

Complete tree species of Panama

Ranges for every species ≥ 3 m tall

A tally of narrow endemics

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Outline

Climatic and geological diversity in Panama

- Broken terrain

- Local variation

Checklist and occurrence data

- Specimens and plots

- The complete updated checklist

Range size and plot occurrence

- Narrow endemic to neotropic-wide

- Comparison with N. America

- Plot records and range size

- Tree height and range

- Dispersal and range

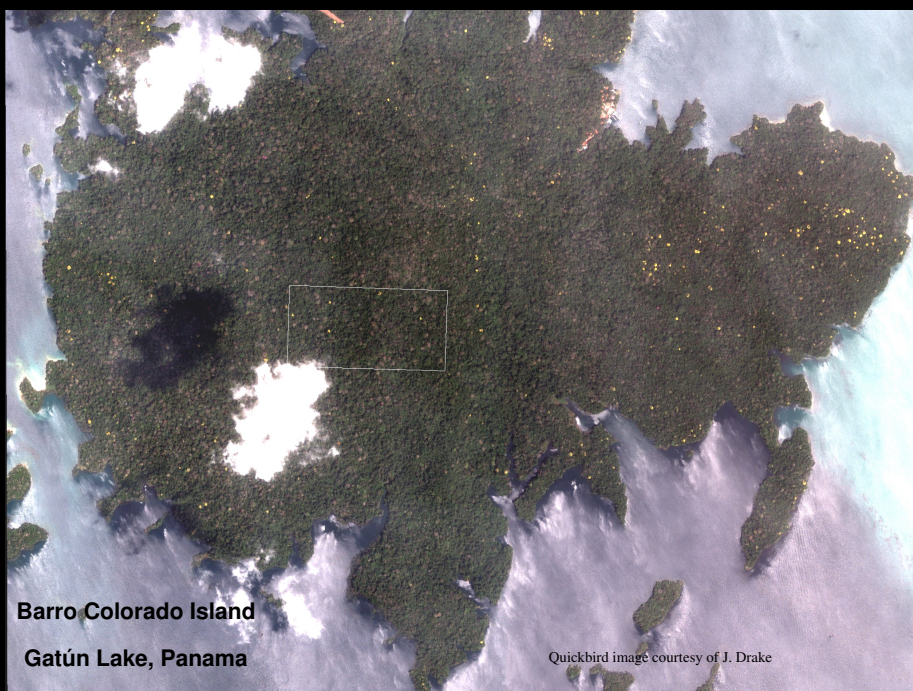
Modeling and mechanisms

- Rainfall and elevation as predictors

- Dynamic theory and range size







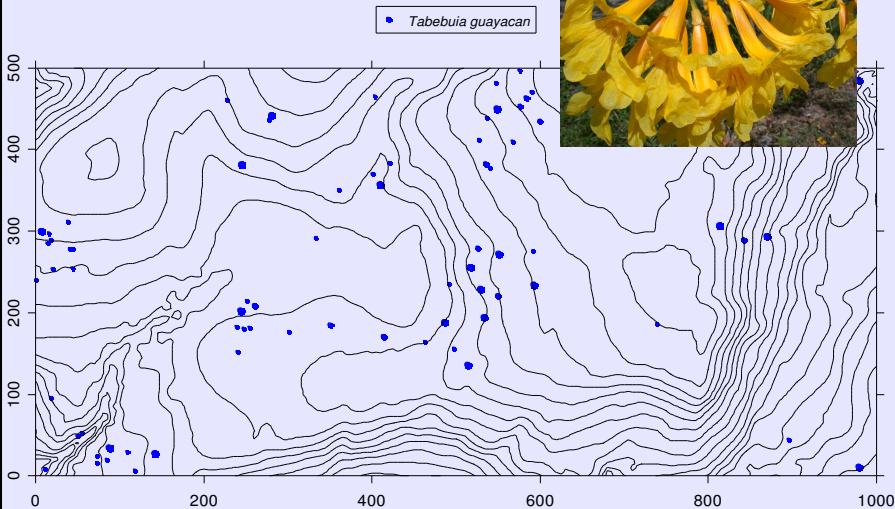
Barro Colorado Island

Gatún Lake, Panama

Quickbird image courtesy of J. Drake

Barro Colorado 50 ha plot (Panama)

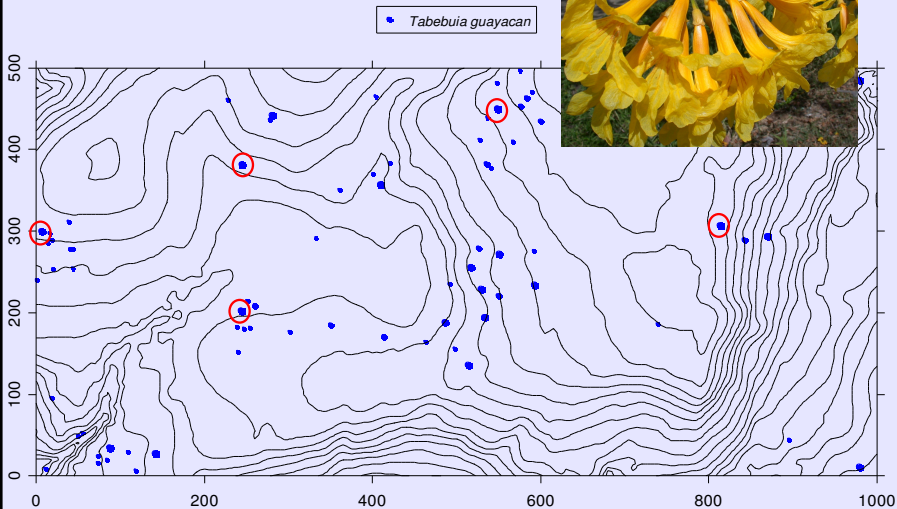
301 species, 213000 individuals in full census ≥ 1 cm dbh



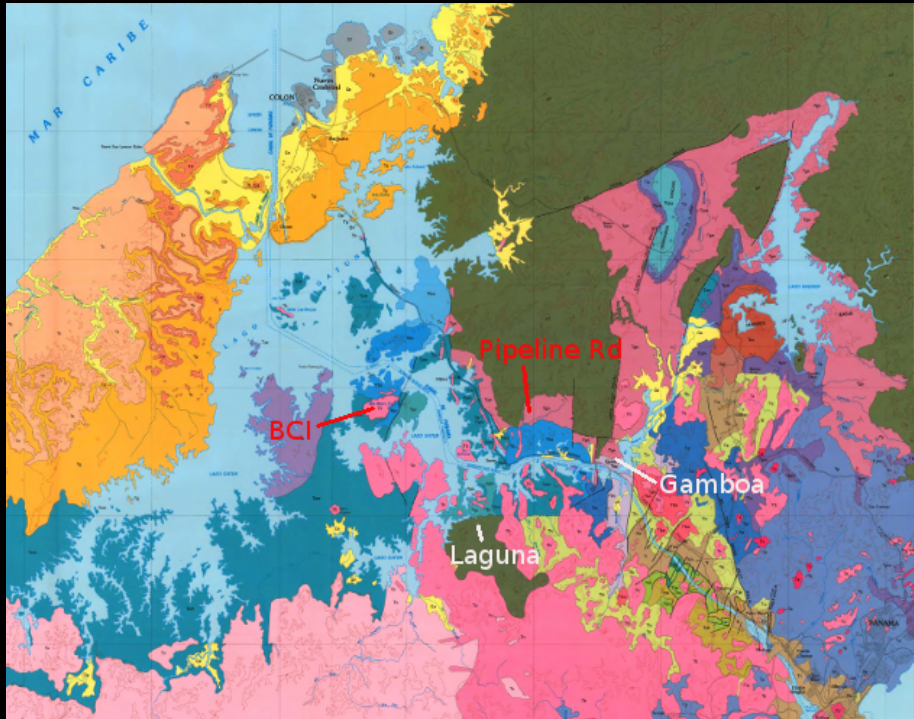
S. Hubbell, R. Foster, R. Condit, R. Perez, S. Lao

Barro Colorado 50 ha plot (Panama)

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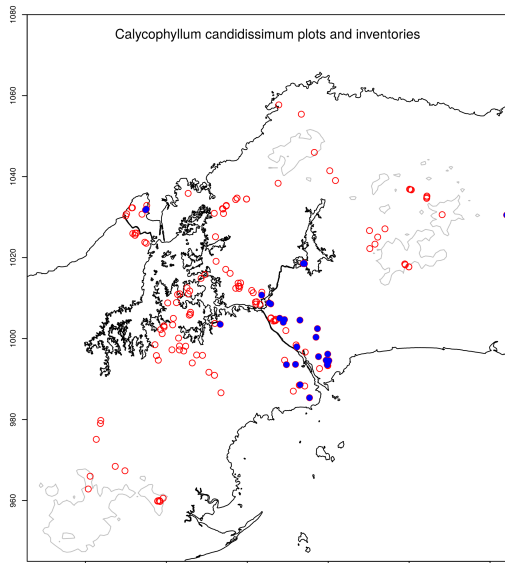
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2015/ 2/16 16:0







How many tree species?

How many tree species?

Including species

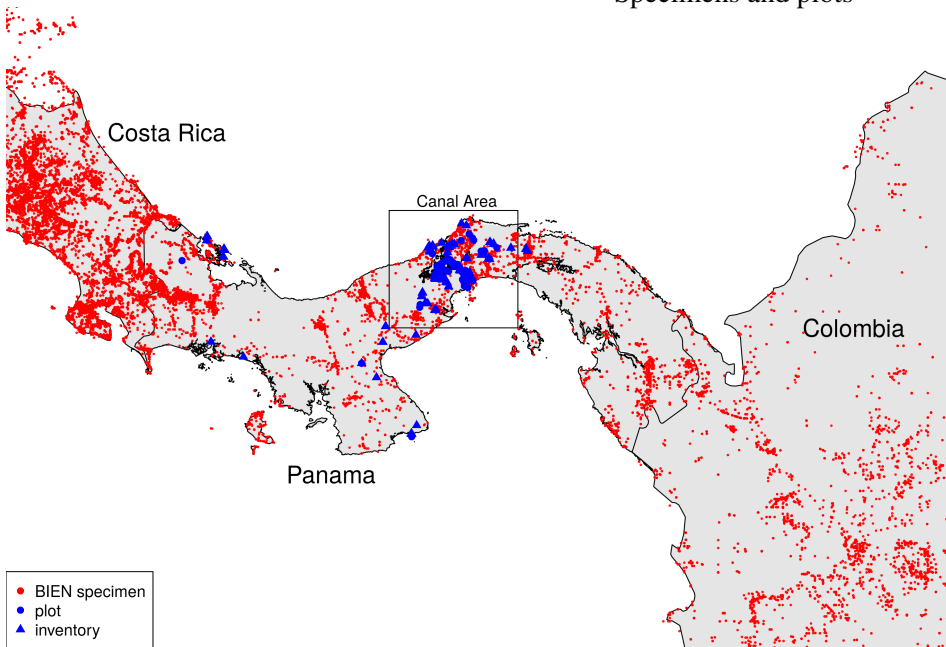
- ▶ Reaching 3 m tall
(matching minimum dbh 1 cm in tree plots)
- ▶ usually free-standing as reproductive (stranglers included)
- ▶ any number of stems (ie clonal or not)

Excluding species

- ▶ lianas
- ▶ epiphytes
- ▶ herbs
- ▶ shrubs < 3 m tall

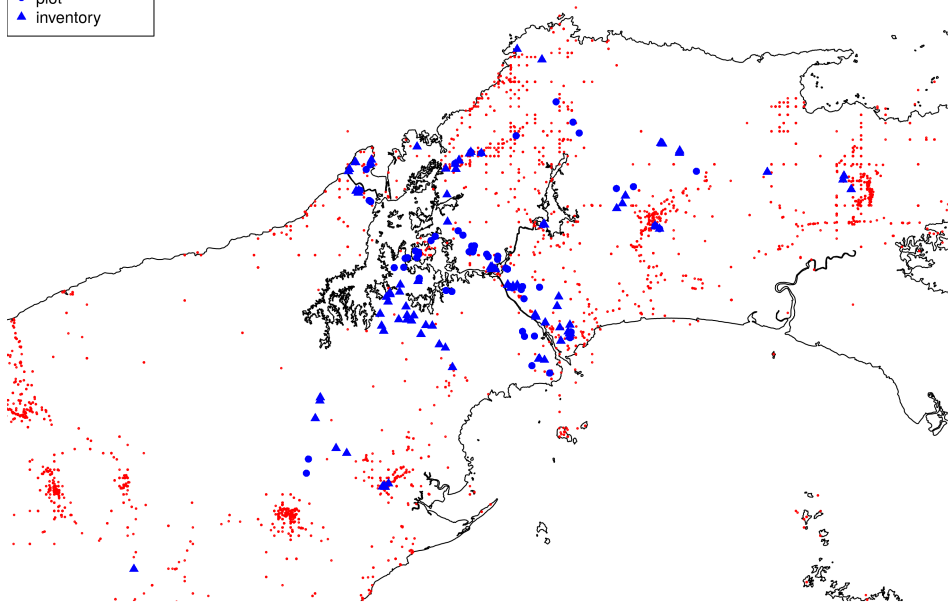
- All beg for precise records of many individuals
- But data either do not exist or are difficult to compile

Specimens and plots



Specimens and plots

- BIEN specimen
- plot
- ▲ inventory



3044 tree species known in Panama

3044 tree species known in Panama

141 families

752 genera

Tree height:

3-5 m: 518 species

5-10 m: 773 species

≥ 10 m: 1753 species

Online maps

<http://conditdatacenter.tech/PanamaTrees>

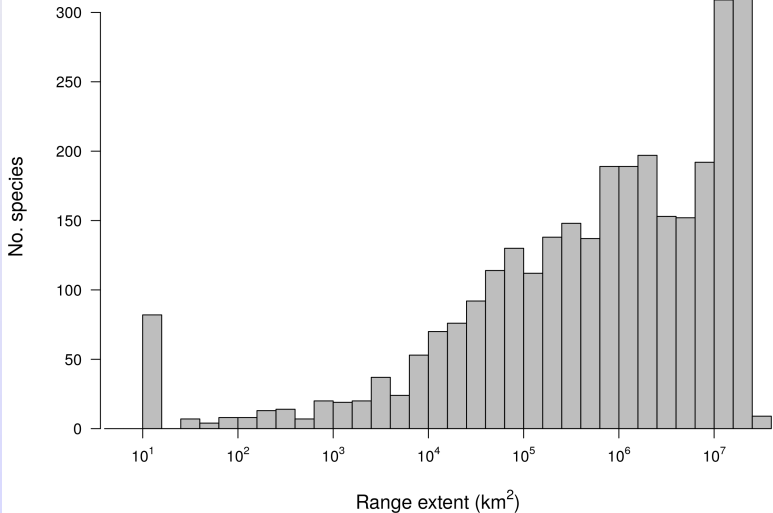
Astrocaryum standleyanum

Astronium graveolens

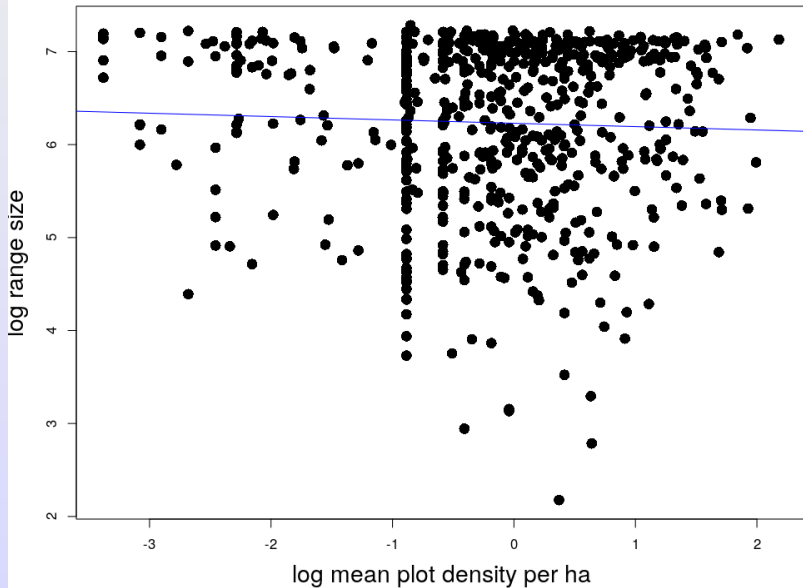
Mosannona garwoodii

Viburnum stellatomentosum

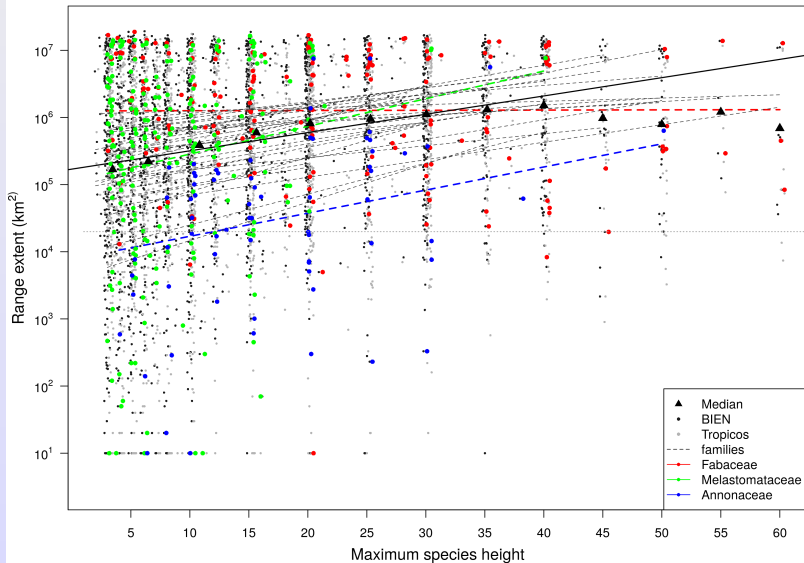
Range sizes 3044 tree species of Panama



Plot abundance does not correlate with range size



Tall trees have wider ranges



Tree species with very narrow ranges in Panama

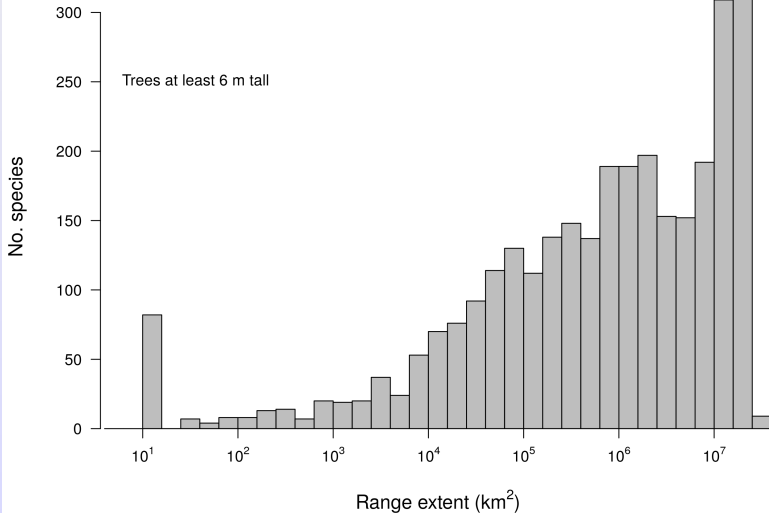
- ▶ 3044 total species:
 - 284 endemic to Panama (9.3%)
 - 474 in one other country (15.6%)
(usually Costa Rica, some Colombia and other oddities)
 - 492 have range $< 20,000 \text{ km}^2$ (16.2%)

Tree species with very narrow ranges in Panama

► 3044 total species:

- 492 have range $< 20,000 \text{ km}^2$ (16.2%)
- 207 of 1852 of species $\geq 6 \text{ m}$ tall (11.2%)

Panama trees



North America (Morin & Lechowicz 2011)

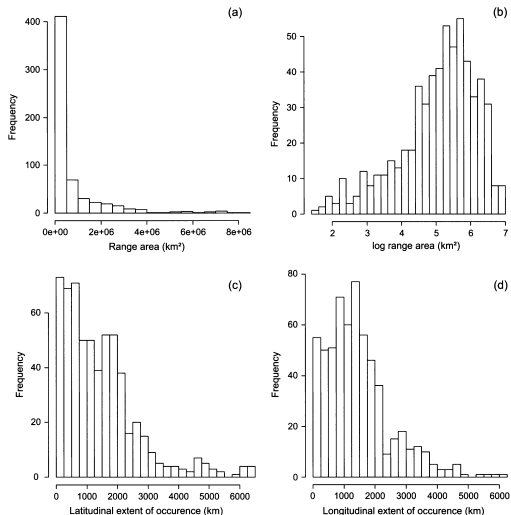


Figure 2. Range characteristics for species of North American trees. (a) Untransformed range areas (in km^2). (b) $\log_{10}$ -transformed range areas. (c) Untransformed latitudinal extent (in km). (d) Untransformed longitudinal extent (in km).

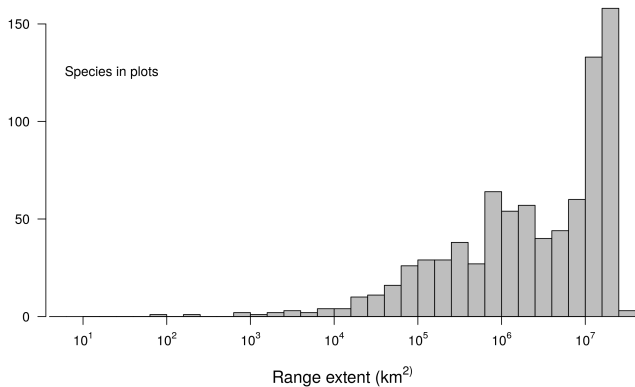
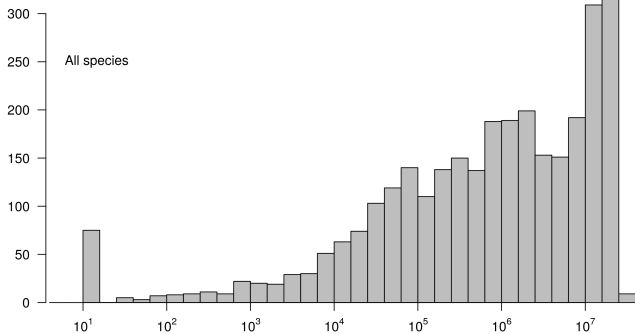
chance in all taxonomic levels of the Gymnosperms, except

Is there a positive correlation between climate

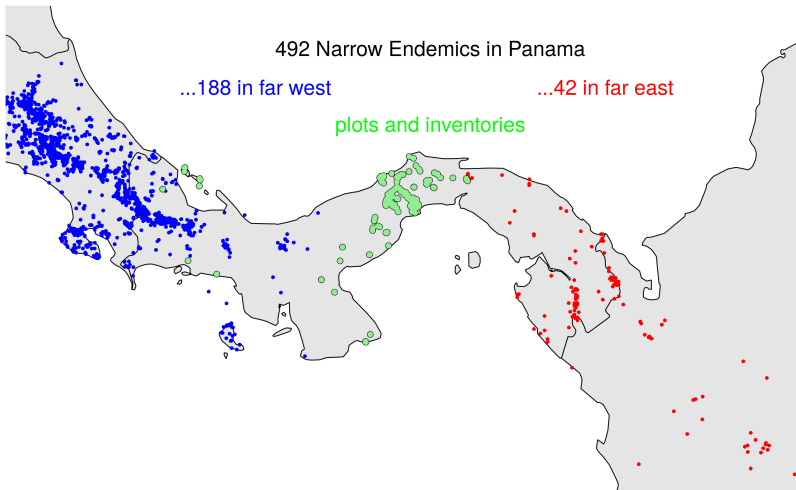
Plot occurrence correlates with range size

Range (km ²)	Found in plots	Not found	% found
$< 2 \cdot 10^4$	37	455	7.5
$2 \cdot 10^4 - 10^5$	72	333	17.8
$10^5 - 10^6$	217	573	27.5
$> 10^6$	324	655	33.4
Total	836	2208	27.5

All ranges (log)



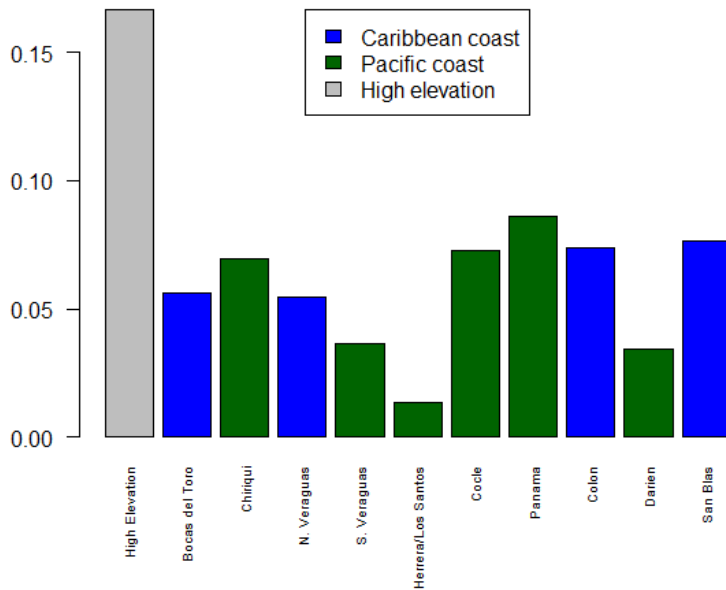
Plots do not reach many narrow endemics



Narrow endemics are concentrated in western mountains



Ratio Rare to All Species



Taxonomic variation in narrow ranges

Important families illustrating wide variation

Family	Narrow	Wide	% narrow
Moraceae	0	72	0.0
Sapotaceae	2	50	3.8
Fabaceae	17	241	6.6
Lauraceae	20	96	17.2
Annonaceae	27	72	27.3
Myrtaceae	28	66	29.8
Primulaceae	41	60	40.6
Total	492	2552	16.1

Is the difference due to biology?

Or taxonomists?

Conclusions and hypotheses for future work

- ▶ Plots capturing tree species
 - In Panama, 33% of tree species appear in plots
 - But only 7% of narrow endemics are in plots
 - Without thousands of plots, most species will be missed
- ▶ Range size
 - Highly variable taxonomically
 - No correlation with plot abundance
 - Wider ranges in tall trees
- ▶ Understanding environmental response
 - Estimate species responses to rainfall and elevation
 - Solving the many errors in location, identification
 - Realized niches and dispersal limitation