

# Geology and tree species distributions in tropical forests of Panama

Beta-diversity in species-rich forests

iDiv, Leipzig

21 Feb 2020

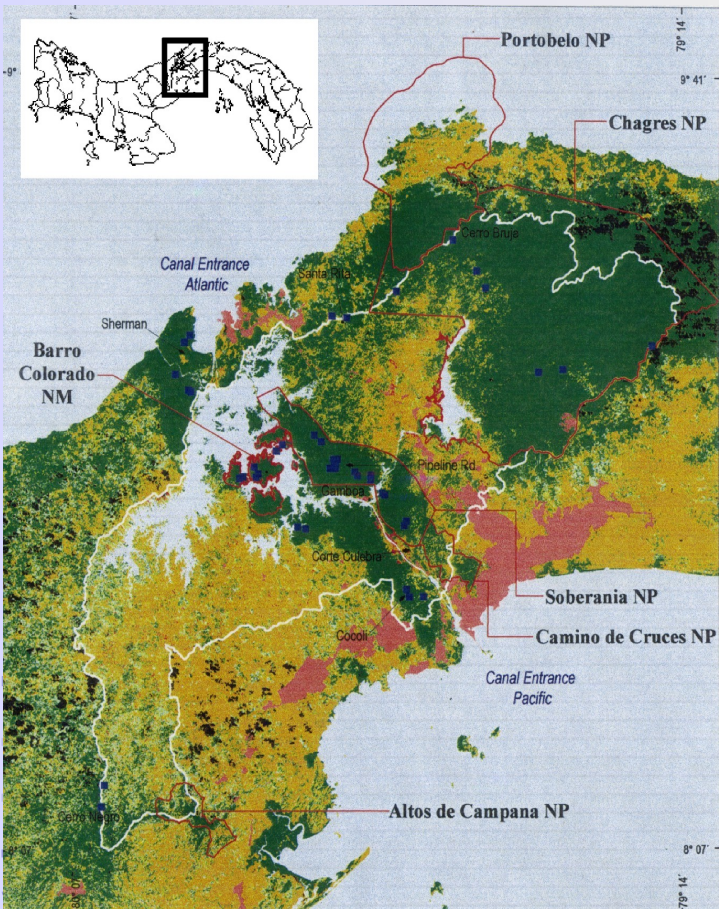
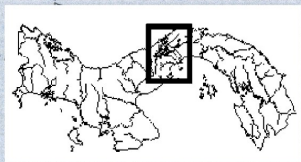




# Robin Foster







# Forest Composition in Tropics of Panama

- 1 Climate (dry season)
- 2 Geology
- 3 Soil Chemistry
- 4 Tree Response to Phosphorus and Moisture



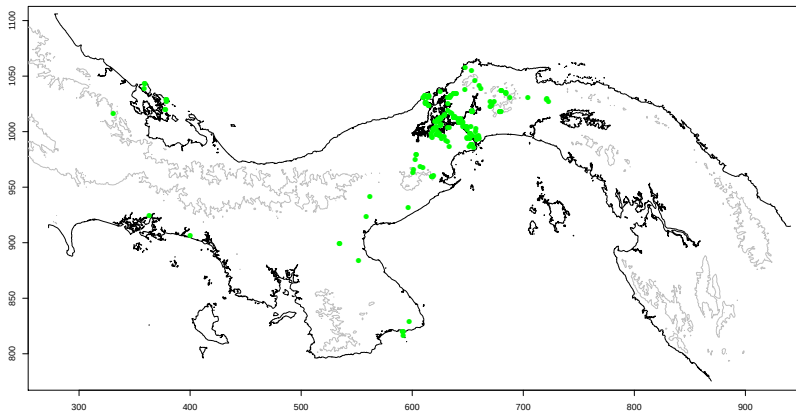




# Surveys of Tree Species

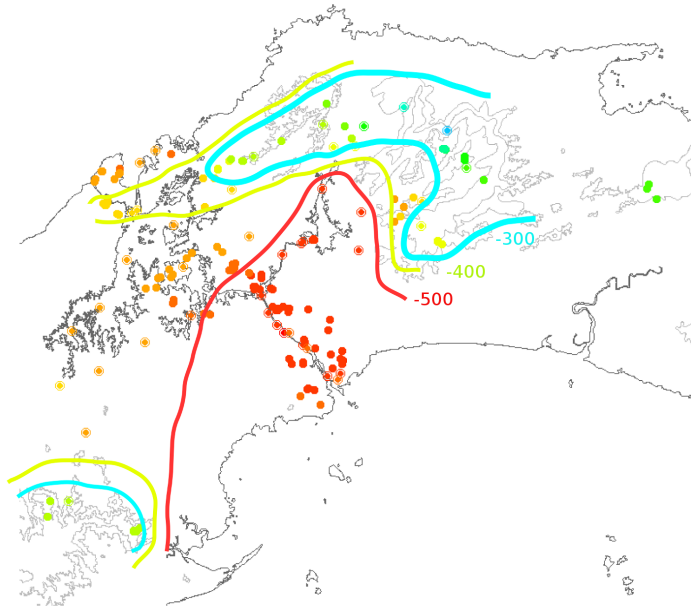
## 183 sites in Panama:

61 plots (full tree census) & 122 inventories (presence-absence)



# Tree inventories

## Estimated dry season intensity at each



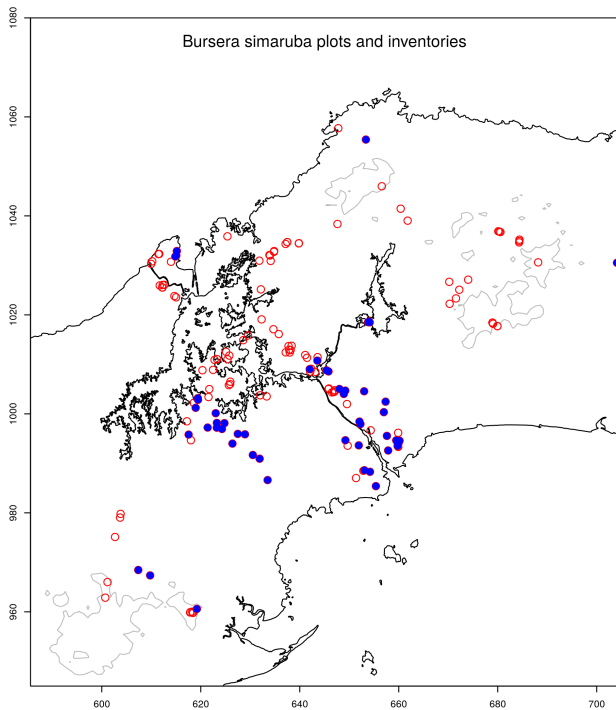


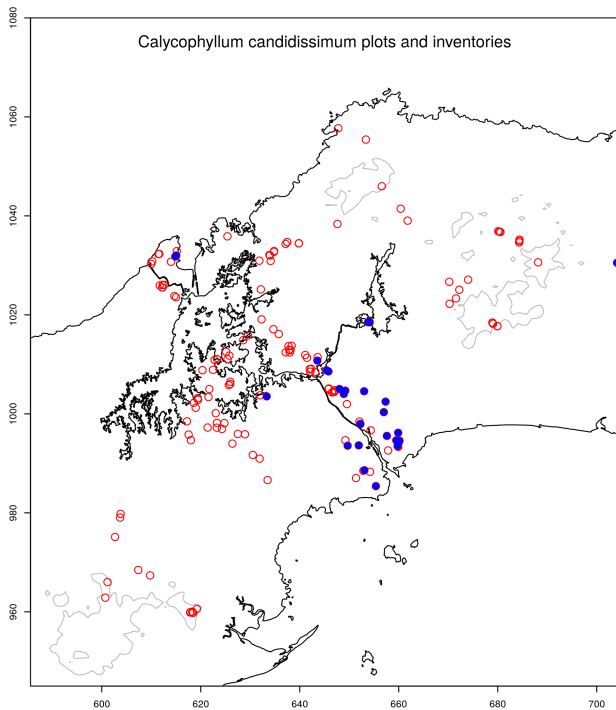




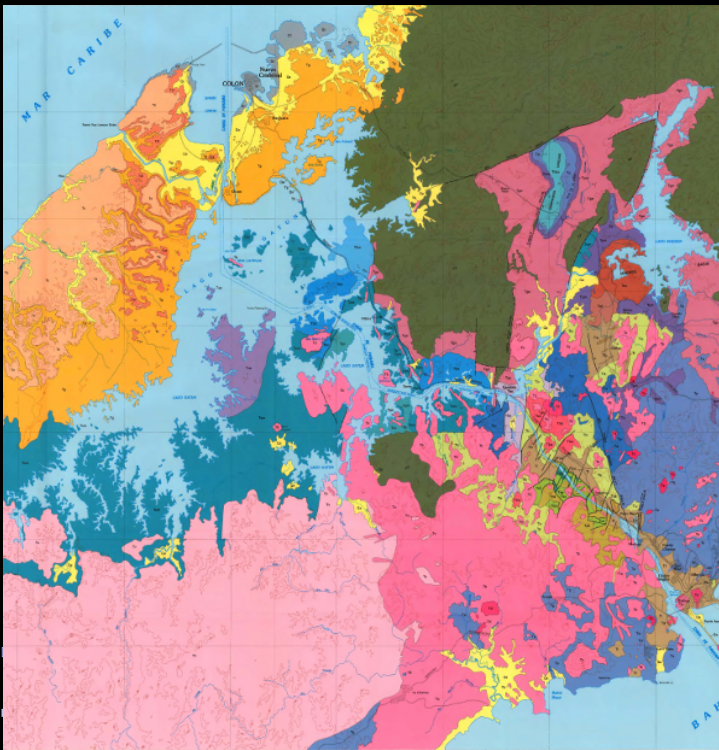


Deciduous species and limestone

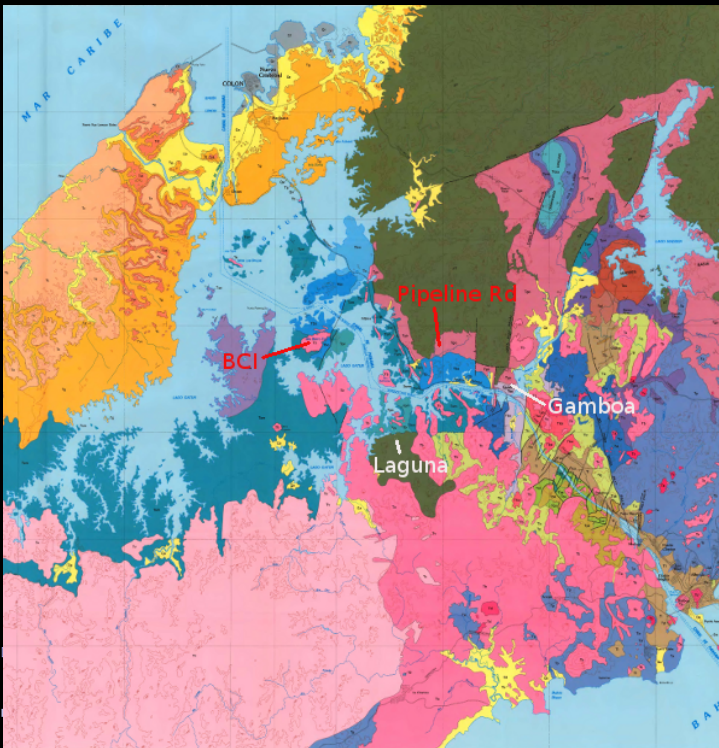




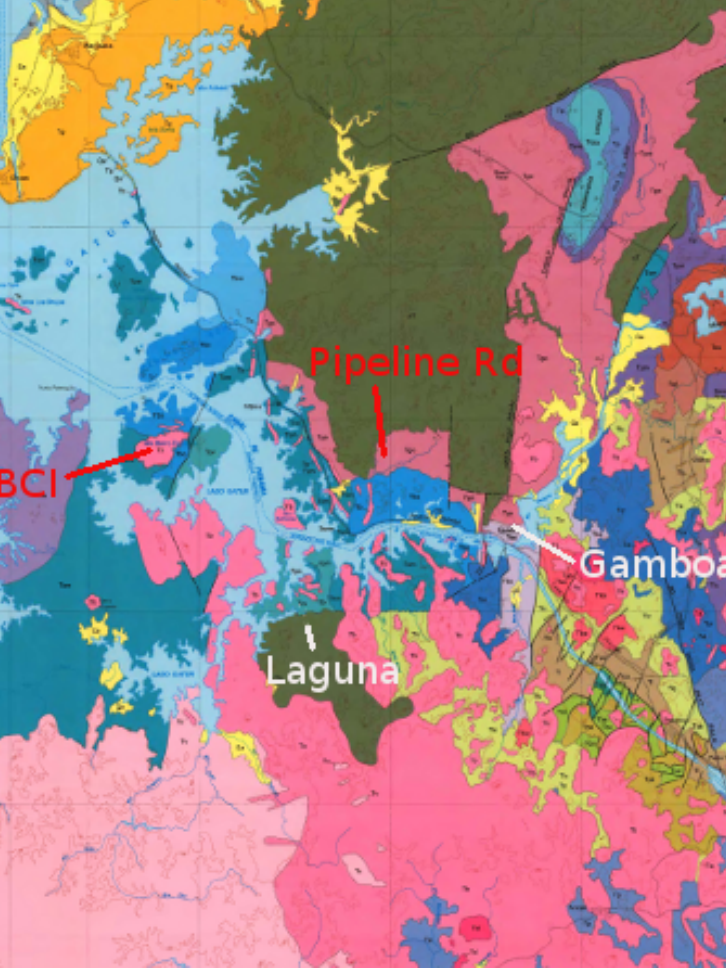




Woodring geology map (1982)



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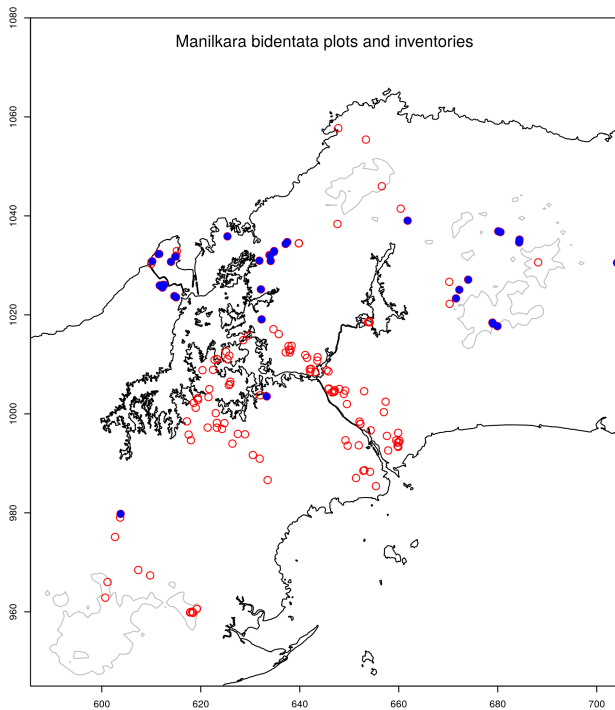


Pipeline Rd

BCI

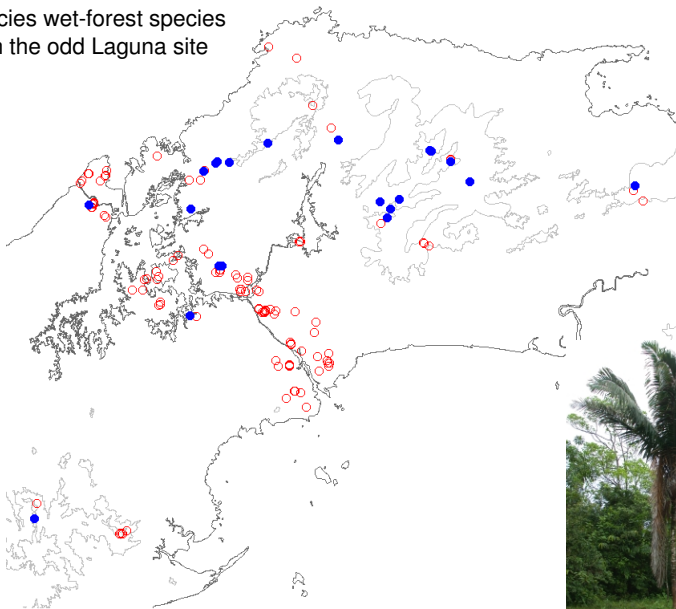
Gamboa

Laguna

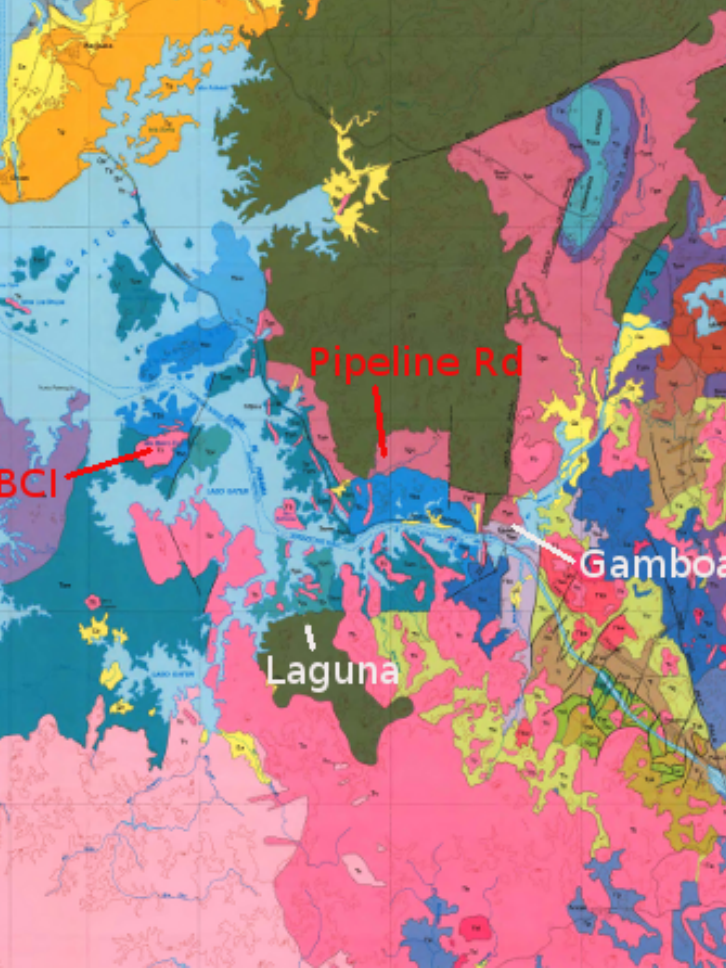


## *Welfia regia* plots and inventories

32 species wet-forest species  
reach the odd Laguna site







Pipeline Rd

BCI

Gamboa

Laguna



2015 / 2 /

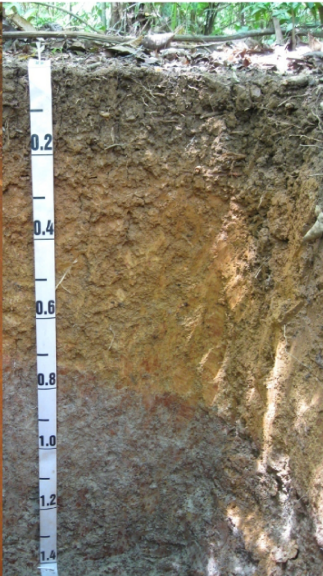


2015/2

## Oxisols (Typic Eutrudox)



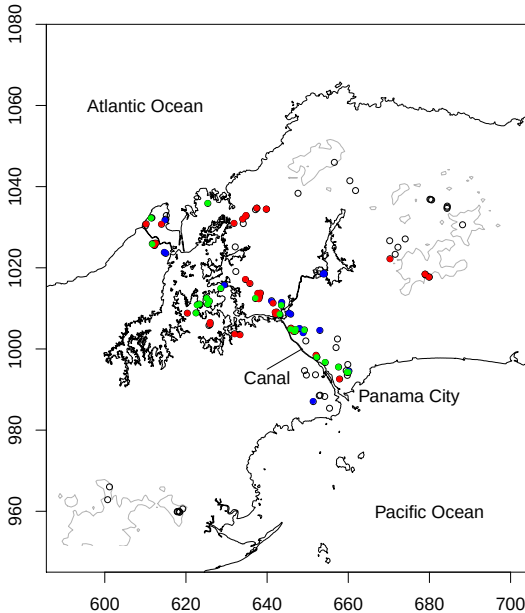
## Alfisols and Ultisols (Oxyaquic Vertic Hapludalf)



## Mollisols (?)



# Phosphorus Map



Low phosphorus

Medium phosphorus

High phosphorus



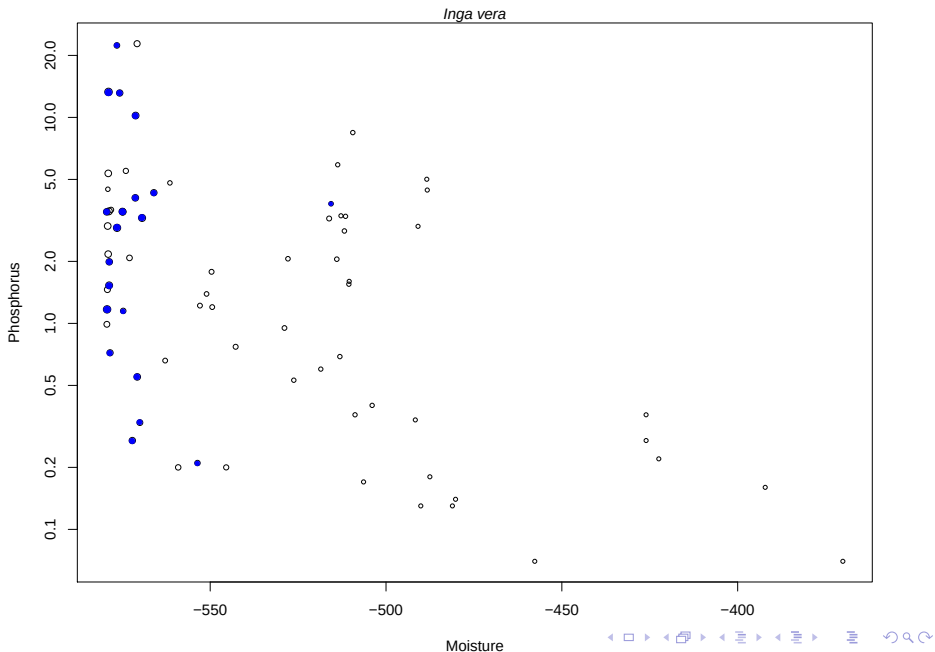
# Soil nutrient comparison

|          | Panama |         | Amazon* |         |
|----------|--------|---------|---------|---------|
|          | Min    | Max     | Min     | Max     |
| Ca       | 25.00  | 9738.60 | 2.90    | 3402.00 |
| K        | 12.30  | 351.90  | 3.80    | 197.00  |
| P(resin) | 0.07   | 22.80   | 1.00    | 21.80   |
| TotalP   | 72.20  | 1552.80 | 25.00   | 968.00  |

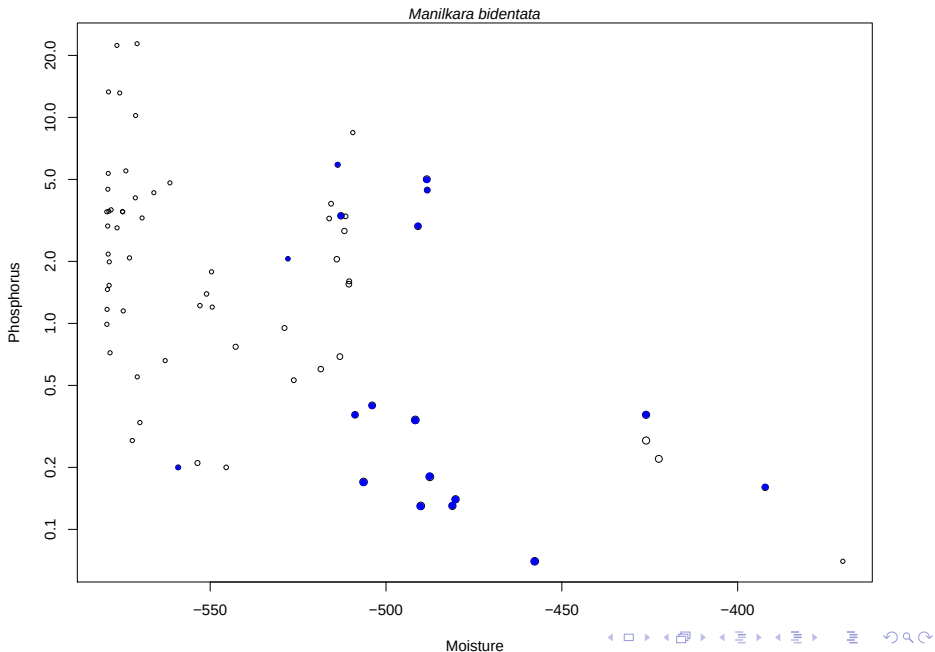
\* Phillips *et al.* 2003, Quesada *et al.* 2011



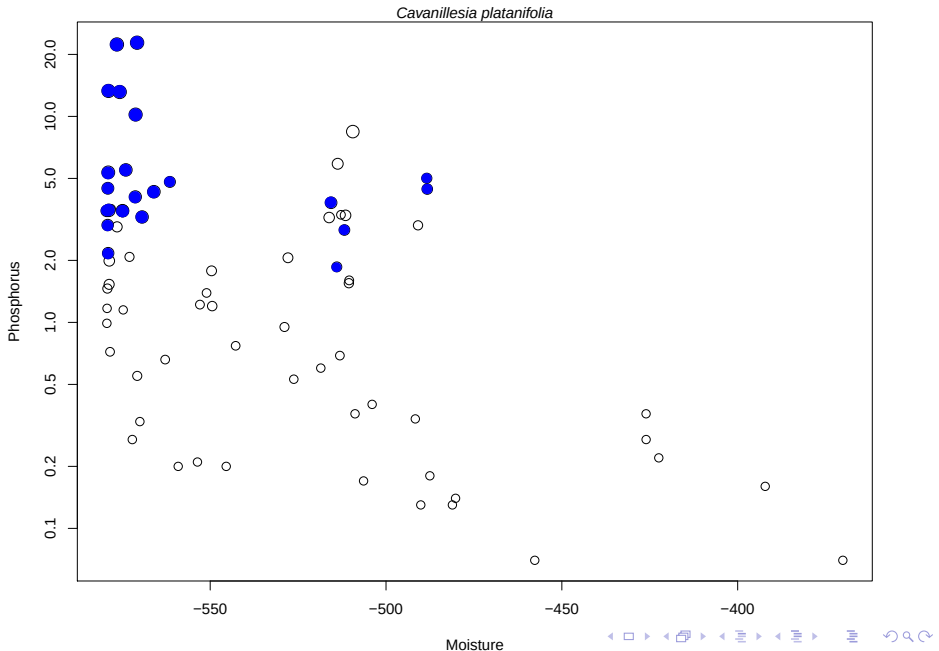
# Phosphorus-Moisture Relation



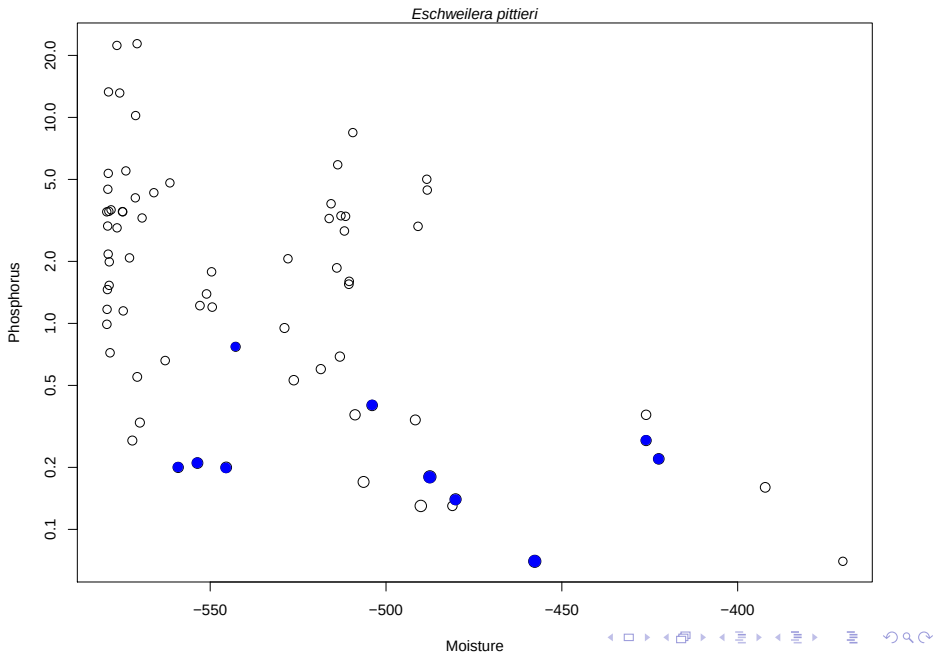
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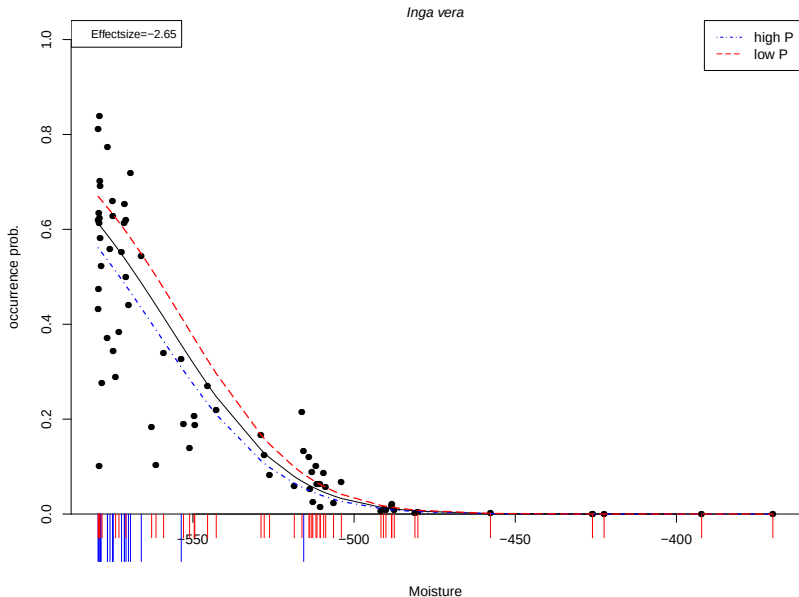
# Habitat response model

Multiple logistic regression

Hierarchical component for species

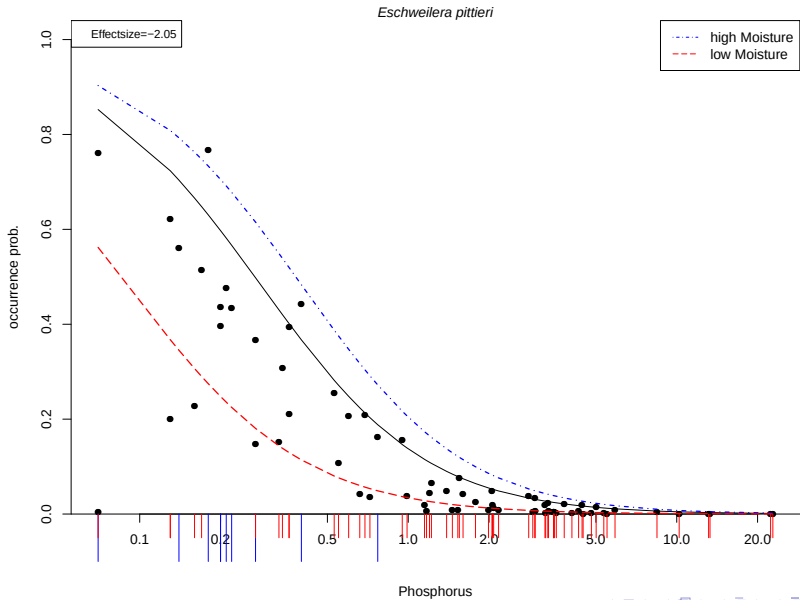
- Multiple logistic regression
  - standard for occurrence modeling against many resources
- $\text{OccurrenceProb} \sim \text{InverseLogit}(\text{Climate} + \text{Soil} + \text{Climate}^2 + \text{Soil}^2)$
- Eight predictors in model:
  - Dry season moisture
  - Al
  - Ca
  - Fe
  - K
  - P (plant available)
  - Zn
  - N (inorganic)

# Habitat response model

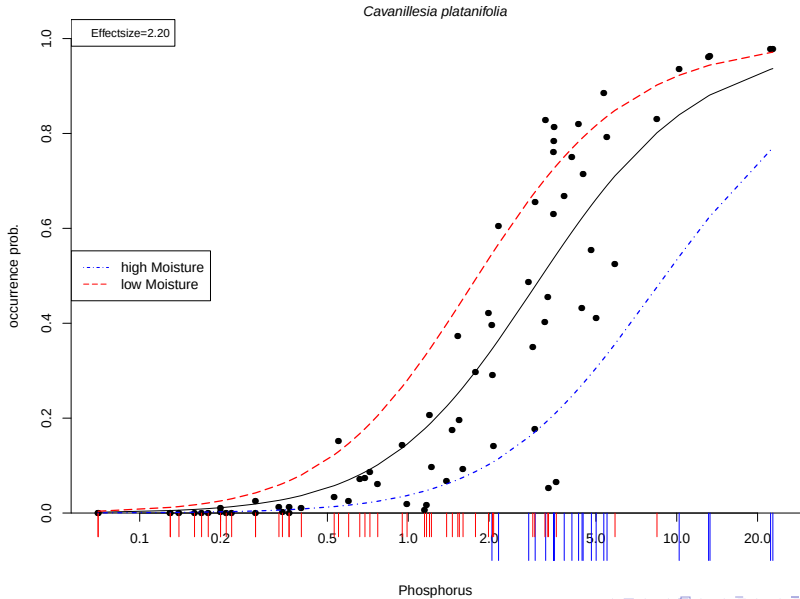




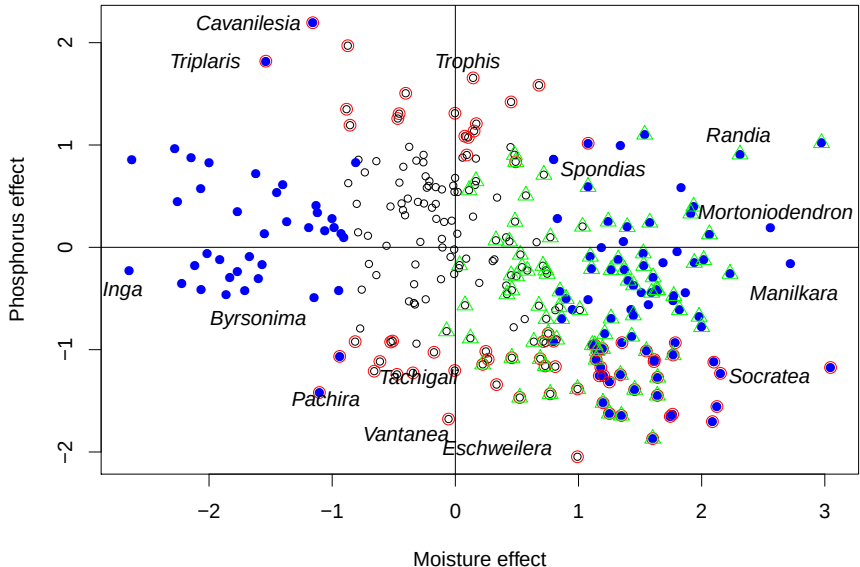
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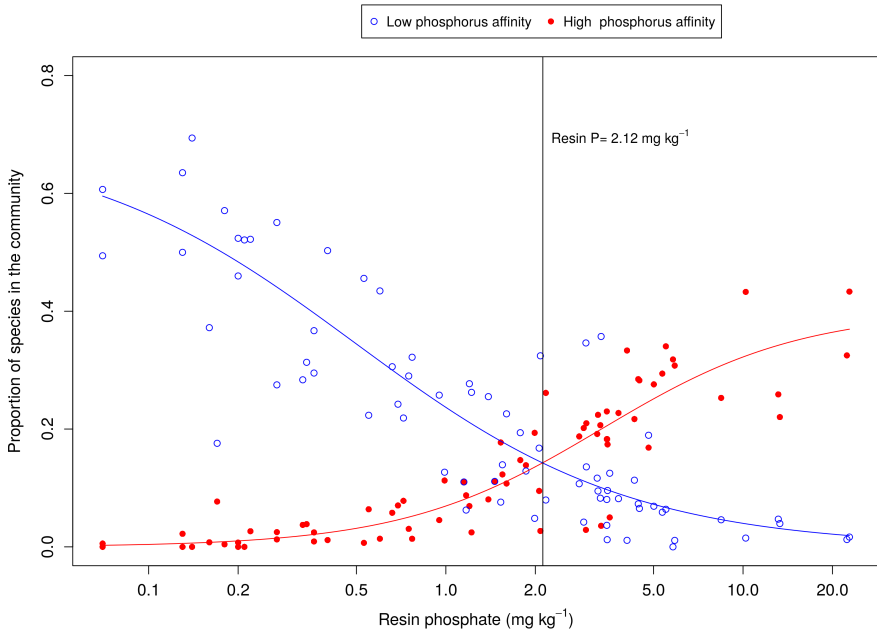
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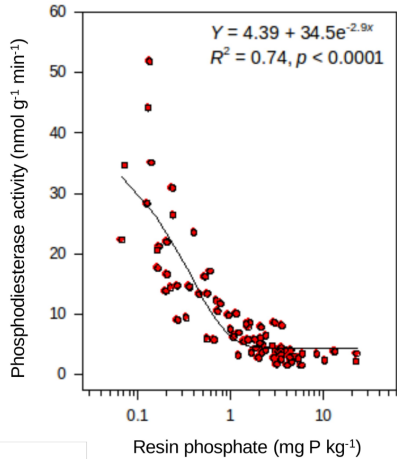
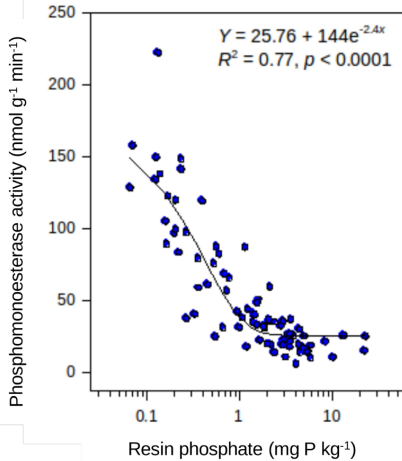
# Bivariate Responses, Moisture and P



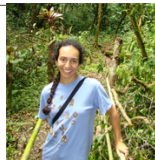
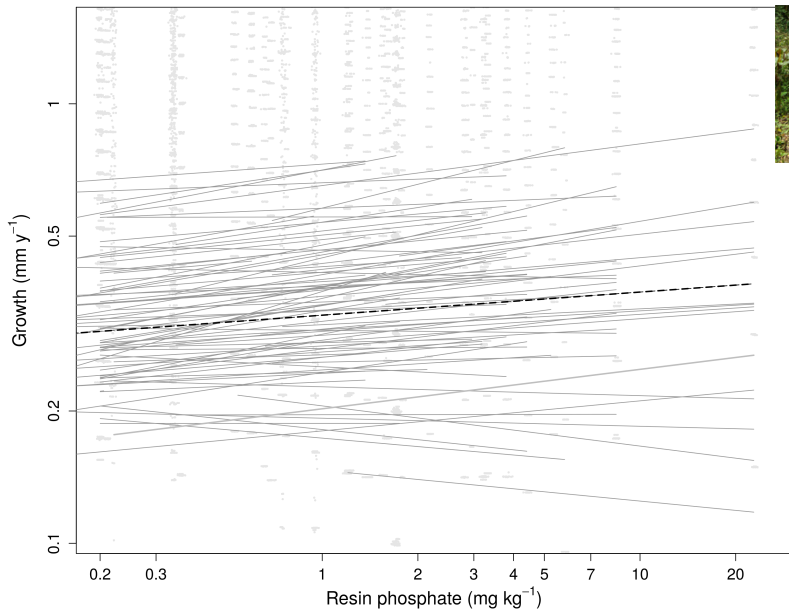
# Turnover of Specialists



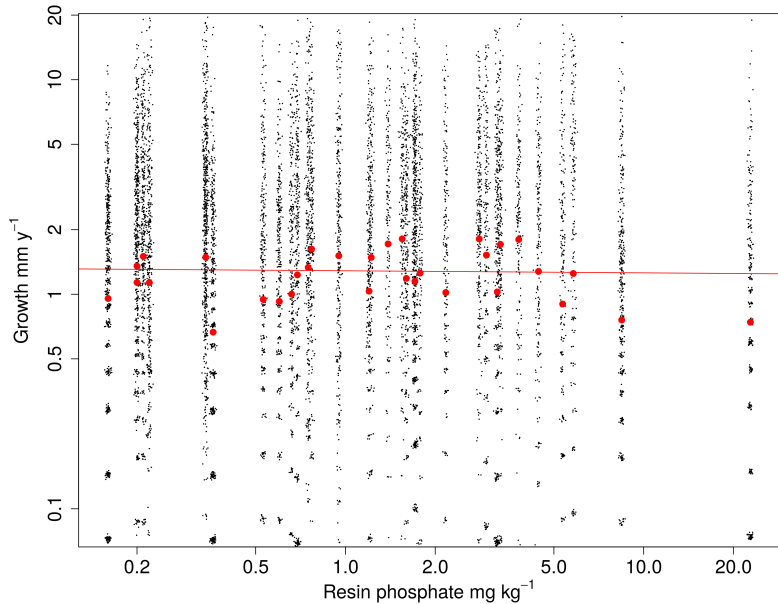
# Microbial Response to Phosphorus



# Individual Species Growth Response to Phosphorus

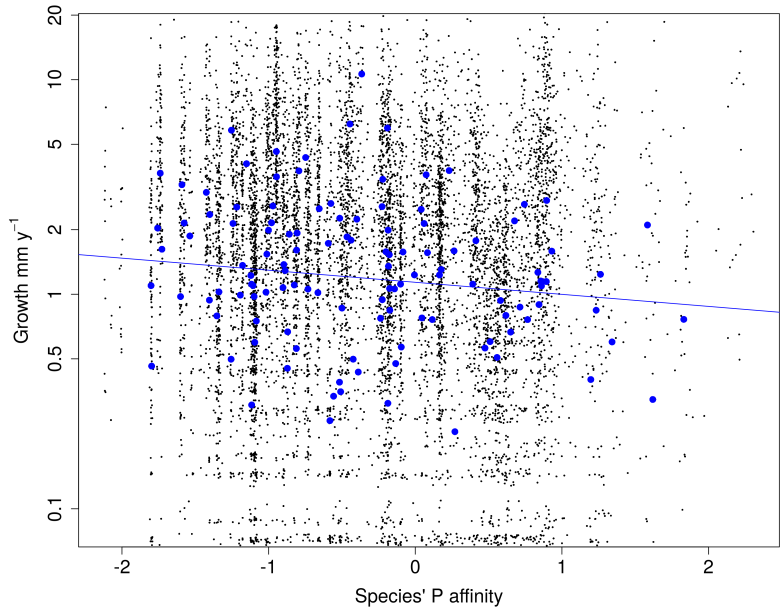


# Mean Forest Growth and Phosphorus

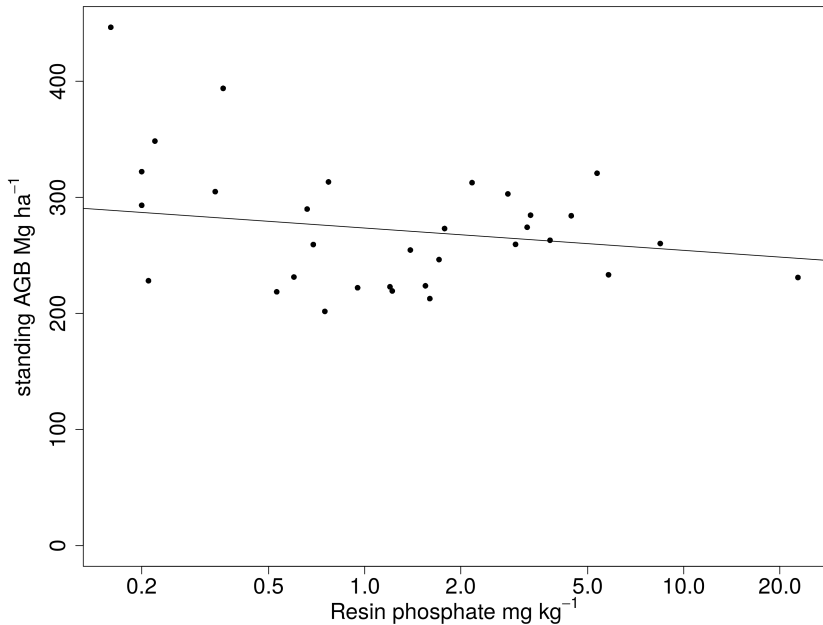




# Mean Species Growth and Phosphorus Affinity

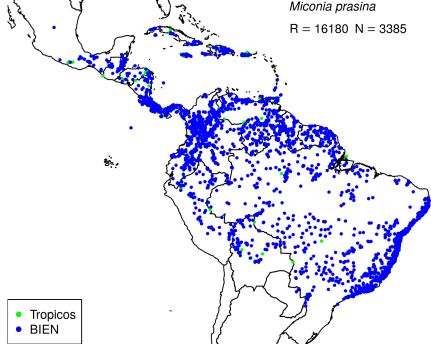


# Forest Biomass and Phosphorus



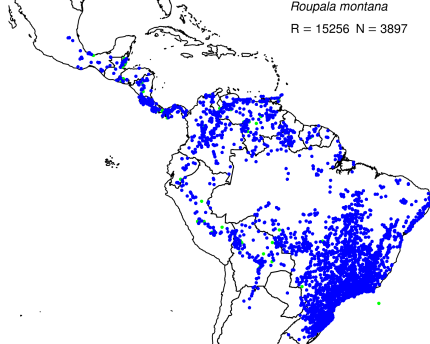
*Miconia prasina*

R = 16180 N = 3385



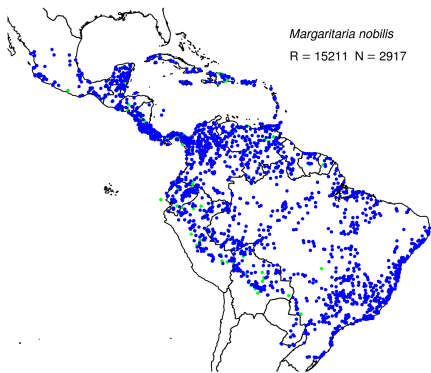
*Roupala montana*

R = 15256 N = 3897



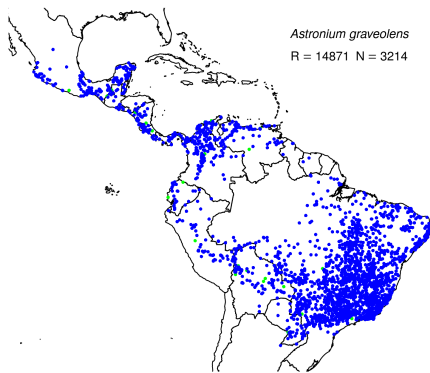
*Margaritaria nobilis*

R = 15211 N = 2917

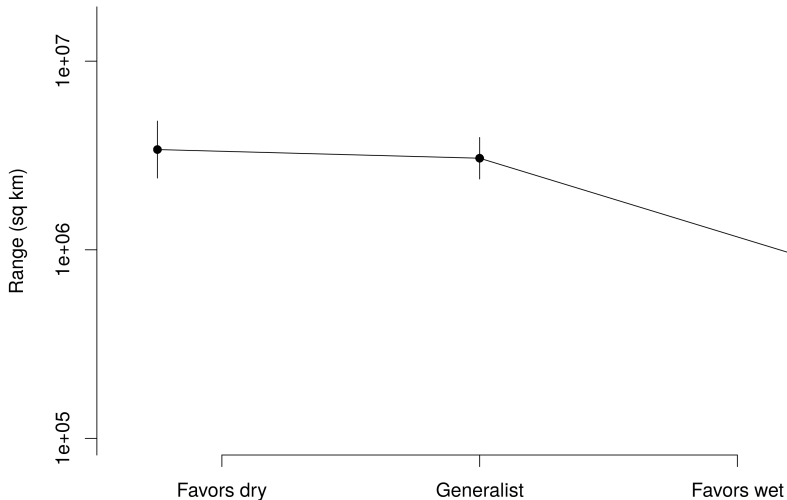


*Astronium graveolens*

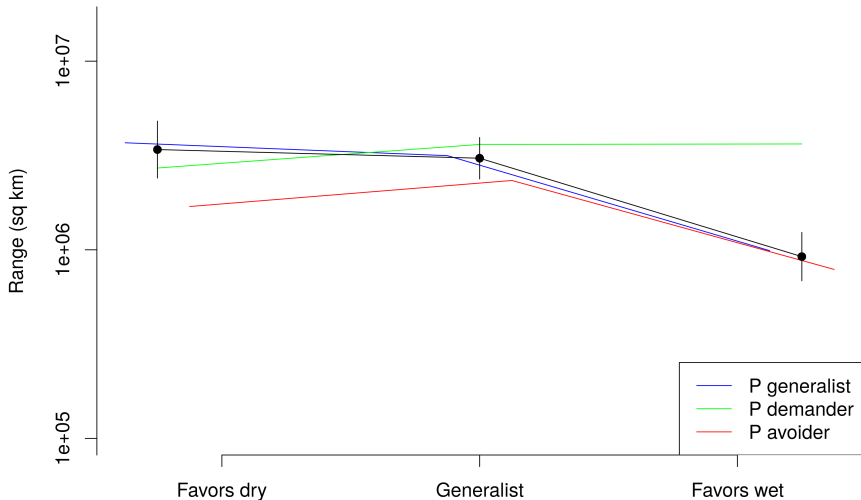
R = 14871 N = 3214



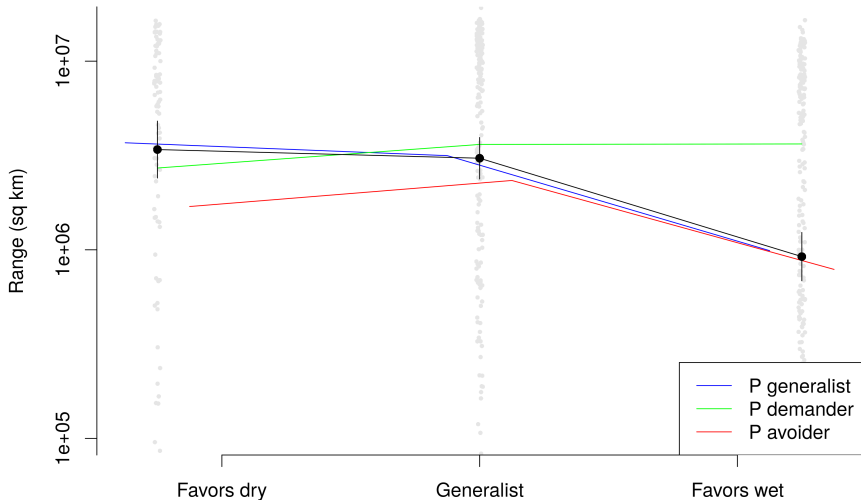
# Full geographic range size Americas



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## **My understanding of Panama's forests:**

### Environmental variation and species composition

#### **Climate and forest**

- Species composition varies greatly with dry season variation
- But there is far more variation than wet vs. moist of Holdridge
- And there are no distinct forest types

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#### **Geology and forest**

- Parent rocks can alter forest beyond the climate
- Many species limited by phosphorus: avoiders and demanders
- Forest community is not limited by phosphorus



