



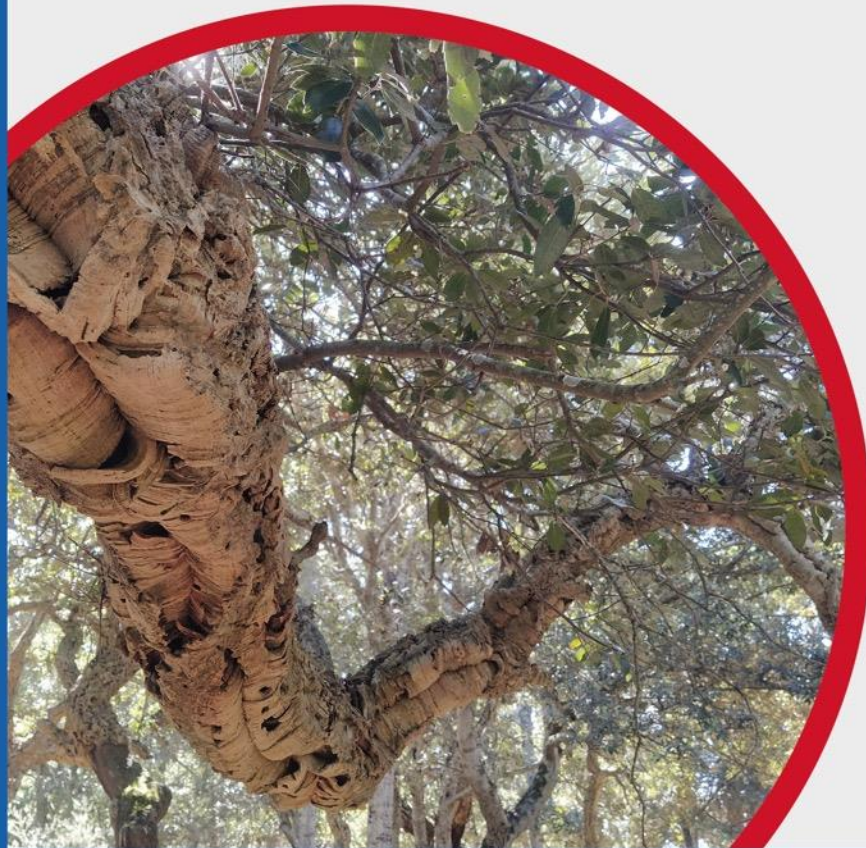
LIFE21-NAT-IT-LIFE  
GOPROFOR MED  
101074738

# PRESERVING AND MANAGING FOREST HABITATS IN THE MEDITERRANEAN AREA

**WORKSHOP - MONDAY DECEMBER 4, 2023**



Co-funded by  
the European Union



## L'approccio allometrico: prima applicazione (Montes)

TOMMASO ANFODILLO, GAIA  
PASQUALOTTO, VINICIO CARARRO,  
SAMUELE PELLIZZARI (UNIVERSITÀ DI  
PADOVA DIP. TESAF)

# Project

The **main aim** of LIFE GoProForMED is to enhance the conservation status of **4 target forest habitats** within the Mediterranean Biogeographical Region. This will be achieved through the application of **close-to-nature management models** in **4 representative countries** in the Mediterranean area (Spain, France, Italy and Greece).

**Identifying models for close-to-nature-management  
is an essential step.**

**How do we select these models?  
Where do we get them from?**

We can choose between **empirical models** (i.e.,  
statistical) or **functional ones** (where we need to  
understand the underlying mechanisms)

- Forest structure



- Forest functionality

- (i.e. productivity, potential evapotranspiration,
- energy/matter for herbivores, C sink, C stock, etc)

# An example of the empirical approach

Lucio Susmel (1980) University of Padova

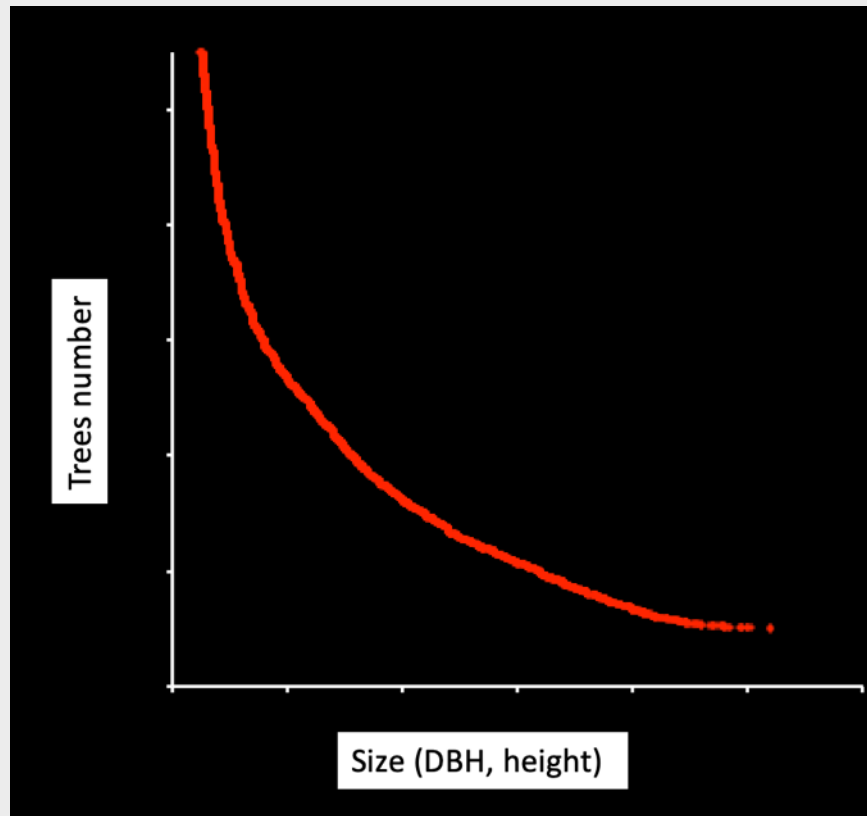
- Study of natural forests (Bosnia, Slovenia - Sardinia)
- Measurement of distribution curves (structure)
- Interpolation of curves and modeling based on forest height
- Application of these curves as a structural model for similar types of forests

*Susmel et al. (1976). Ecologia della lecceta del Supramonte di Orgosolo. CEDAM-PD*

- **we moved from empirical to functional models**

**Forest structure has been extensively studied**

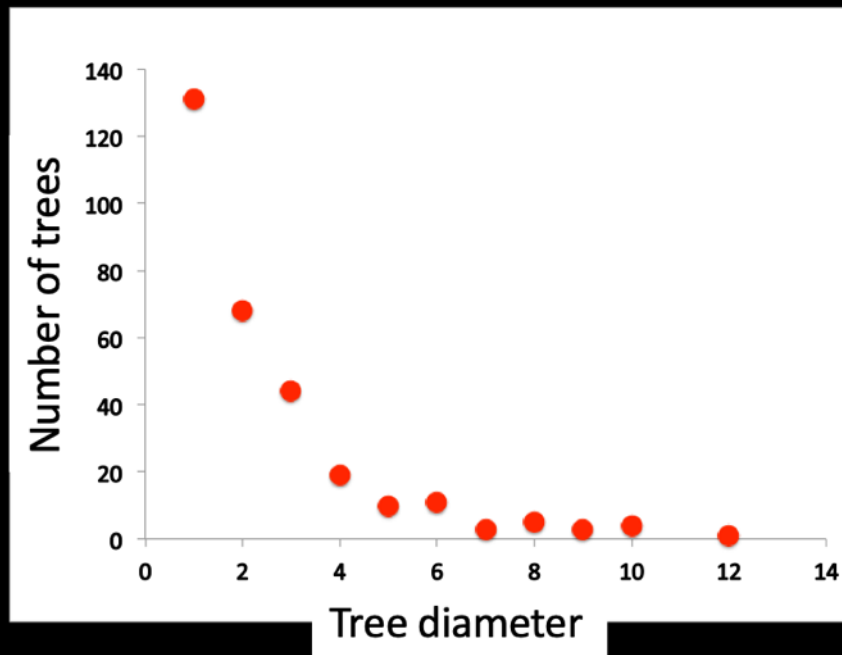
**An excellent descriptor of the structure is the  
“tree-size distribution”**



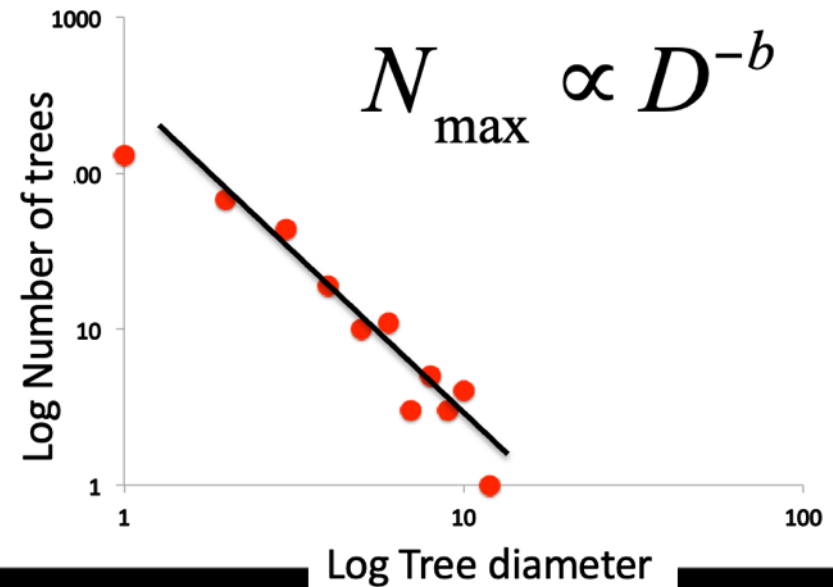
**Reversed J-shape curve**

# “Managing” a tree size distribution curve

## Not-transformed



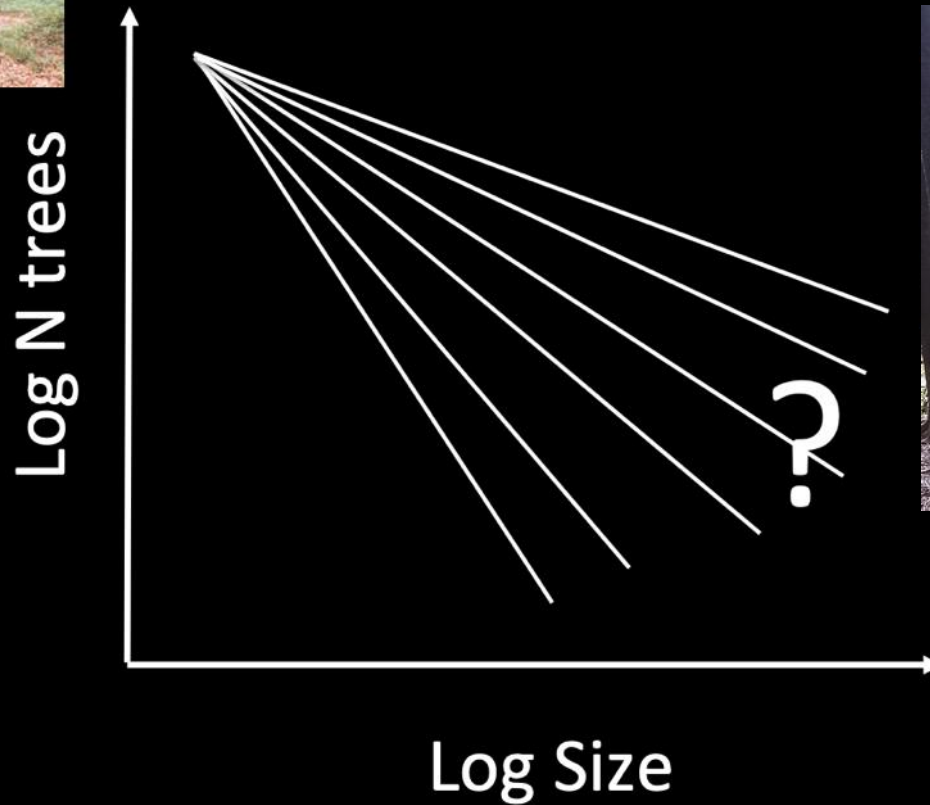
## Log transformed Power-law behaviour appears



# A FUNDAMENTAL QUESTION



**HOM MANY POSSIBLE SLOPES ARE THERE? Different models?**



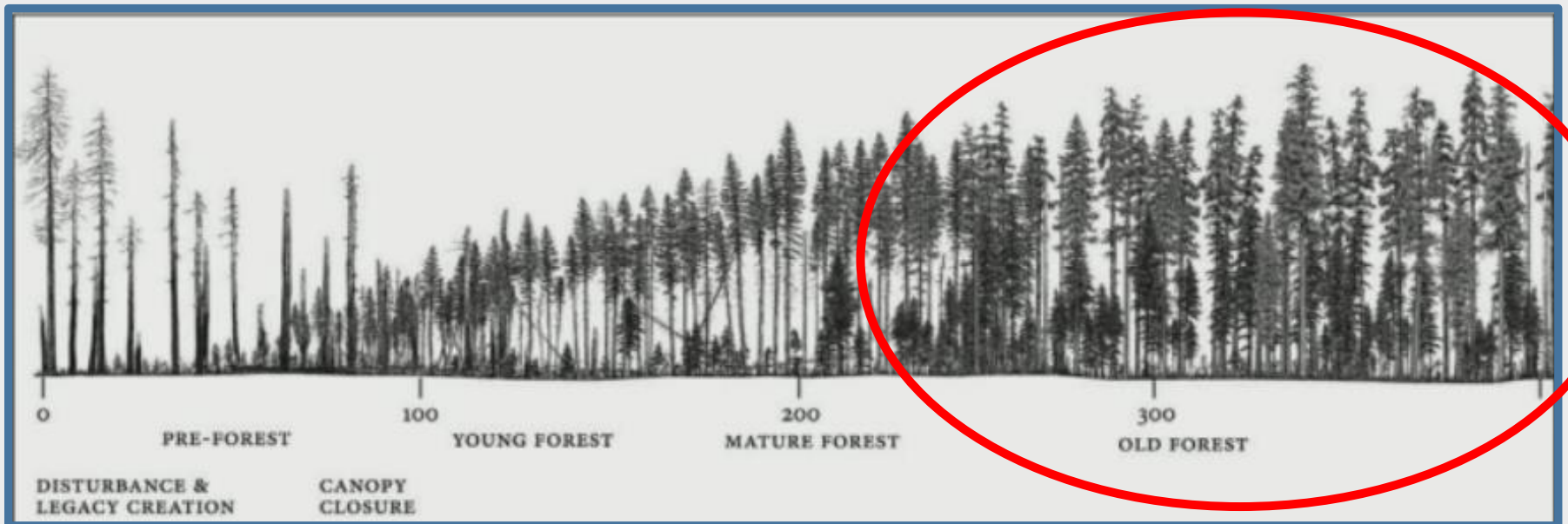


**Is there a general “rule” determining how trees are arranged in a community?**

**We would need a general theory about trees arrangement within a community  
i.e. a functional model**

# Main assumption

The forest can reach a successional status where it utilizes all available resources

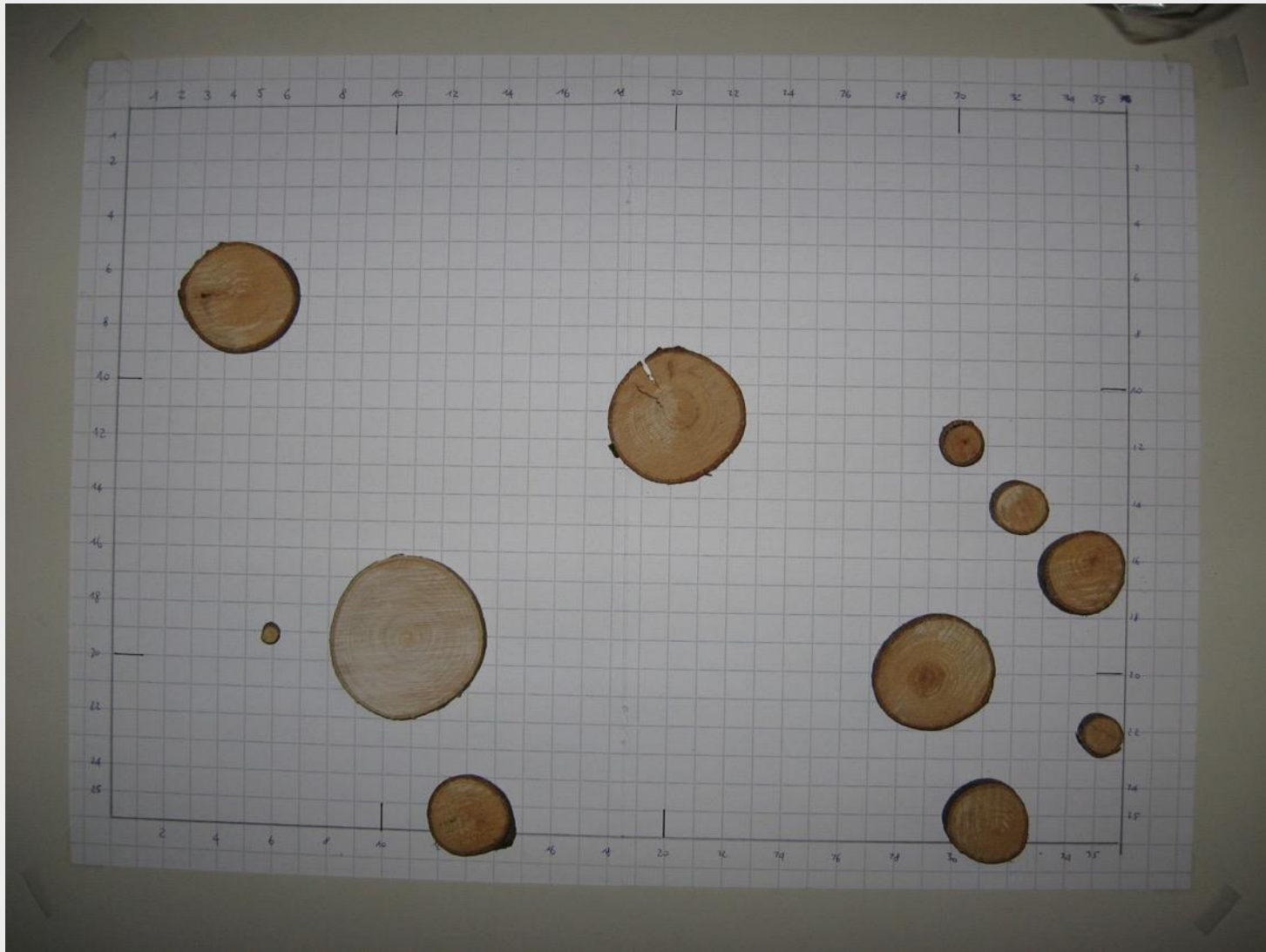


The biomass doesn't change significantly

## The concept is easy

- Casual drop of seed on the ground (dices)
- Different sizes of trees





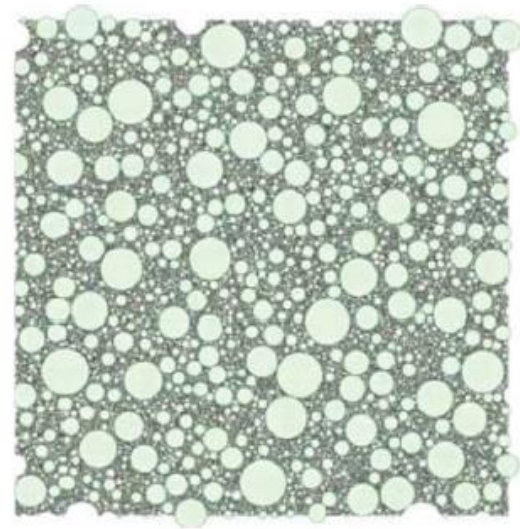
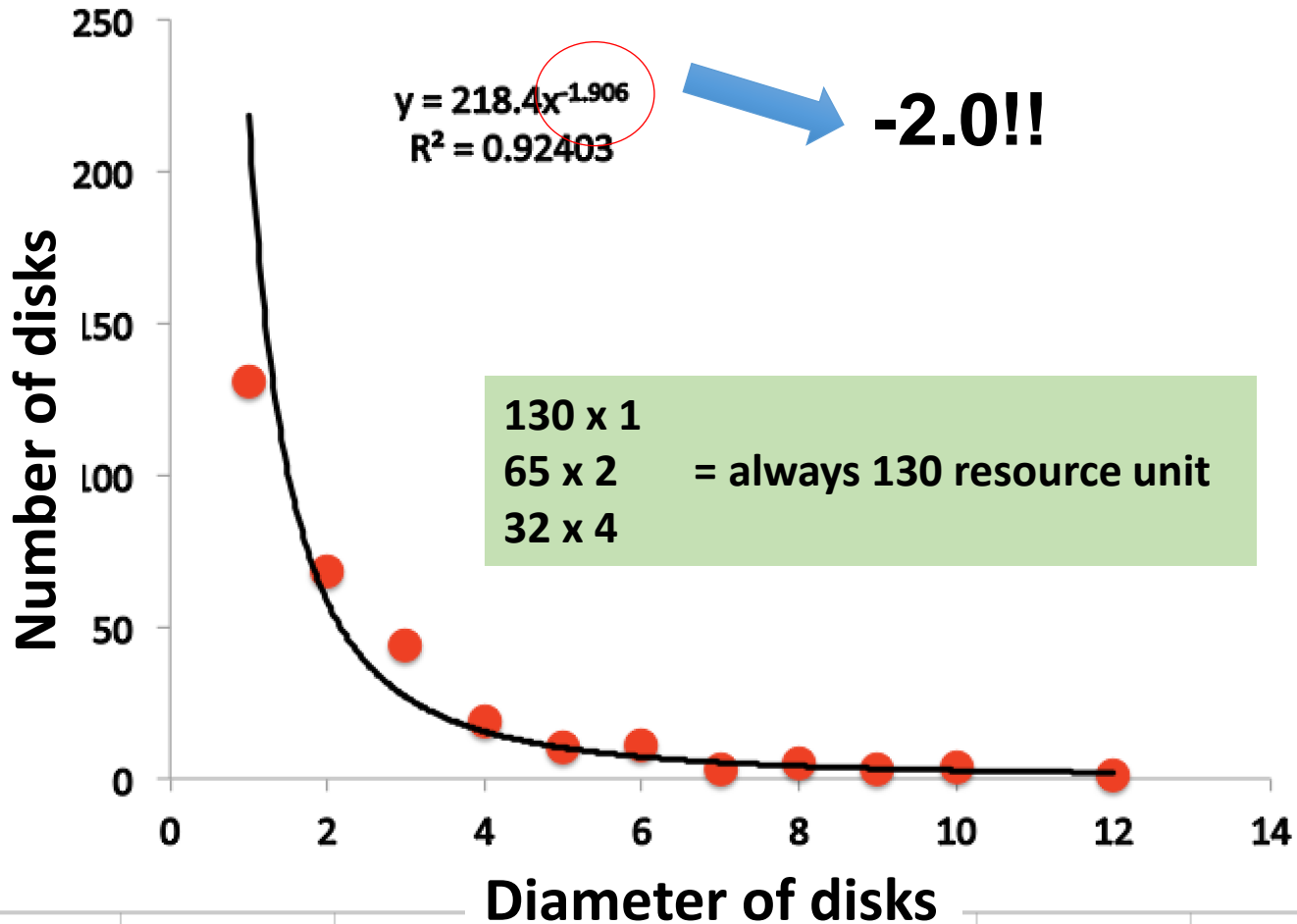


Figure 4. Numerical example of the finite-size scaling.

# What is the distribution obtained from the principle of total resource use?



**Total area=  $N_1 \cdot D_1 = N_2 \cdot D_2$ .. Is COSTANT!!**

**$N_i \propto A_i^{-1}$  or  $N_i \propto MR_i^{-1}$**

Metabolic rate

# Energy equivalence principle/rule

Any size class uses the same amount of energy

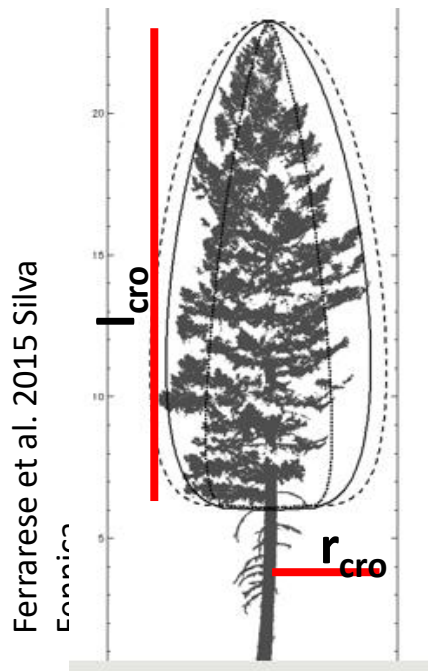
We would like to test if forests follow the same principle

- We have to find a metric of the metabolic rate of a tree (we suggest to use the crown volume)
- We can predict the optimal distribution as  $N_i \propto MR_i^{-1}$
- This distribution represents our close-to-nature model



## Crown volume $V_{cro}$

good proxy of resource use by tree & for the metabolic rate  $MR$



$$V_{cro} \propto r_{cro}^2 * l_{cro}$$

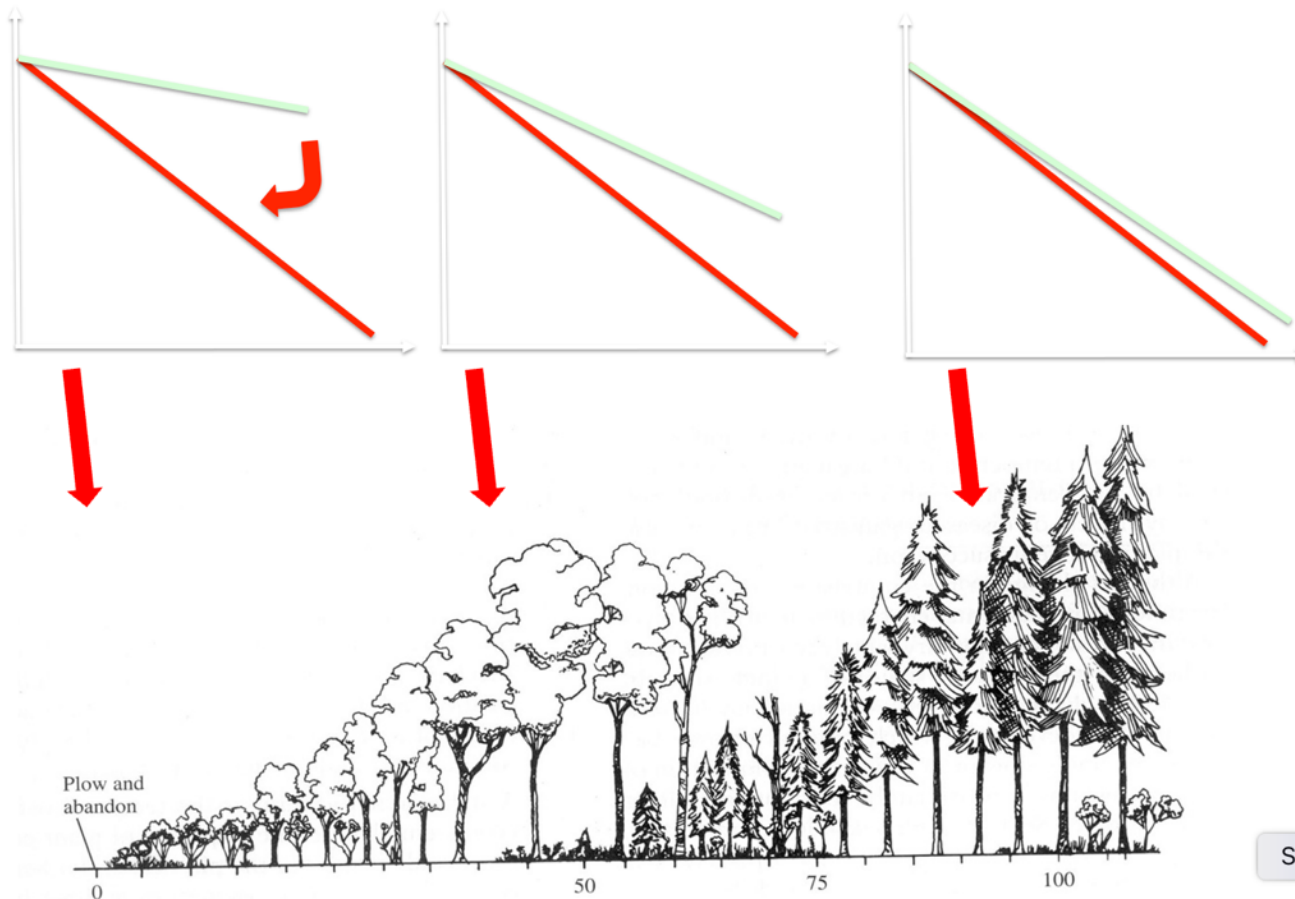
$$V_{cro} \propto h^{b = 1+2H}$$

*b is empirically estimated*

## • SUMMARY

- The scaling exponent of canopy volume vs.  $h$  ( $b$ ) is an indicator of resource utilization at the individual level and does not depend on potential disturbances
- The structure of maximum complexity has an exponent of  $-b$  (when using height in x-axis)
- The forest is the tree

The different slopes represent how far is the actual distribution from its potential

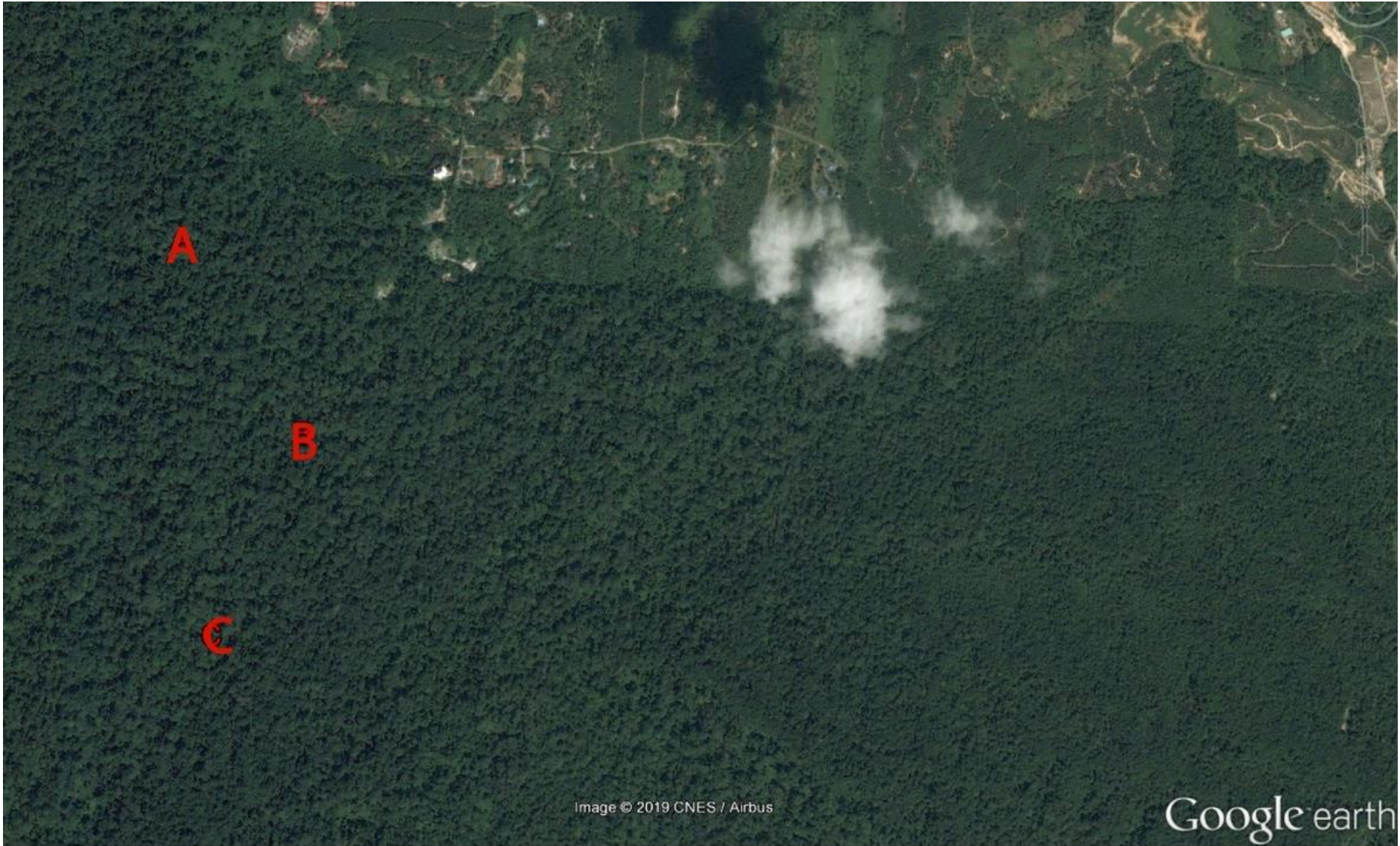


# Forests in Borneo

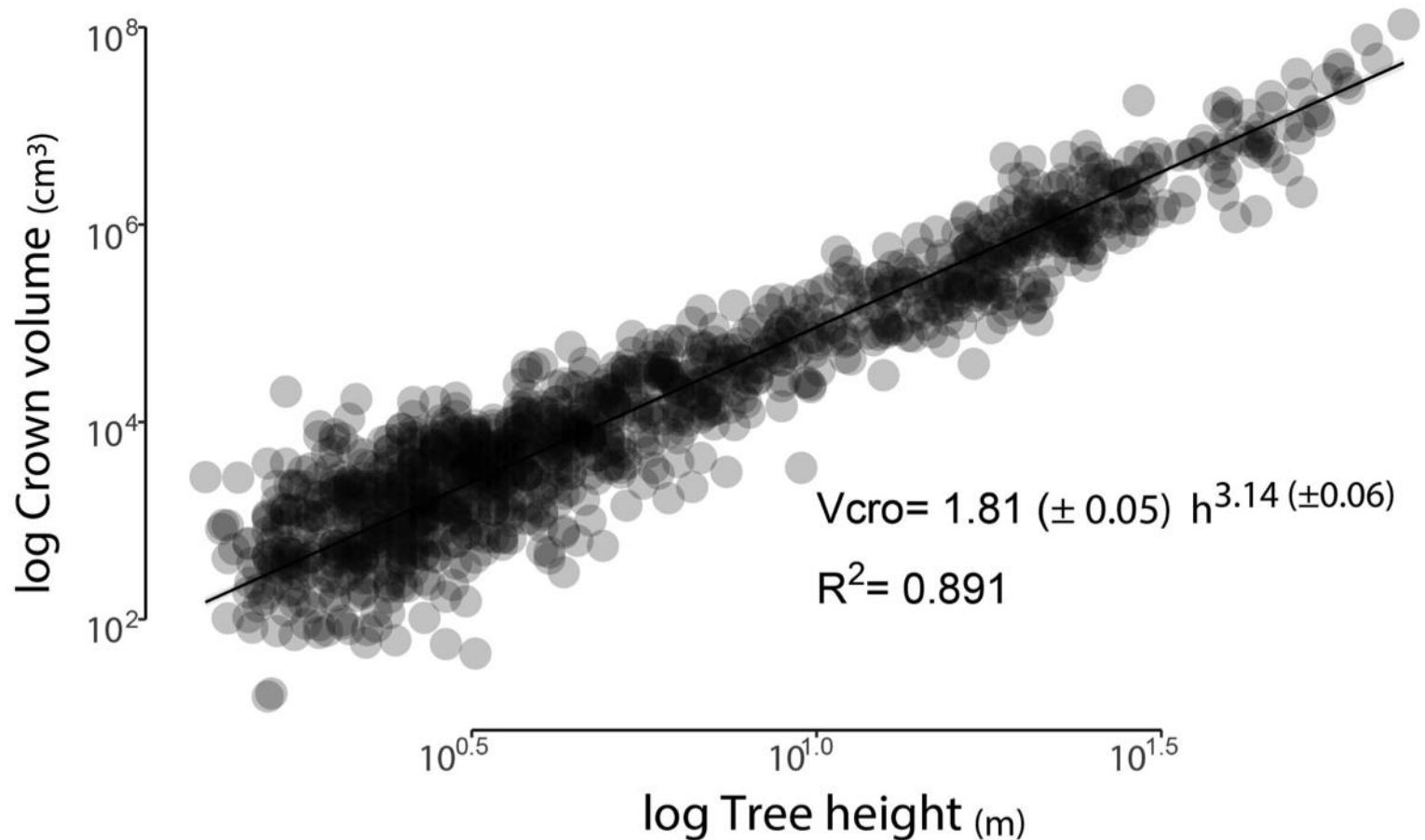
A

B

C

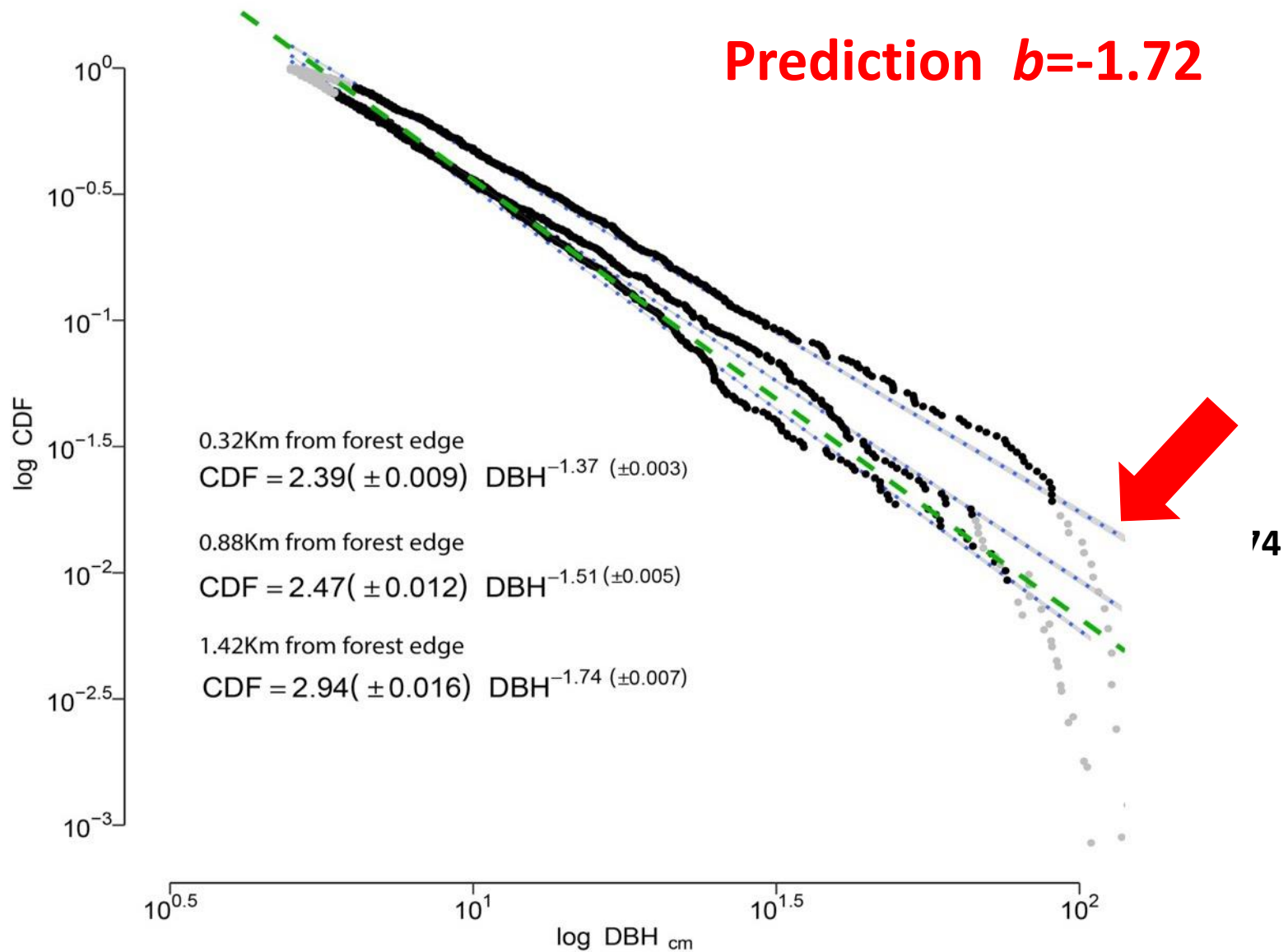


Borneo:  $V_{cro} \propto h^{3.14}$



**PREDICTION:  $N_{max} \propto h^{-3.14}$  or  $DBH^{-1.72}$**

# Borneo (distance from the edge) CDF



# Lecceta di Montes (Sardegna, Italy)

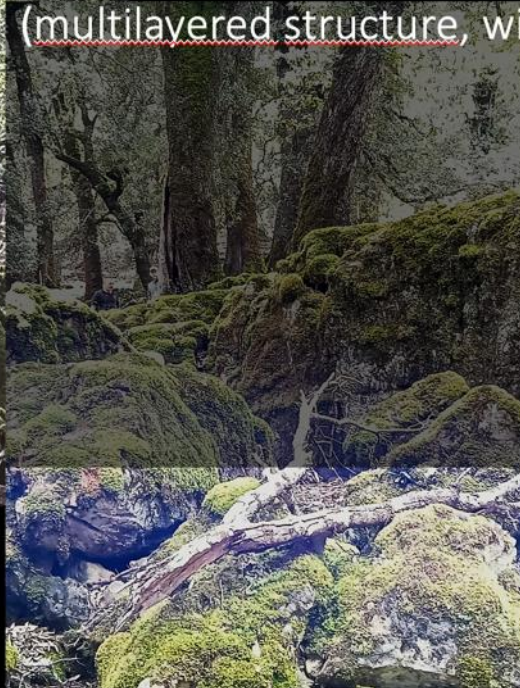
## June 2023



## Study areas

Areas of old growth mediterranean forest  
**CORE AREA**

(multilayered structure, wide variability of age and dimensions)



Forest in transition  
**SENESCENCE AREAS**

(often 1 layer, low number of life stages)





# Data collection

- Crown volume during *Q. ilex* ontogenesis

species, DBH, total height (h), height of the lowest living branches and two radii of the vertical crown projection in the two directions

Trupulse laser technology + ground measures (DBH)

- Class size of 2 mt height
- 4-5 trees per class

Total 110 trees measured



Screenshot

# Data collection



- Sample areas

- ❖ Trees > 2 m high – adult  
Diameter relascope areas

DBH from  
1 cm class  
size is  
measured !

- ❖ Trees < 2 m high – regeneration  
Linear transect 10 m x 1 m

50 sample areas in old growth

20 sample areas in transitional forest

20 Trasects 10 m<sup>2</sup> for natural regeneration

General requirements per each forest

40-50 relascope areas

20-30 regeneration transects

Time needed

7/10 days per team (4 people)



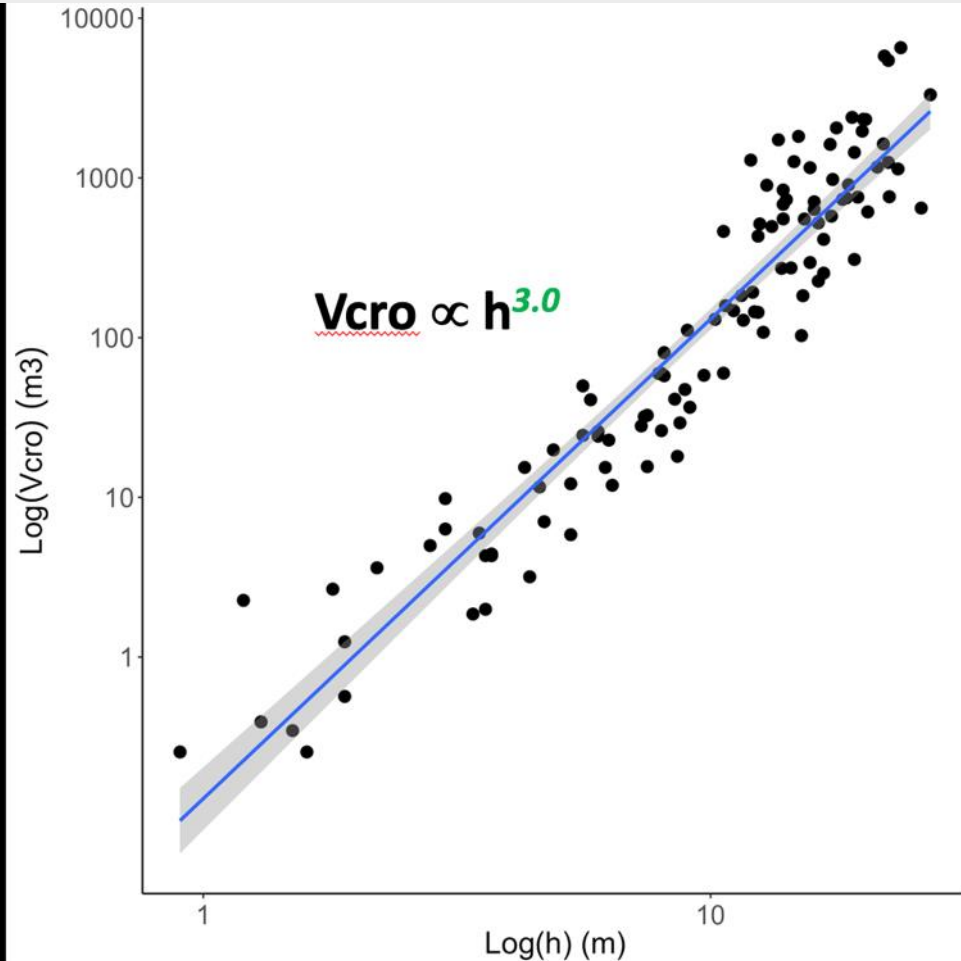
Screenshot

# Results

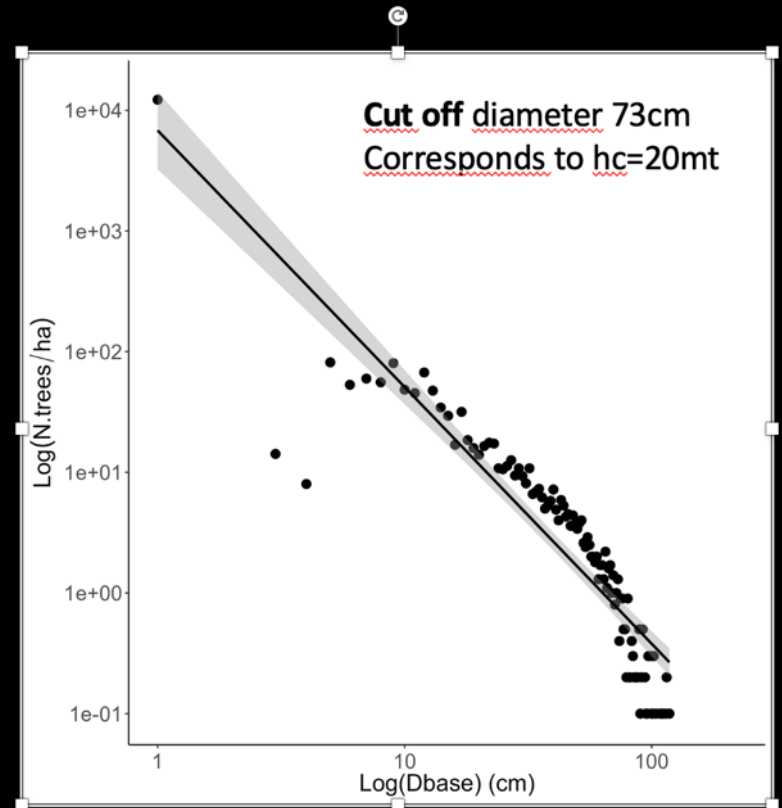
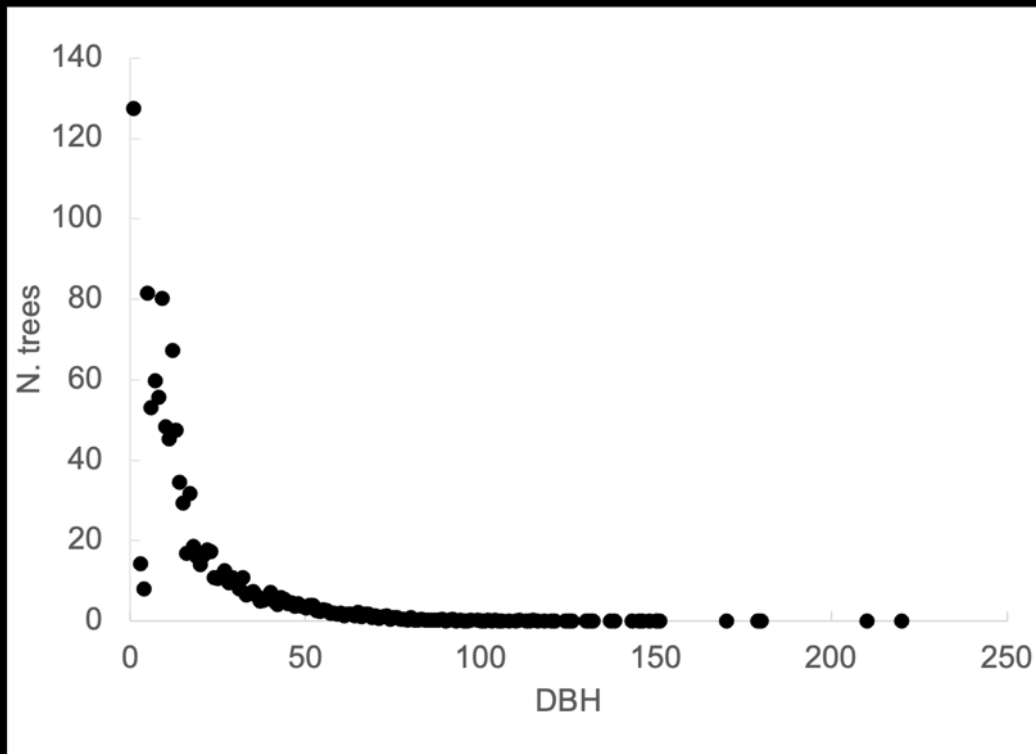
## Scaling $V_{cro}$ with $h$ Montes 2023

Linear model	intercept	exponent	R2 mrsq
$\text{lm}(\log(V_{cro}) \sim \log(h))$	-2.042	3.003	0.8977

**USING BASE DIAMETER  
the exp. is -2.4**

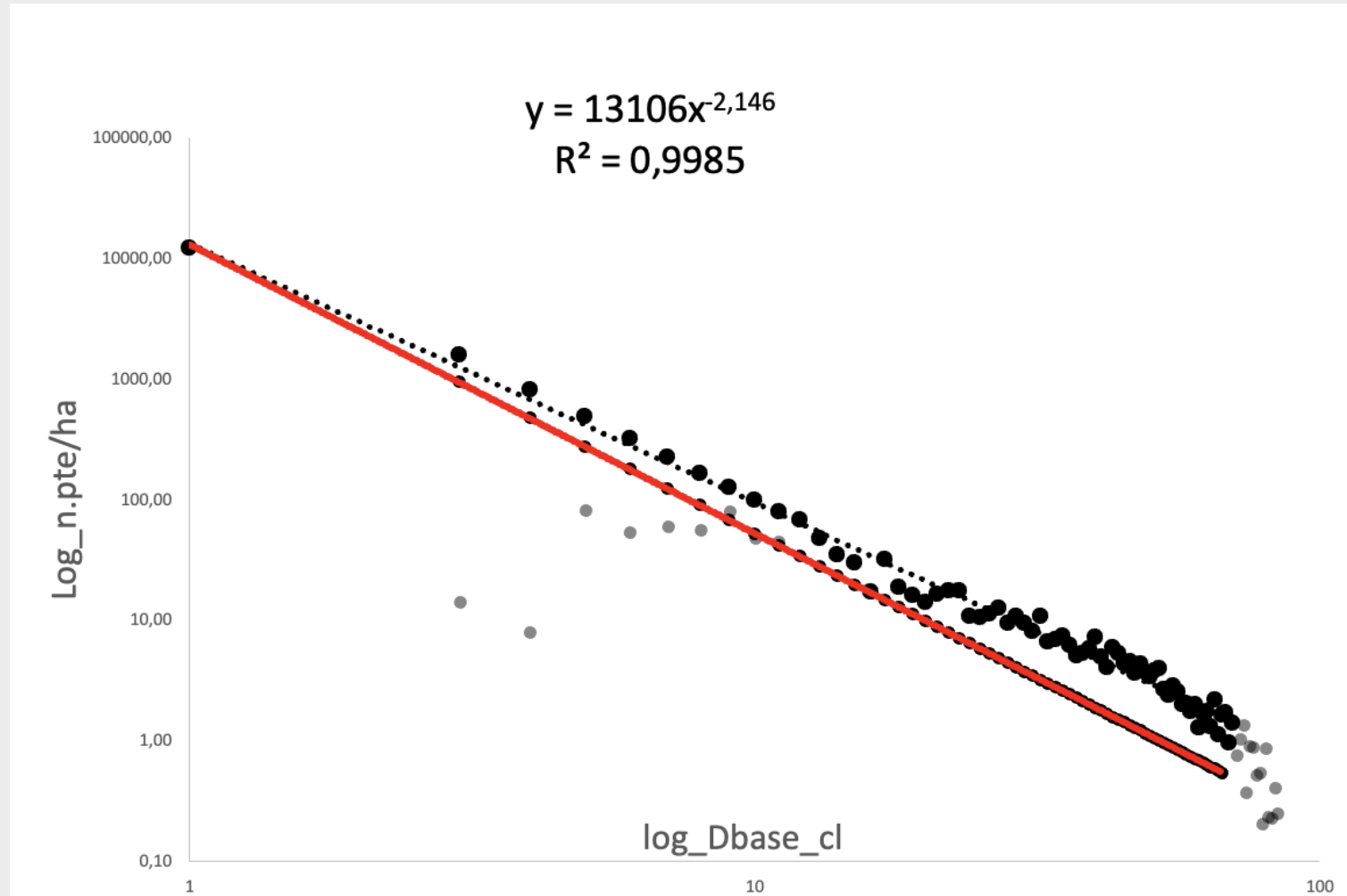


# Structure – Montes 2023



# Comparing actual-potential structure

## -2.146 vs -2.4



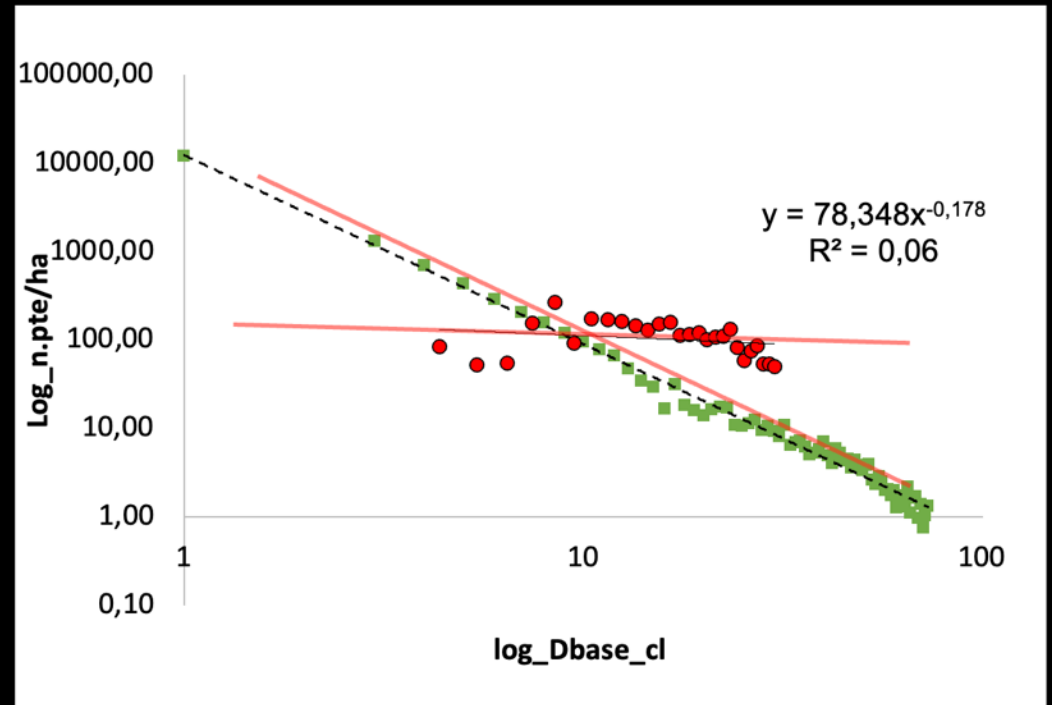
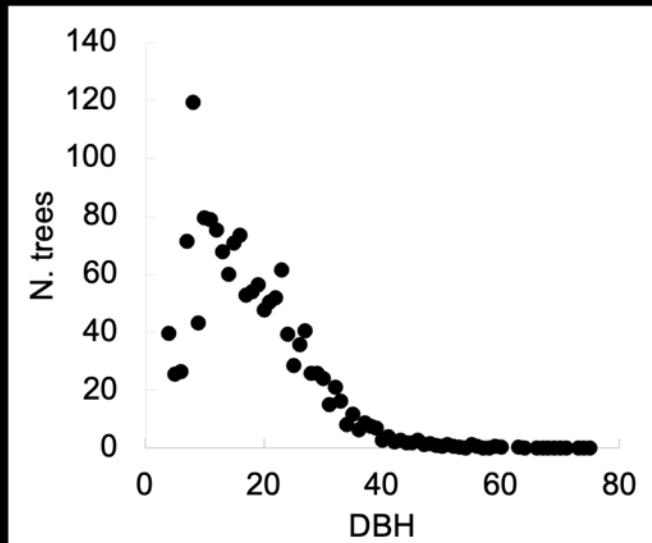
# Missing small plants

Base diameter	N/ha
1	0,00
3	1567,25
4	807,09
5	405,89
6	267,16
7	164,71
8	109,32
9	45,61
10	50,30
11	33,97
12	0,00

# Results

## Transition forest – senescence islands

How far from potential?



# Conclusions

- The allometric approach allows to predict the structure that corresponds to the maximum resource use (close-to-nature model)
- By comparing the actual structure with the potential it is possible to define the degree of disturbance (i.e. slopes difference)
- The approach is universal, site and species independent and it is easily applicable to any forest