LANDSCAPE HETEROGENEITY INFLUENCES DIVERSITY OF SHRUBS AND TREE SPECIES IN TEMPERATE MIXEDWOOD FORESTS

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UQÀM

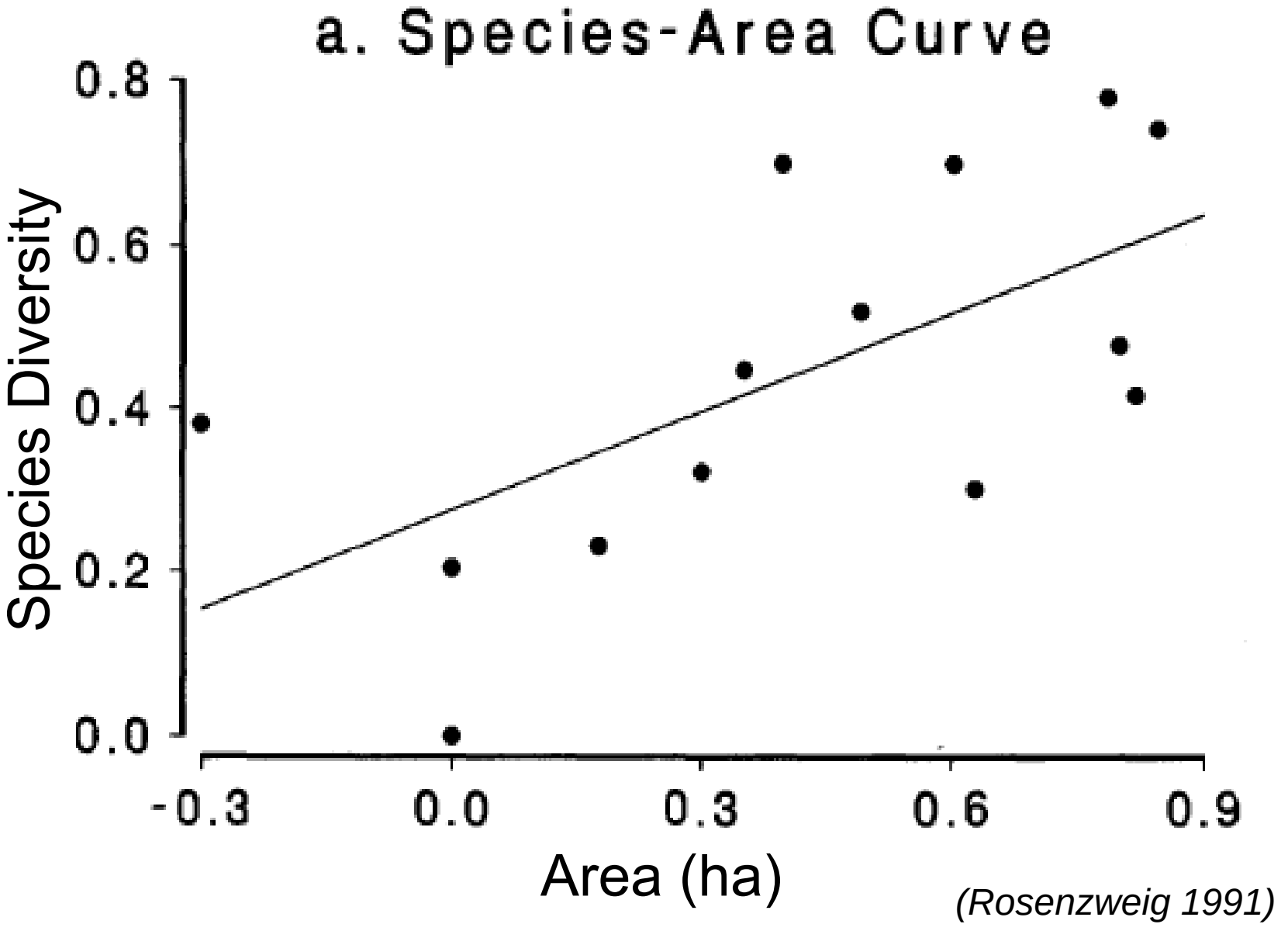
Plant diversity

- More than **120 hypotheses** identified by Palmer (1994)

- A hierarchical top down approach:
  - Climate regionally
  - Environmental heterogeneity at intermediate scales
  - Competition at local scales

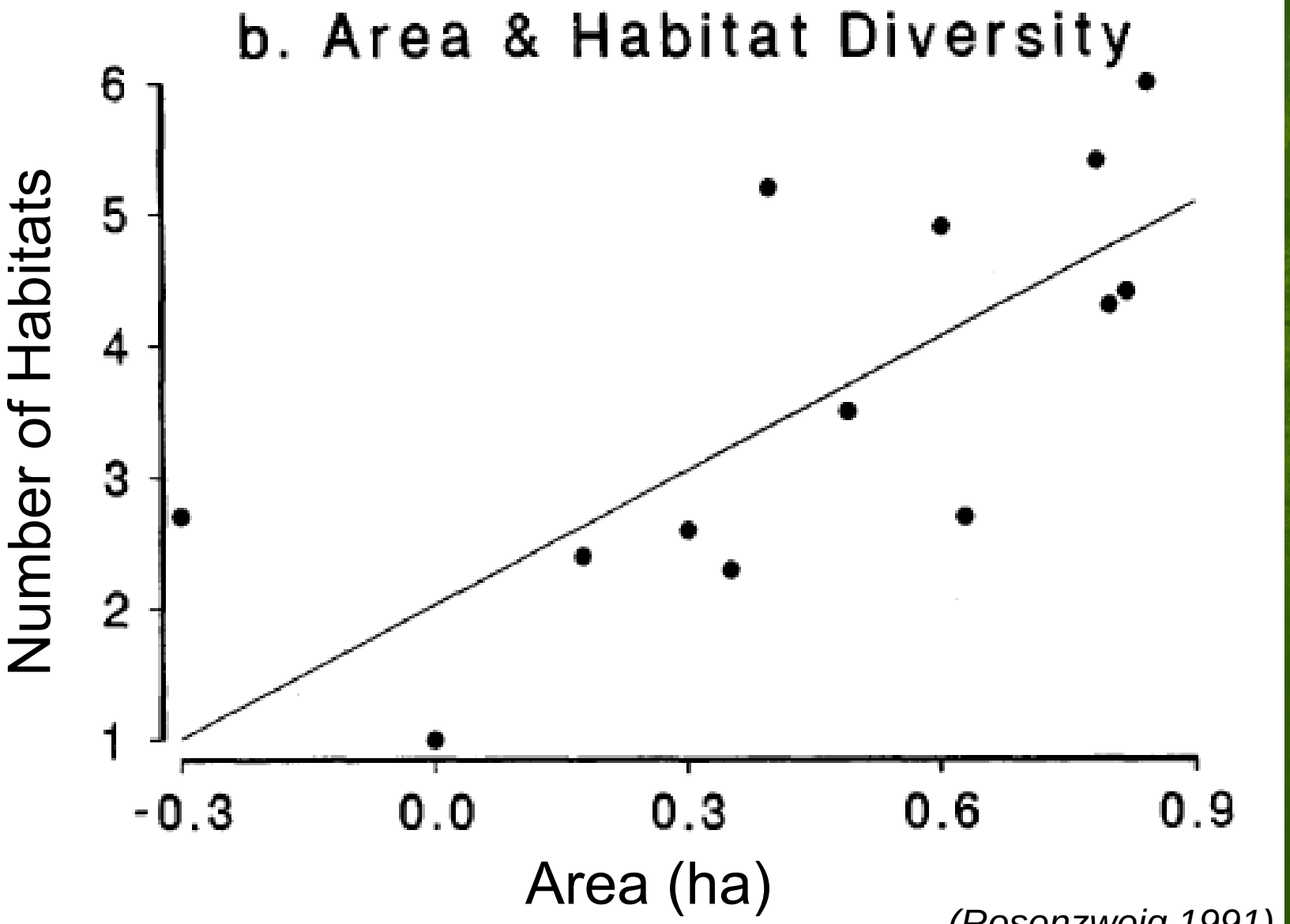
(Shmida and Wilson 1985, Whittaker et al. 2001, Ricklefs 2004, Sarr et al. 2005)

Environmental heterogeneity



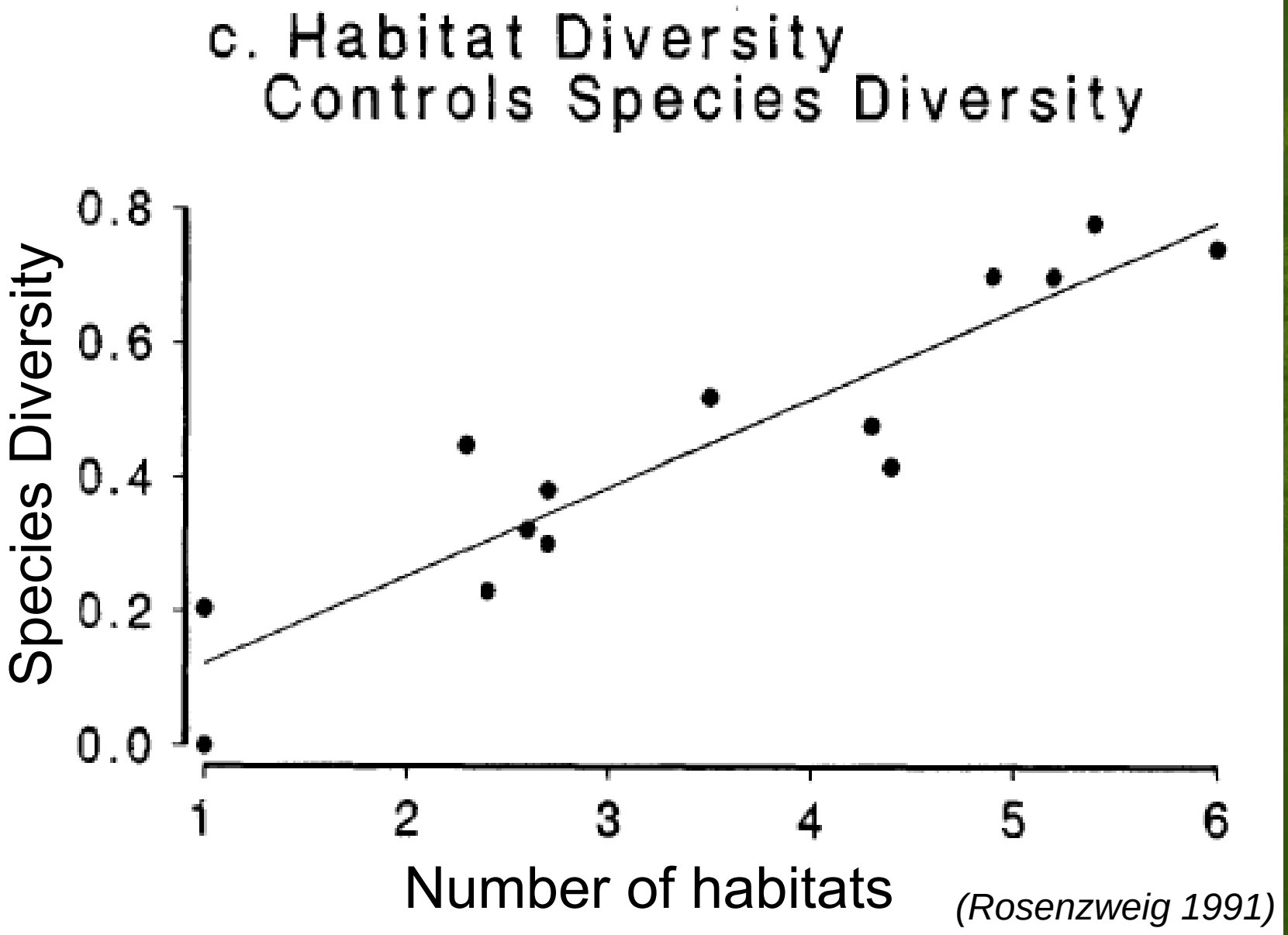
(Rosenzweig 1991)

Environmental heterogeneity



(Rosenzweig 1991)

Environmental heterogeneity



(Rosenzweig 1991)

Environmental heterogeneity

- Heterogeneity correlates with richness

(Zenner 2000, Carey 2003, Deutschewitz et al. 2003, Dufour et al. 2006, Kumar et al. 2006, Proulx and Parrott 2008, Coulson and Tchakerian 2010, Costanza 2011)

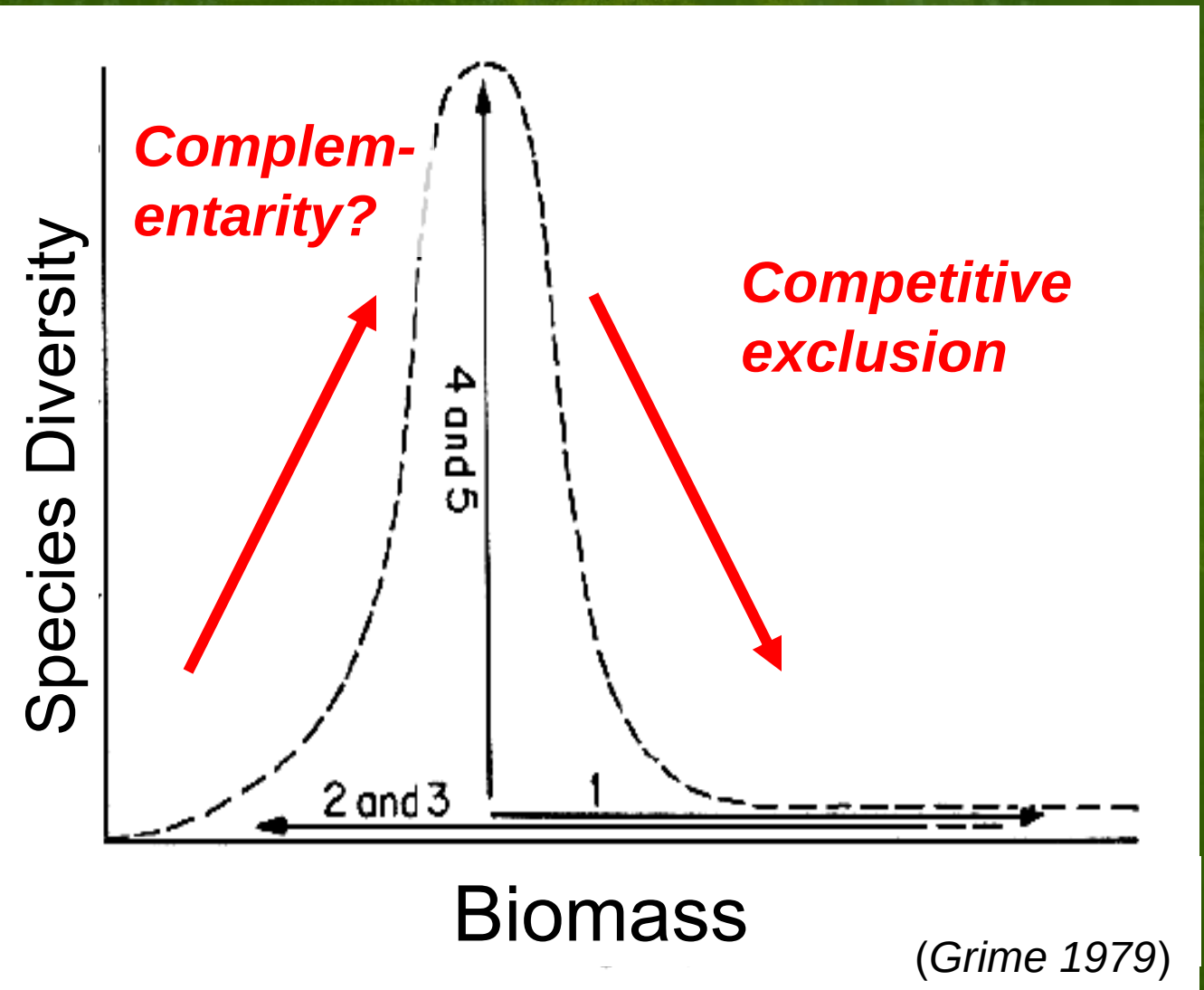
- Do not confuse with fragmentation studies
  - Non contiguous landscapes

- **Does this mean we should manage for heterogeneity?**

Hypothesis

Species diversity will be greatest in heterogeneous landscapes having experienced multiple intermediate disturbances

Local diversity - Biomass diversity relationship



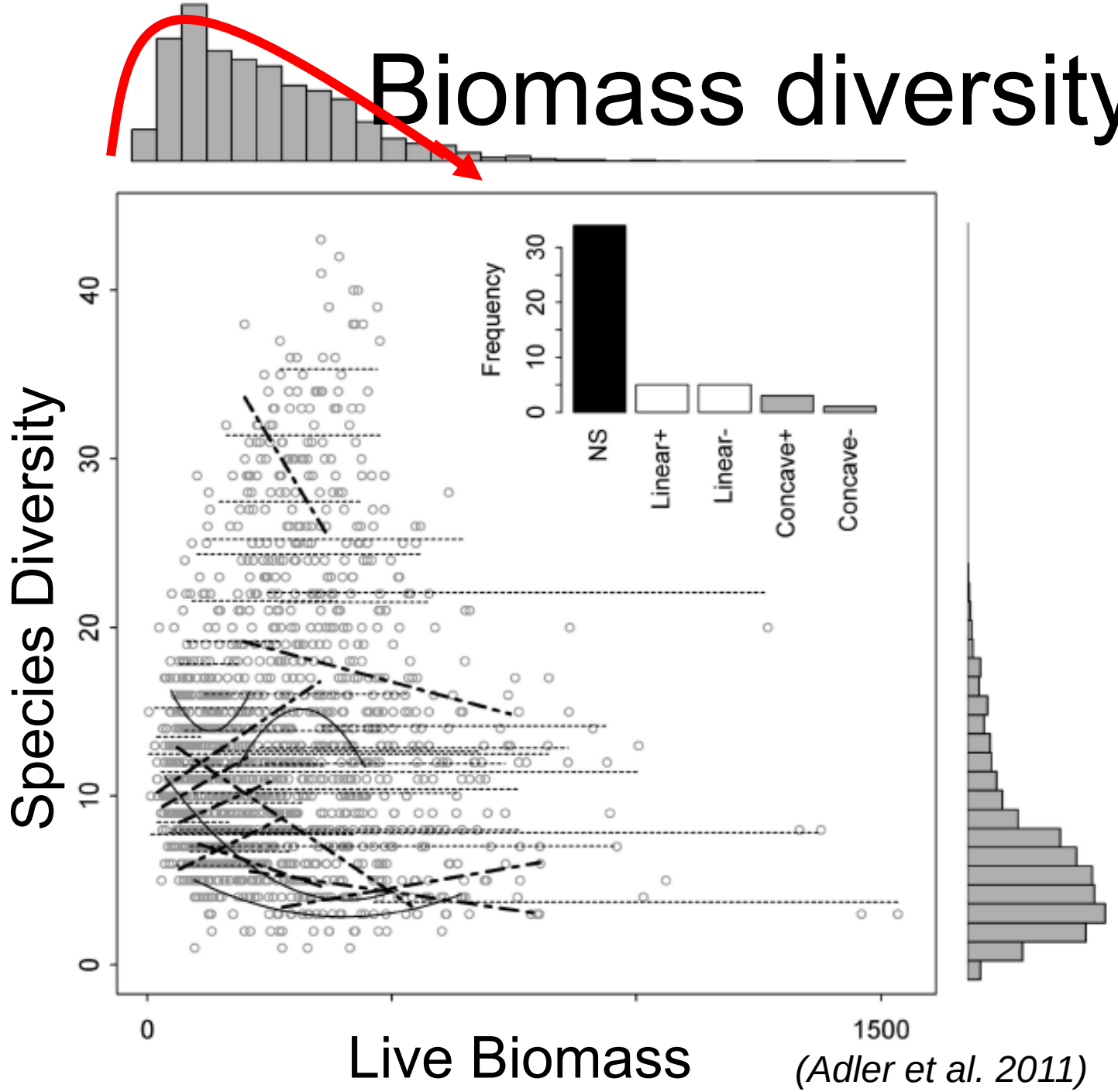
(*Grime 1979*)

- 30 years of debate
- Hump-shaped relationship

(Adler et al. 2011)

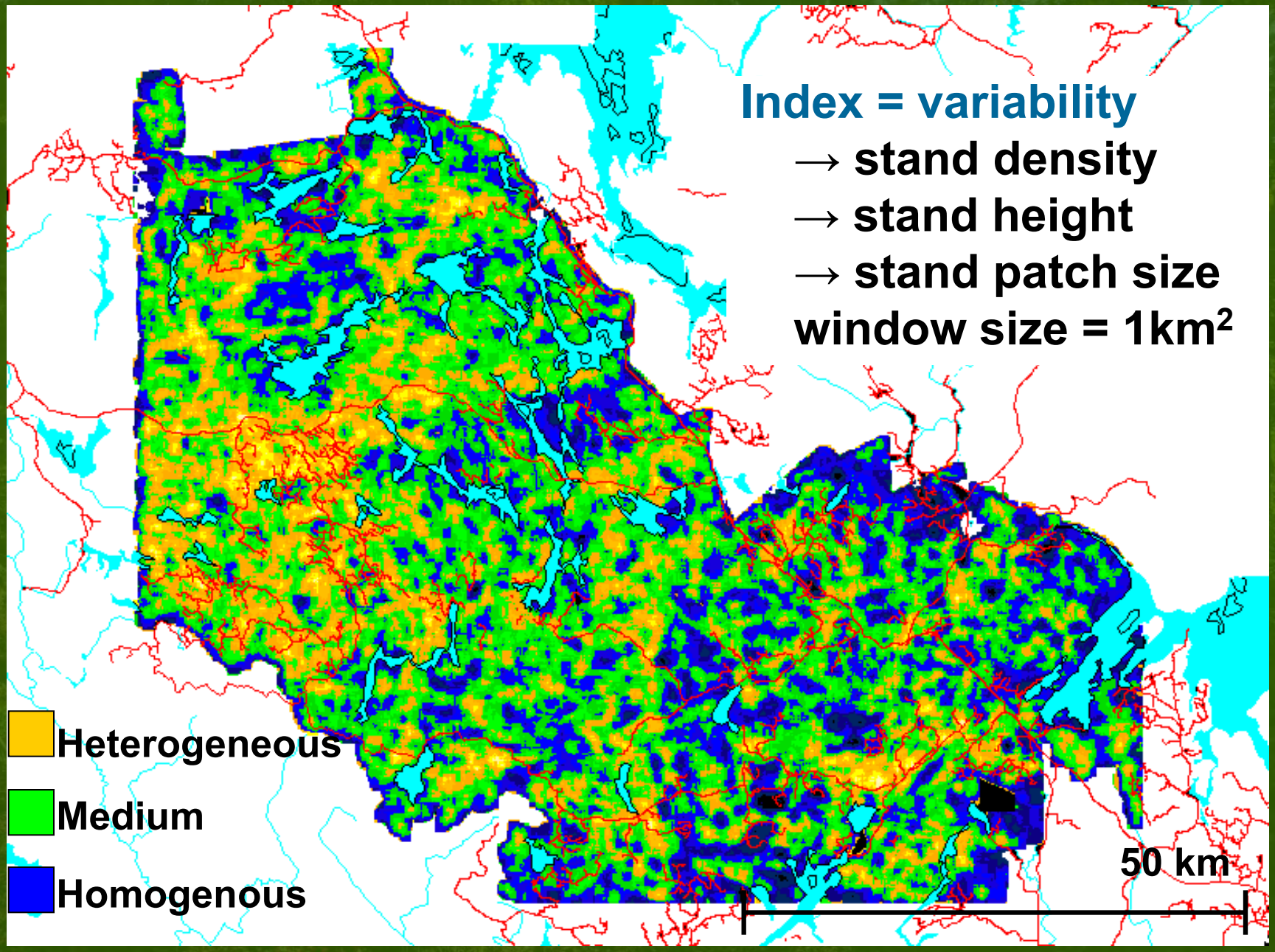
Conclusion

Biomass diversity

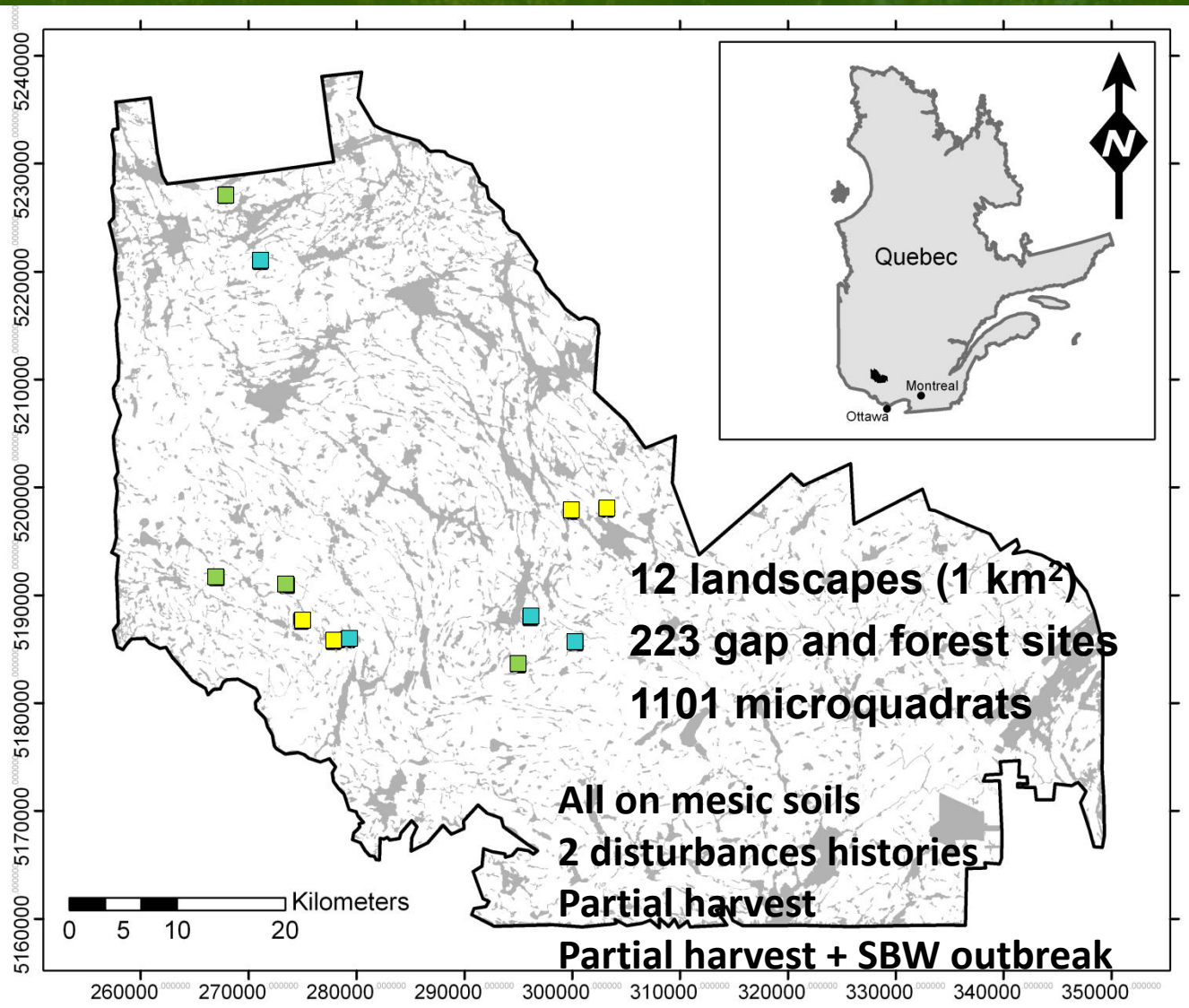


(Adler et al. 2011)

Methods


Index = variability
→ stand density
→ stand height
→ stand patch size
window size = 1km²
Heterogeneous
Medium
Homogenous
50 km

Methods


Quebec
Montreal
Ottawa
N
12 landscapes (1 km²)
223 gap and forest sites
1101 microquadrats
All on mesic soils
2 disturbances histories
Partial harvest
Partial harvest + SBW outbreak
Kilometers
0 5 10 20
5240000
5230000
5220000
5210000
5200000
5190000
5180000
5170000
5160000
260000
270000
280000
290000
300000
310000
320000
330000
340000
350000

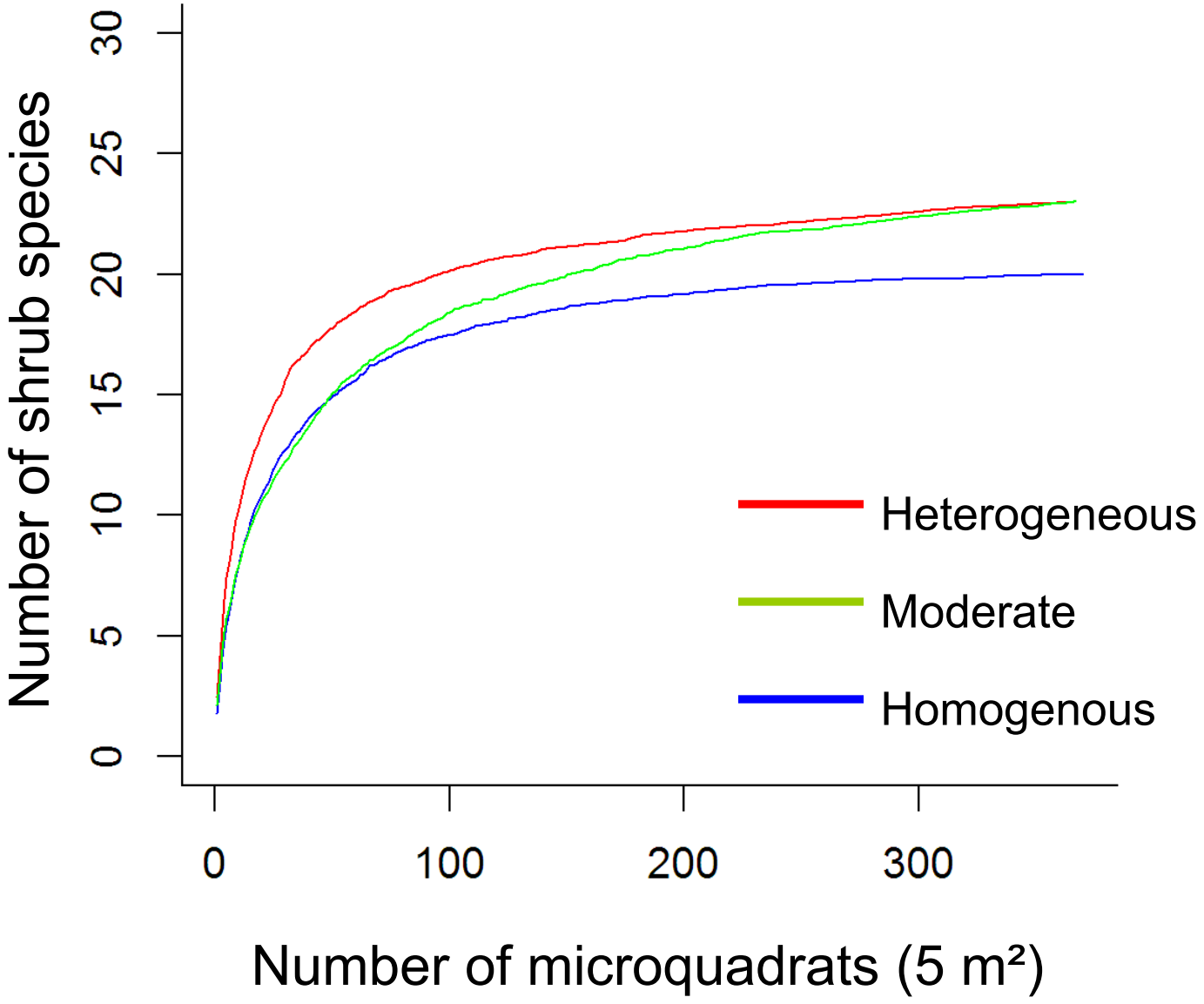
α Diversity

Shrubs	Shannon	Het > Mod P(f) = 0.03
		Het > Hom P(f) = 0.01
	Richness	Het > Mod P(f) = 0.01
		Het > Hom P(f) = 0.01
Tree seedlings	Shannon	Hom > Het P(f) = 0.02
	Richness	Hom > Het P(f) = 0.01
Tree saplings	Shannon	Mod > Het P(f) = 0.01
	Richness	Mod > Het P(f) = 0.03
		Hom > Het P(f) = 0.05

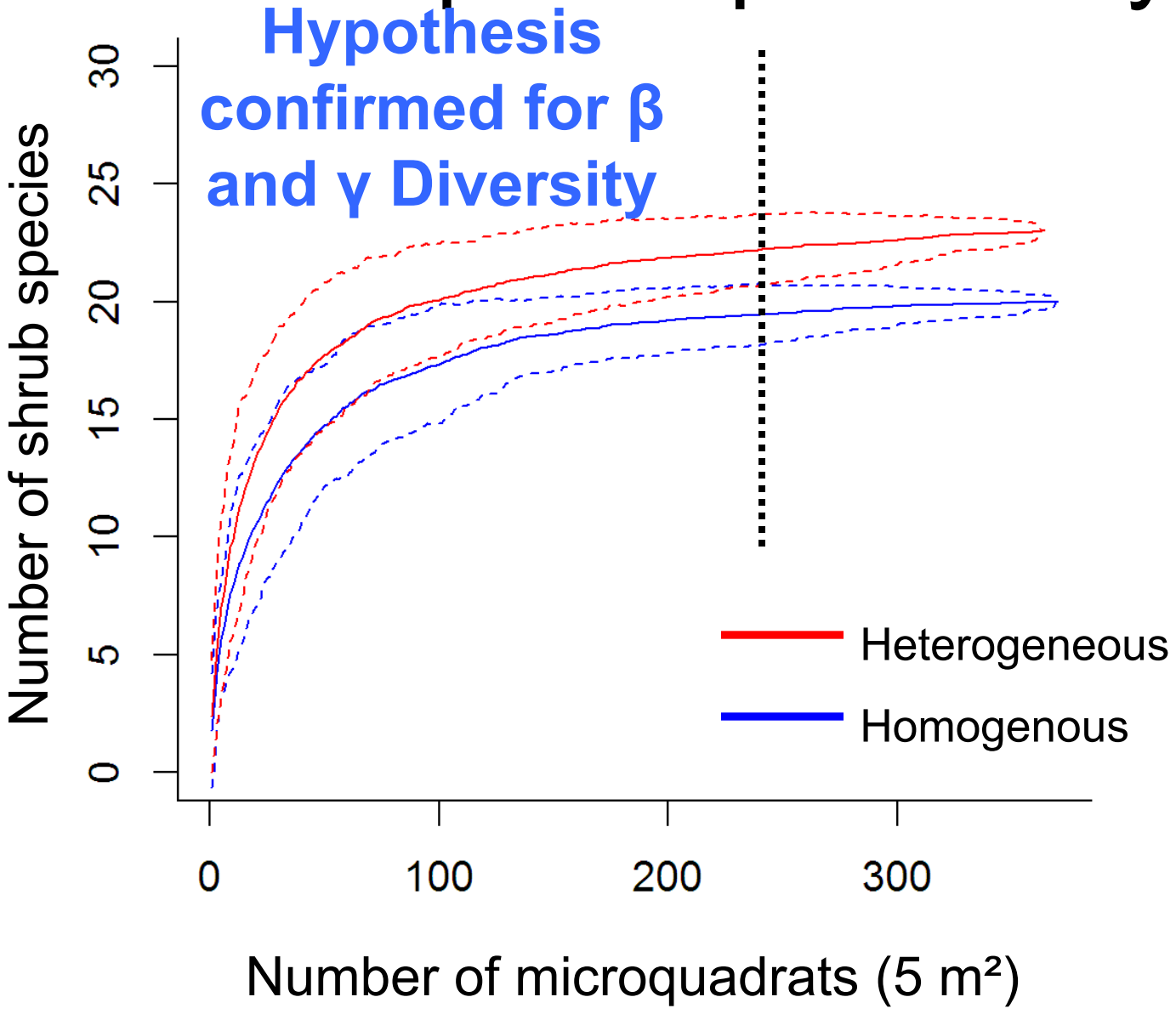
Hypothesis rejected for tree α-diversity

Statistics - Two factor ANOVA mixed models with gap or forest site identifier as the random factor

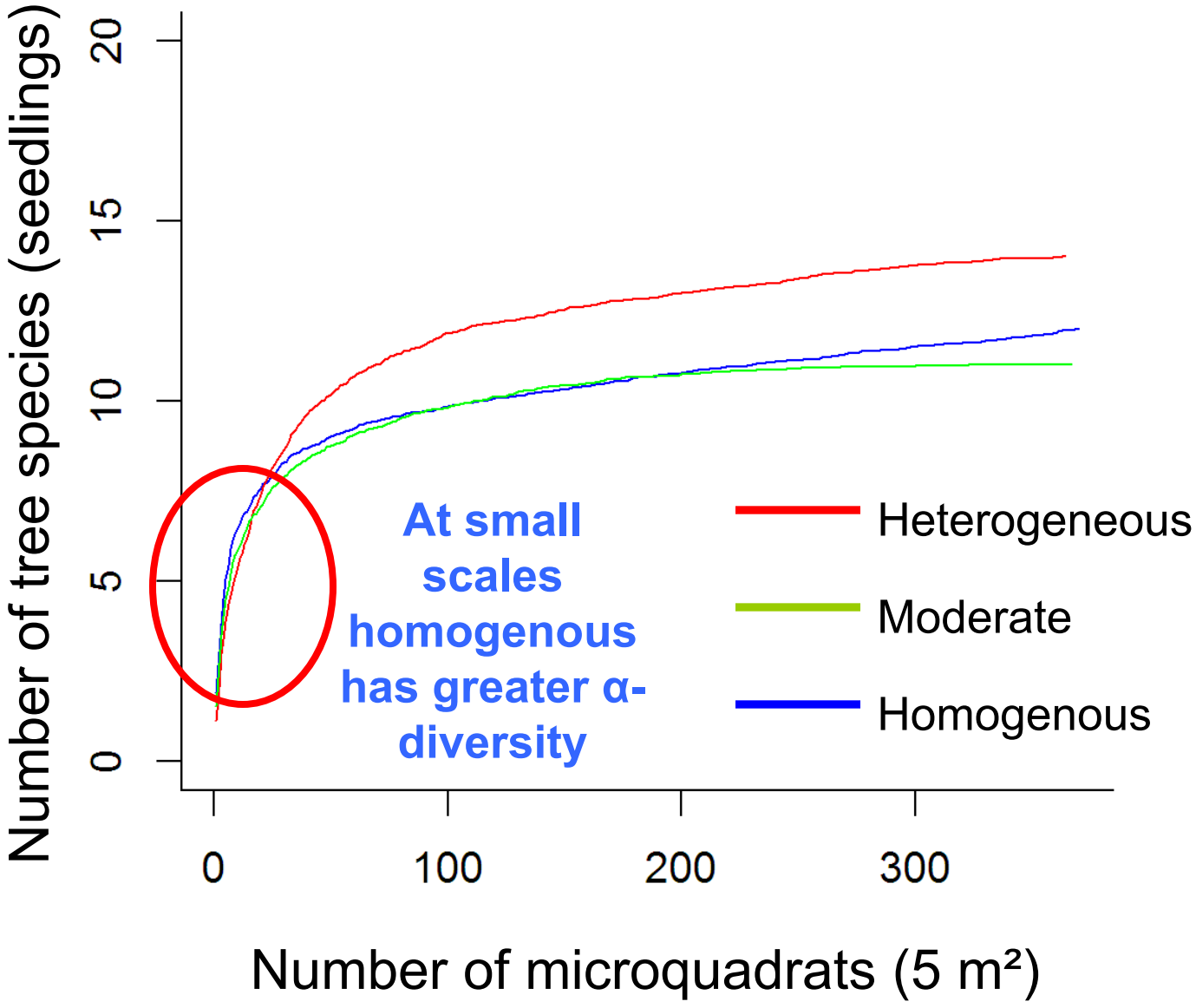
Shrubs – β and γ Diversity



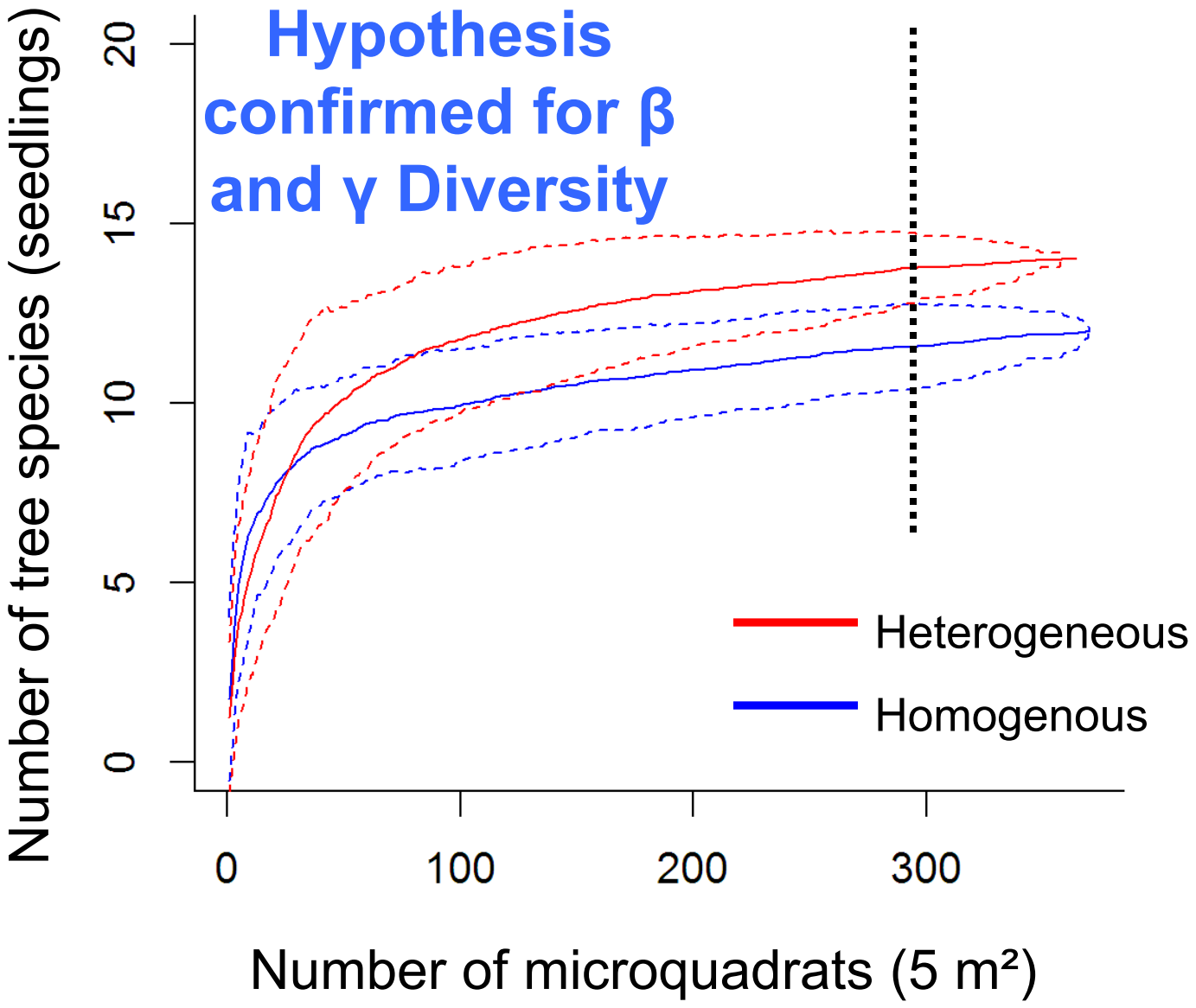
Shrubs – β and γ Diversity

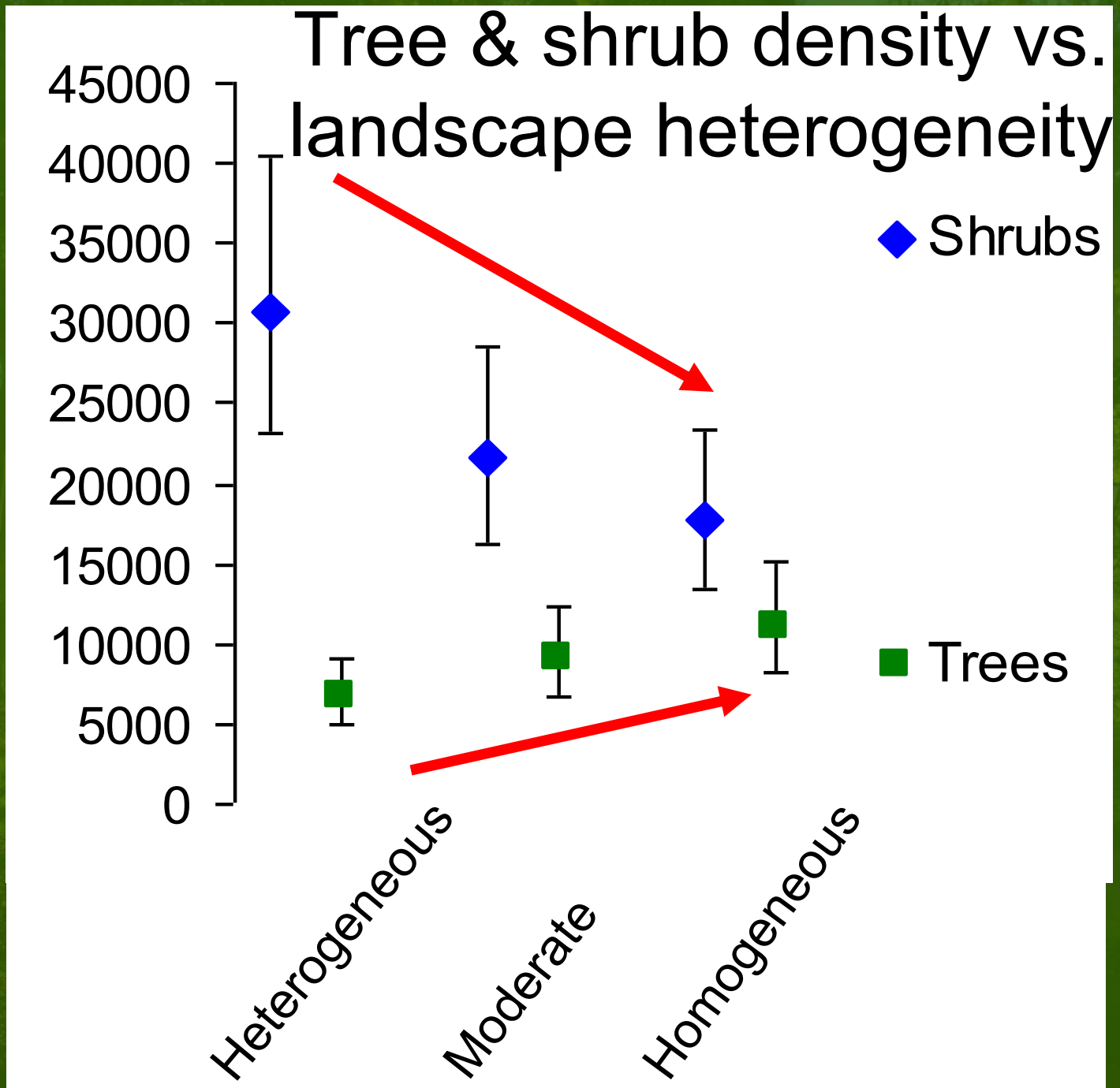


Trees – β and γ Diversity

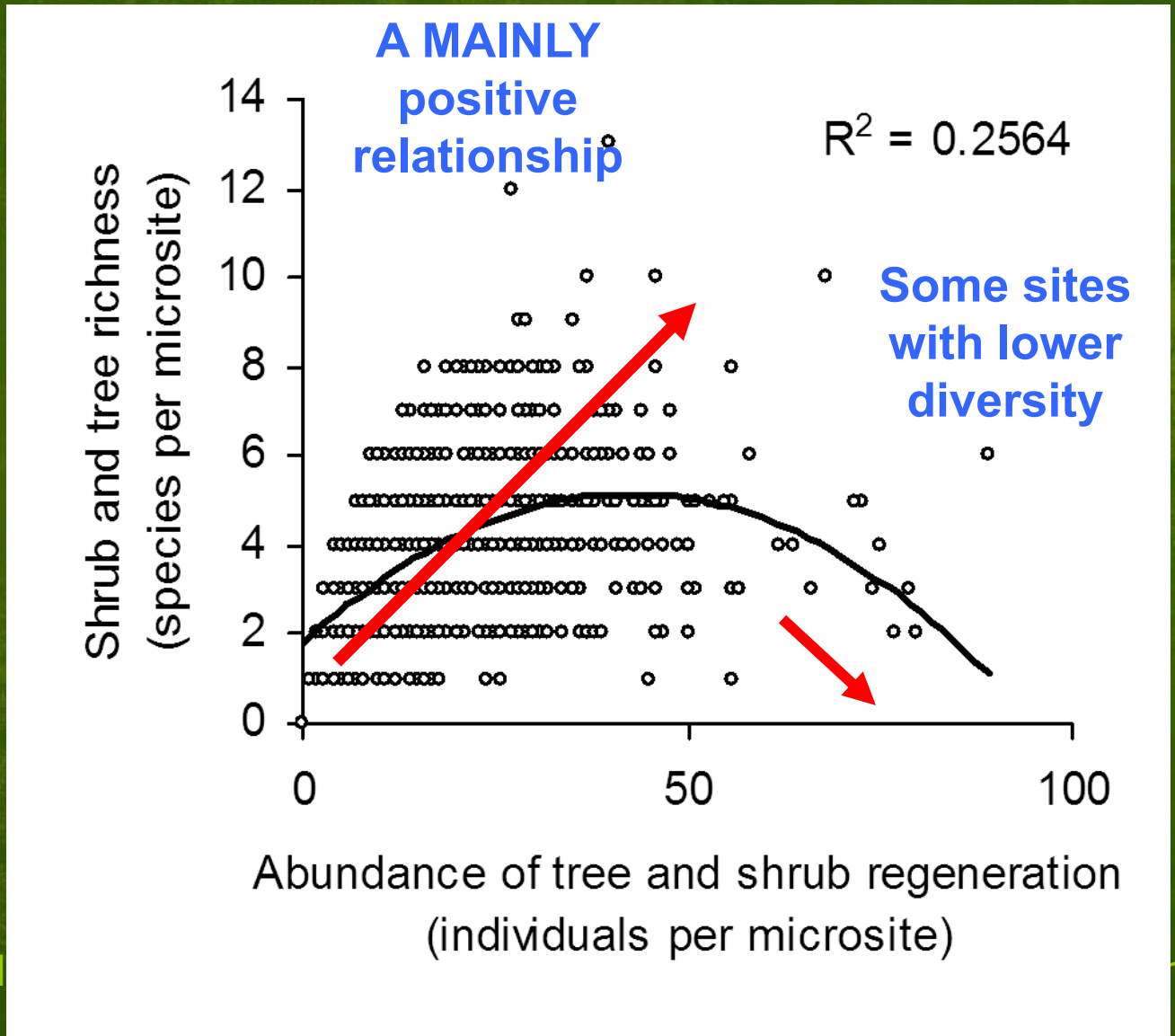


Trees – β and γ Diversity

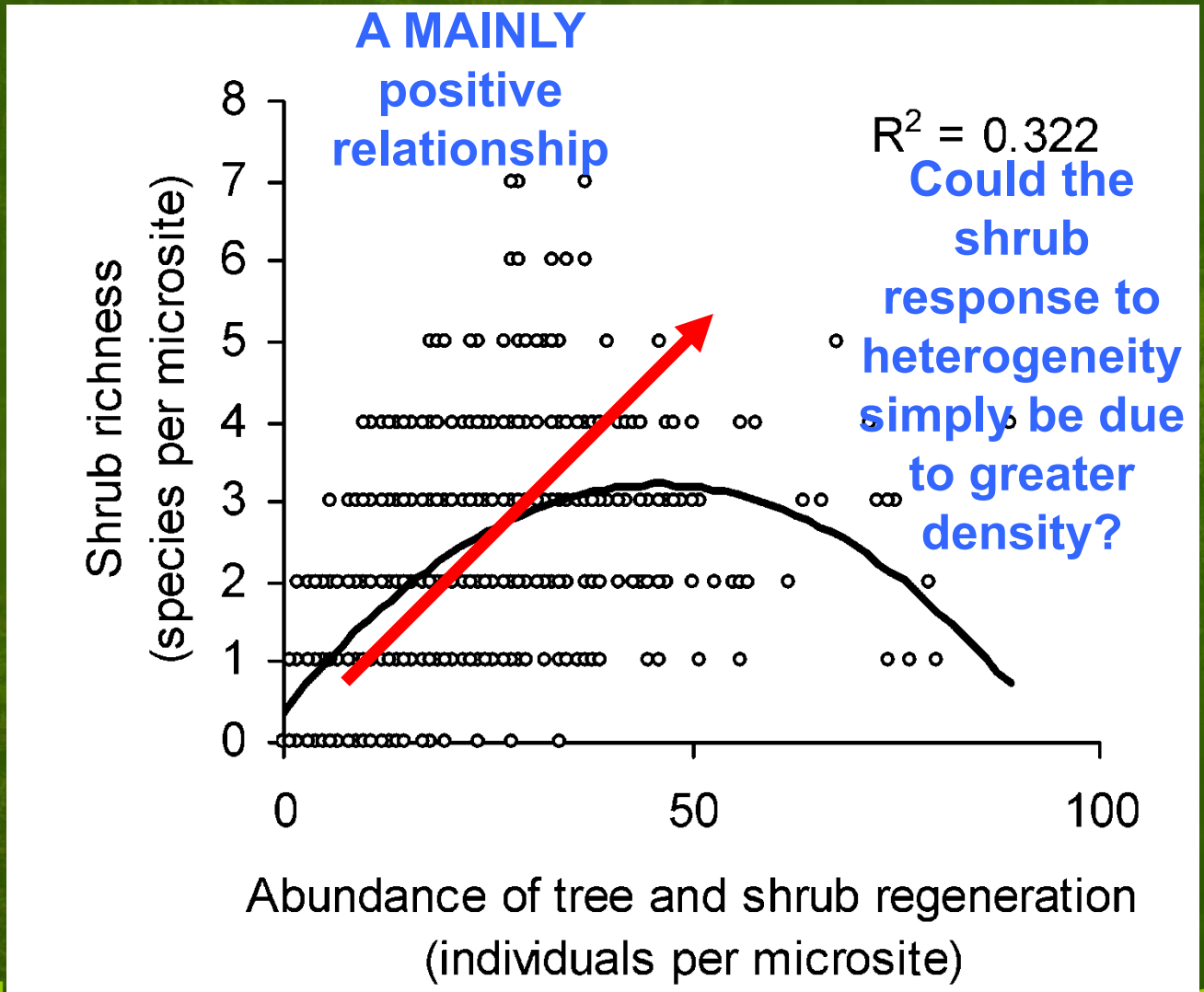



Tree & shrub density vs. landscape heterogeneity
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Shrubs
Trees
Heterogeneous
Moderate
Homogeneous

Diversity Biomass Relationship

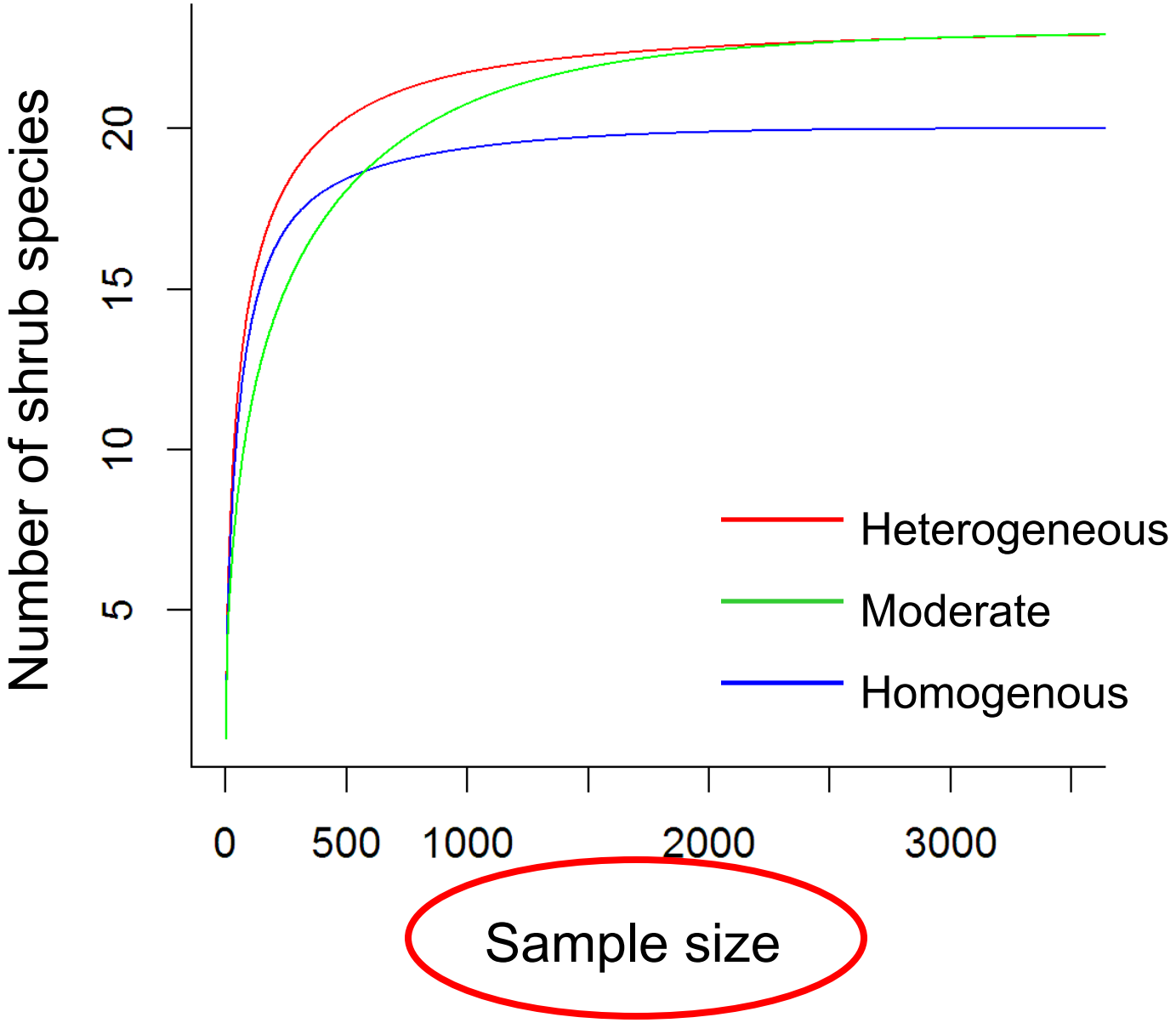


Diversity Biomass Relationship

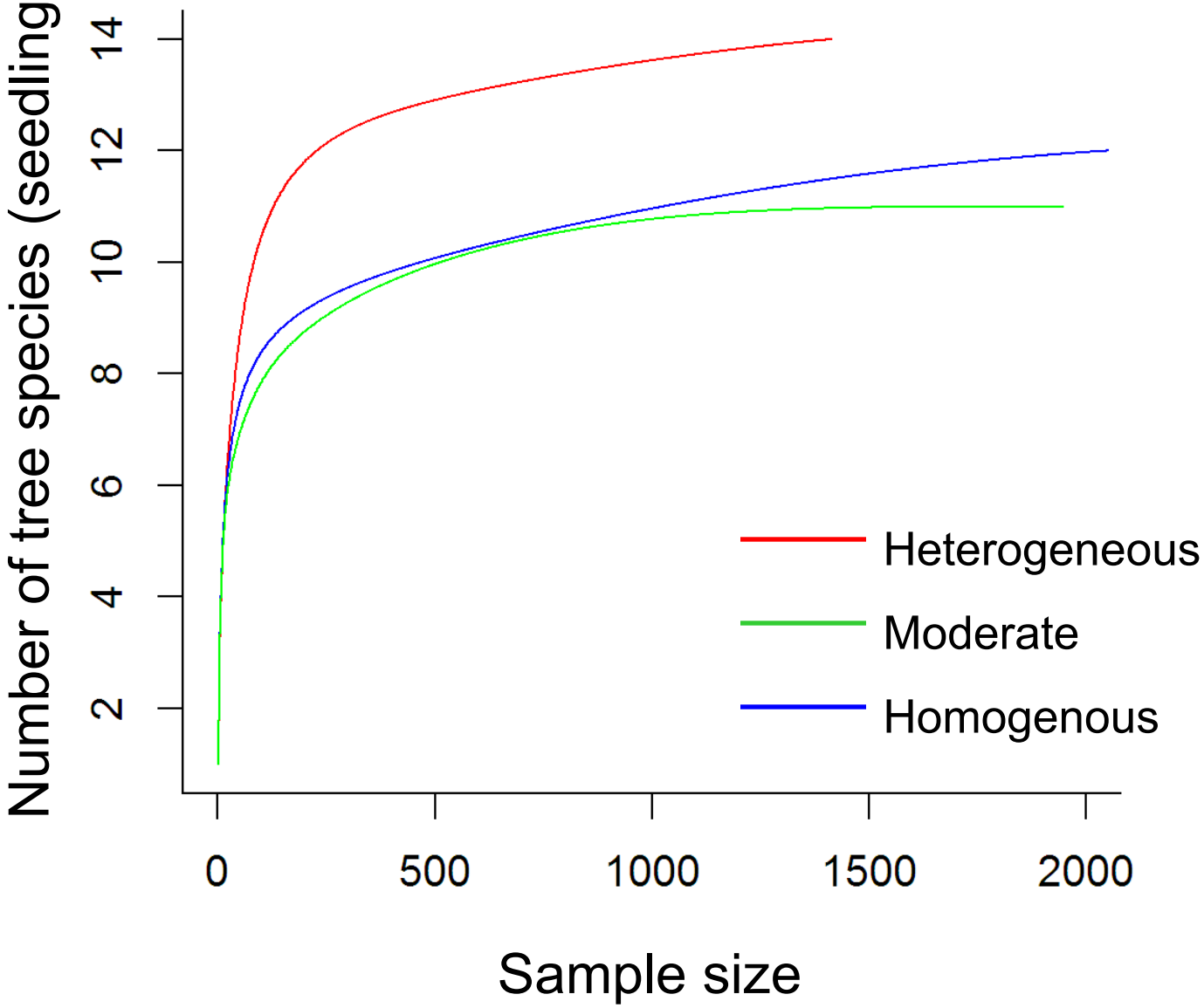


And not biological processes ?

Rarefaction



Rarefaction



Conclusion

1. Hypothesis rejected for tree seedlings
   - ↓ α-diversity in **Het** landscapes

2. ↑ shrub diversity in **Het** landscapes result of greater shrub density in **Het** landscapes? **NO!** Rarefaction results suggest a biotic interaction

2.5 **Increased heterogeneity** from multiple intermediate disturbances (SBW, tree harvest) favor the density and diversity of shrubs, and limits the density and diversity of trees

Future planning

3. Management implications heterogeneous landscapes are not necessarily more diverse for trees
   SPB + Cut + Natural disturbance = TOO MUCH!

3.5 Precautions must be made in forest management to avoid crossing a threshold in landscape heterogeneity. Comprehension of previous disturbances must therefore be taken into account for future planning.