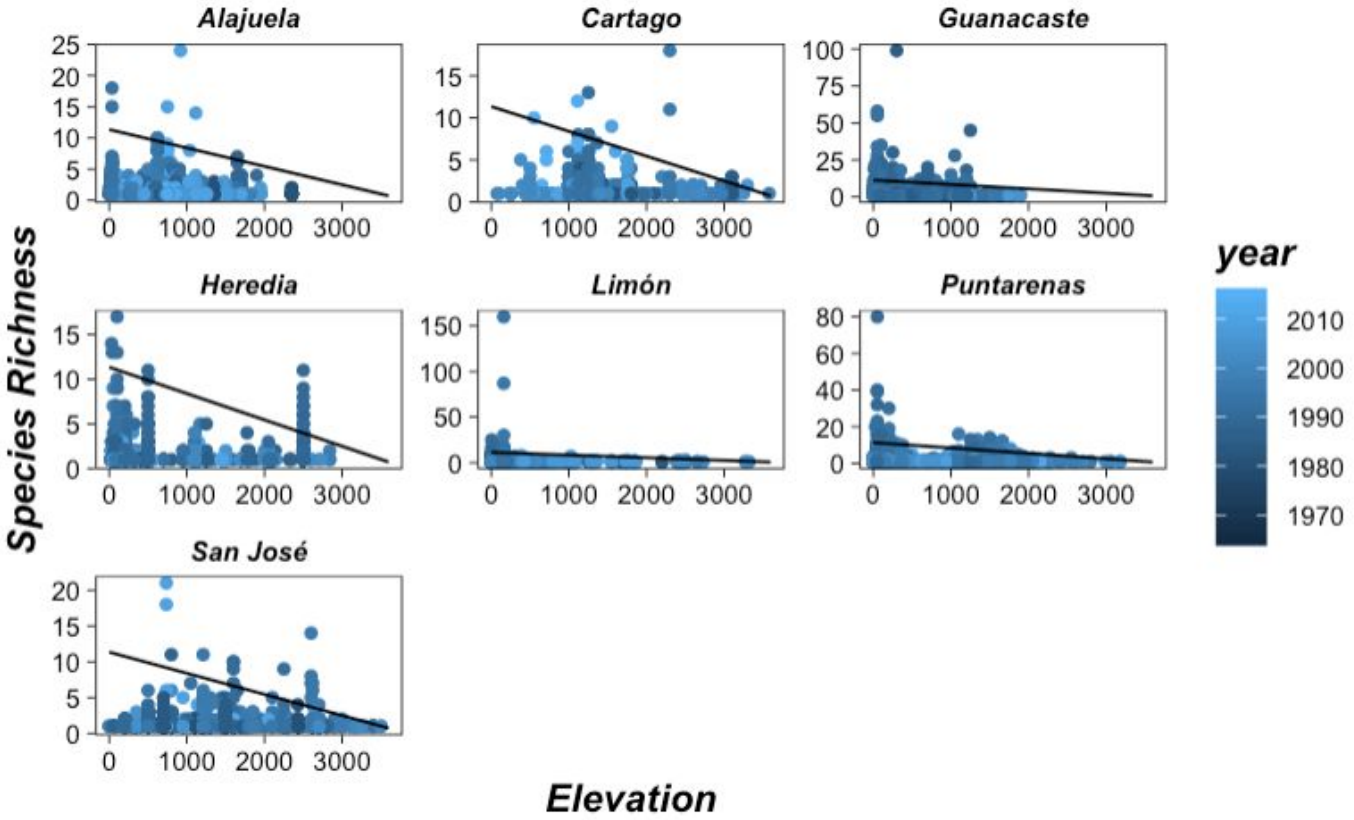


Figure 6 – Scatterplots of mixed effects model fitted to species richness data.

Maximum species richness varies over time

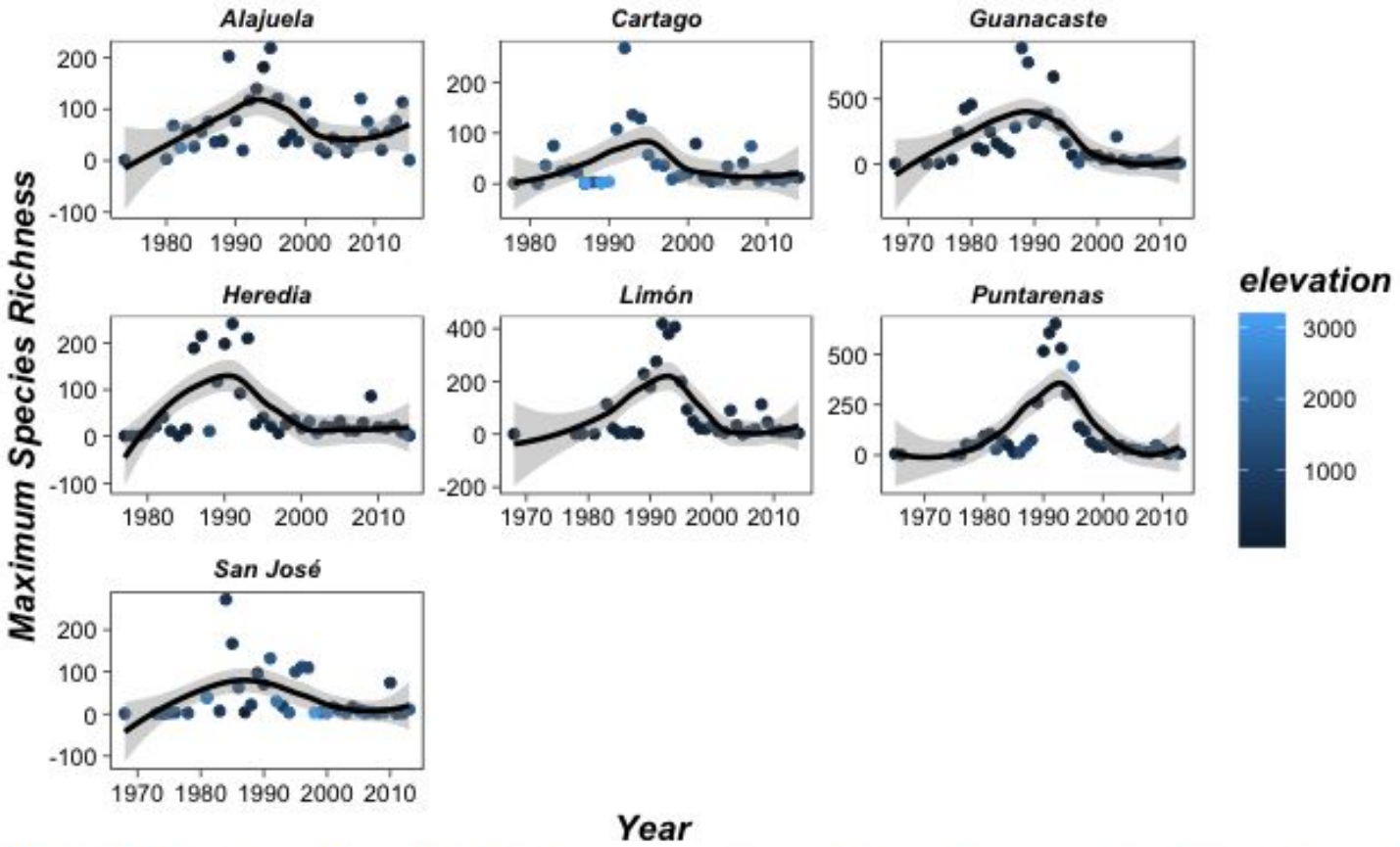


Figure 7 – Scatterplots of the change in maximum species richness over time and elevation.

Maximum species richness decreases significantly with year

	Dependent variable:
	maximum species richness
year	-1.575*
	(0.629)
elevation	-0.019
	(0.014)
Constant	3,232.023**
	(1,254.709)
Observations	286
Log Likelihood	-1,785.043
Akaike Inf. Crit.	3,580.086
Bayesian Inf. Crit.	3,598.366
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 8 – Mixed effects model of the effect of year and elevation on maximum species richness.

Fixed effects model (year/elevation) indicates a decrease in maximum species richness over time

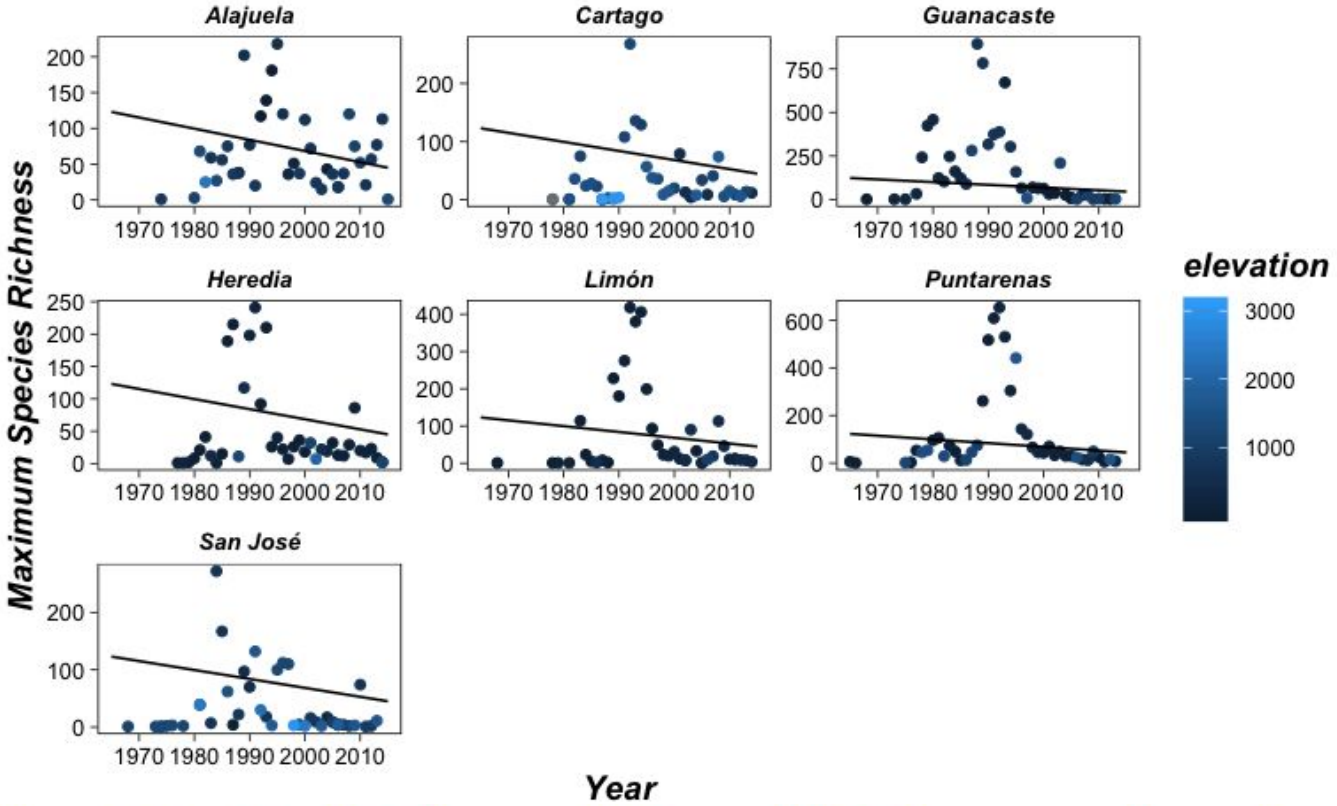


Figure 9 – Scatterplots of the mixed effects model fitted to species richness data.

Average elevation of maximum species richness varies over province

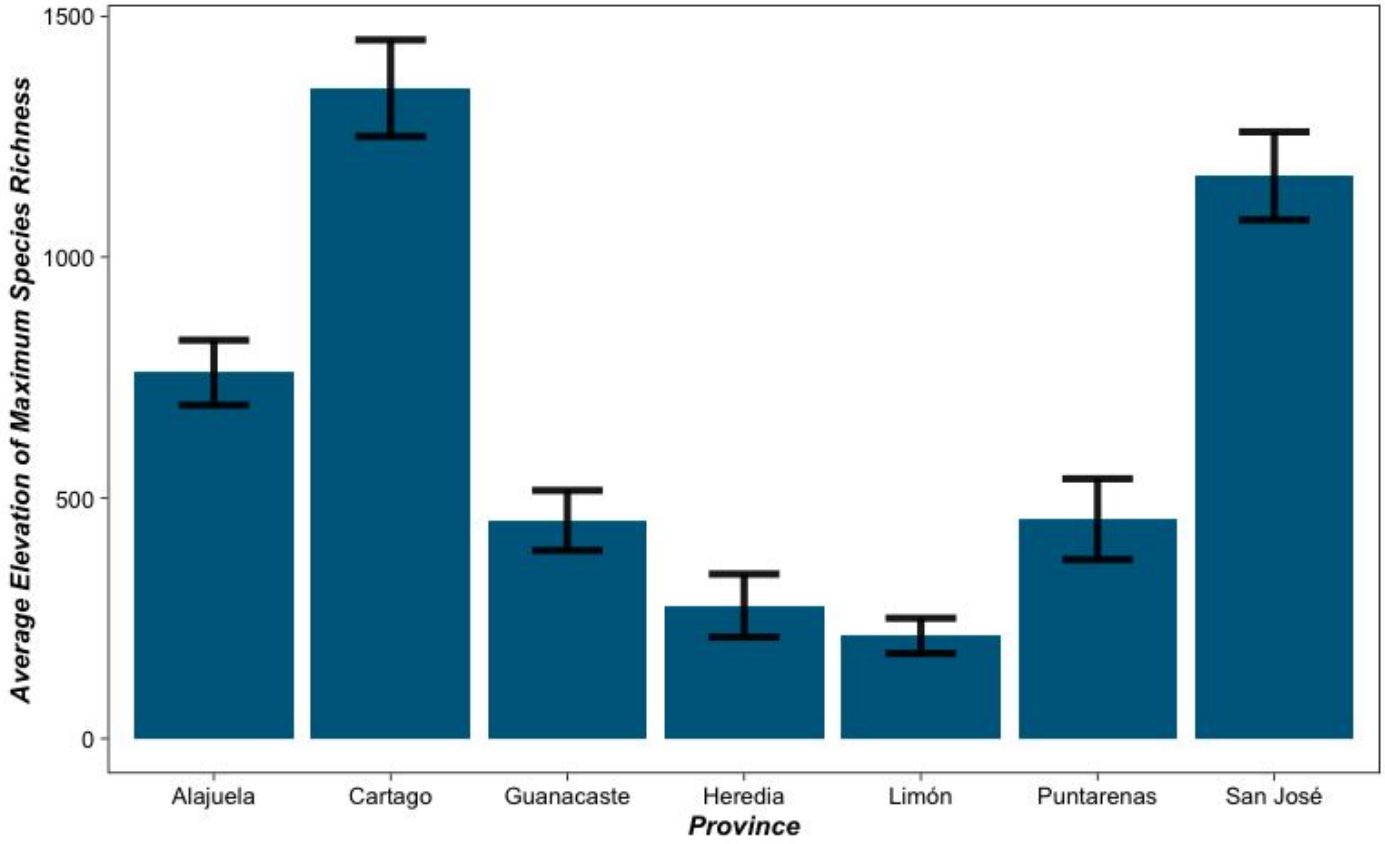


Figure 10 – Bar graph of the average elevation of maximum species richness by province.

Conclusions

- Species richness declines with elevation and year, indicating temporal and spatial factors affect diversity
- Maximum species richness declines by year but not by elevation

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Significance

The results of this study can be used to help protect species into the future

- Help model for the effects of future environmental changes
- Determine where species are moving and which areas are sensitive to change

Information can be used to aid in conservation efforts

Limitations of an open source dataset

- GBIF data are prone to misidentification of species
- Method of data collection is unclear, but points to observational data collected by a variety of sources
- 1976 Costa Rica NPAS (National Protected Area System)[1]
- Confounding factors: temperature, precipitation, variations in conservation efforts

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Questions?

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