# *Allometric models for the estimation of leaf area and dry weight from sapwood and heartwood area in black locust (R. pseudoacacia).*

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# Objectives

This work was carried out within the COFORMIT (COntribution FORest MITigation) project. COFORMIT studies the performance of black locust restoration plantations in rehabilitated open-cast coal mines of the Public Power Corporation (PPC) in Western Greece.

- The objectives of the study are:
  - ➤ to establish and evaluate species-specific allometric equations for *black locust* for the estimation of foliage leaf area and dry weight based on the sapwood area, current sapwood area and total cross sectional area of the trunk measured at different tree heights.
  - ➤ to assess the variability of the ratio of foliage area to sapwood area across the tree gradient.
  - ➤ to test whether the diameter at breast height could be reliably used for the estimation of the tree leaf area and the diameter at the base of the tree's live crown

# Study area
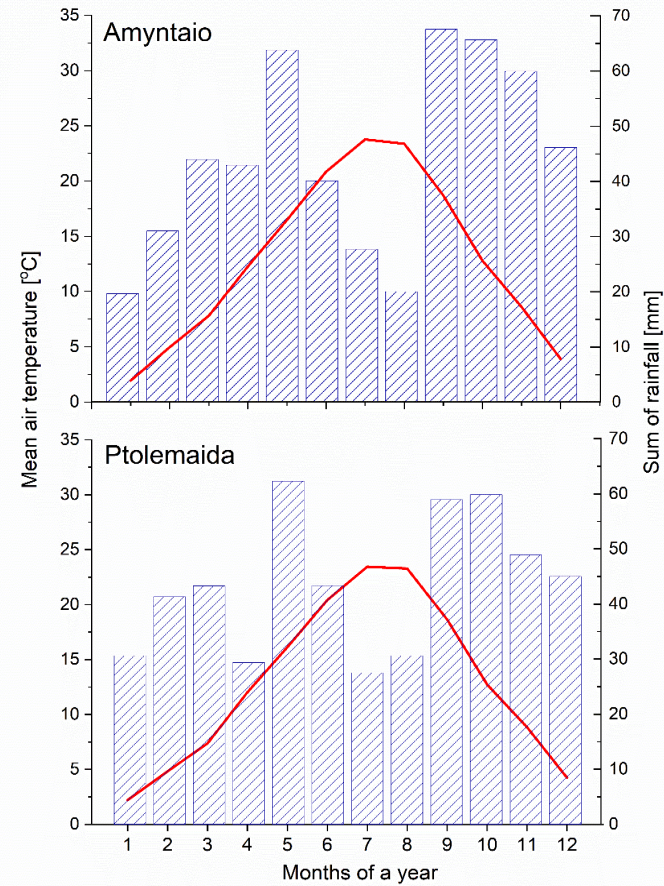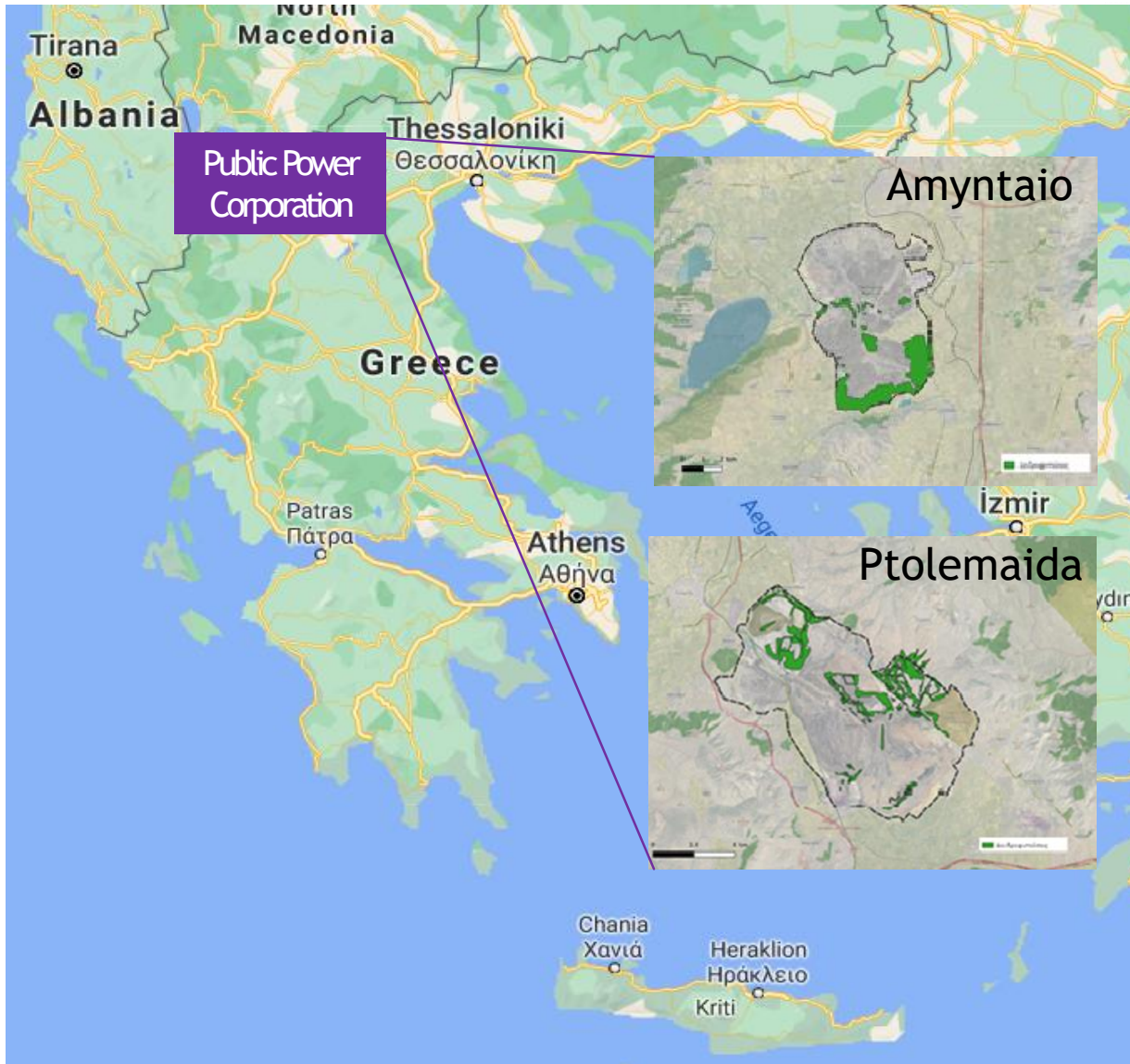


Ombrothremic diagram of the period 2008 - 2018.

Representative black locust restoration plantation in the study area.

# Materials – Field work

- Tree sample selection
- Tree logging
- Diameter measurements
- Collection sample leaves
- Trunk segmentation
- Collection brunches samples from all sections of the stem
- Collection of the crown
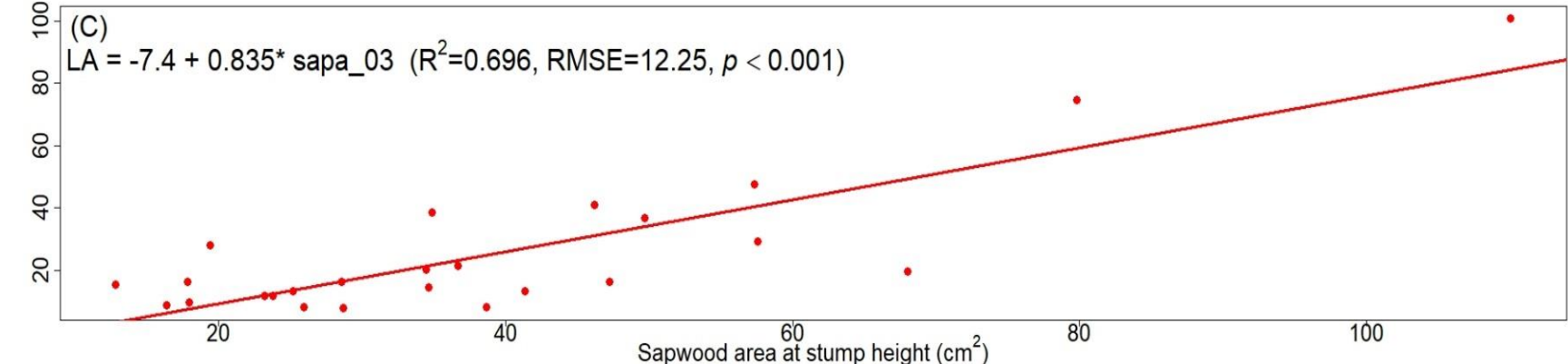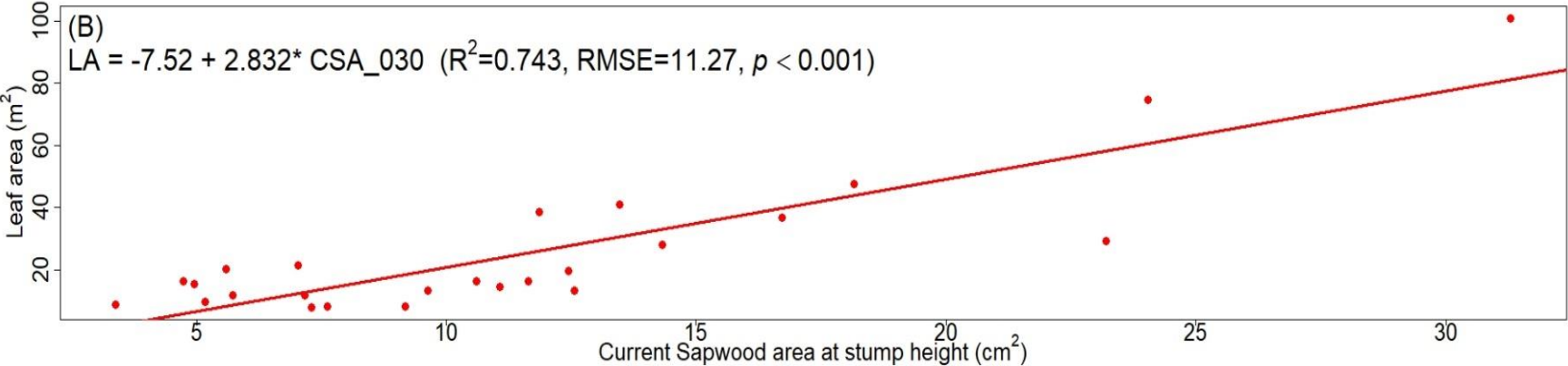- Weighing of fresh weight of stems and crown

# Materials – Lab work
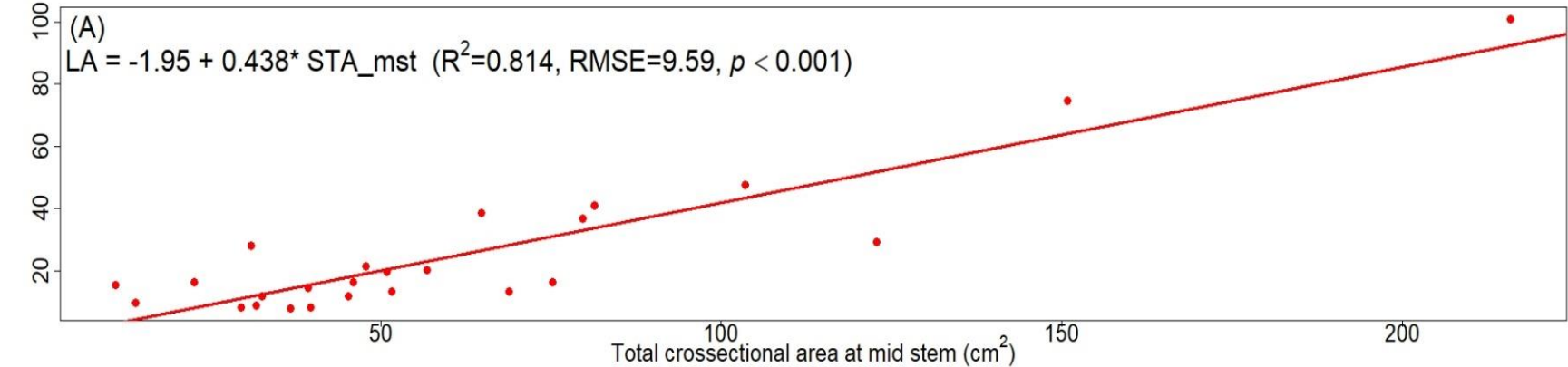


- Weighing of fresh weight of leaves and samples
- Digitization of leaves and wood essays
- Drying (80˚C)
- Weighing of dry weight of leaves and samples
- Leaf area calculation (Lafore)
- Calculation of Sapwood area, Current sapwood area and
  Total cross-sectional area (imagej)
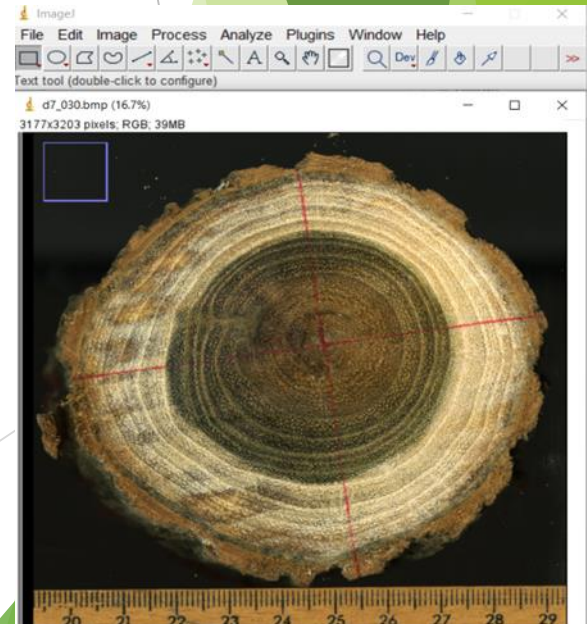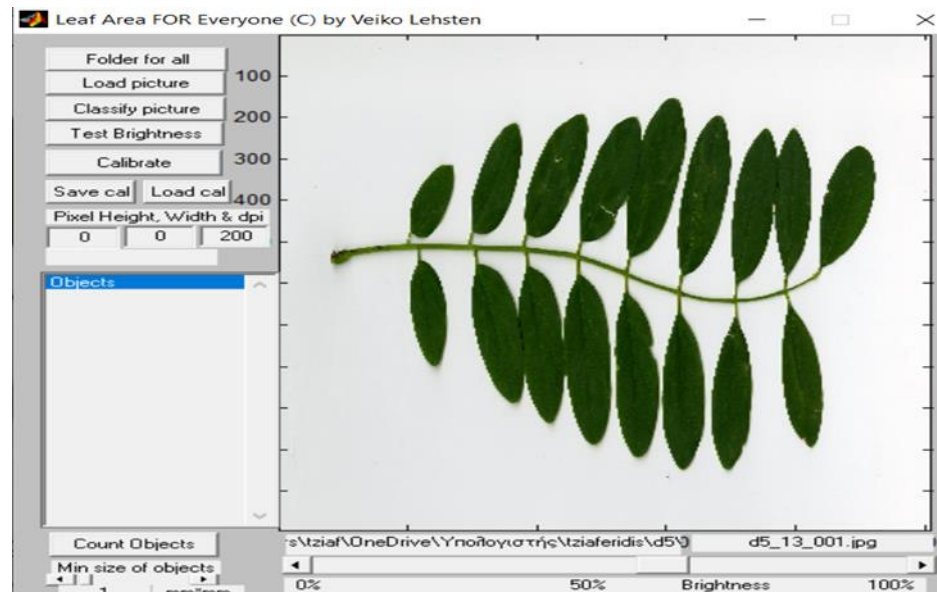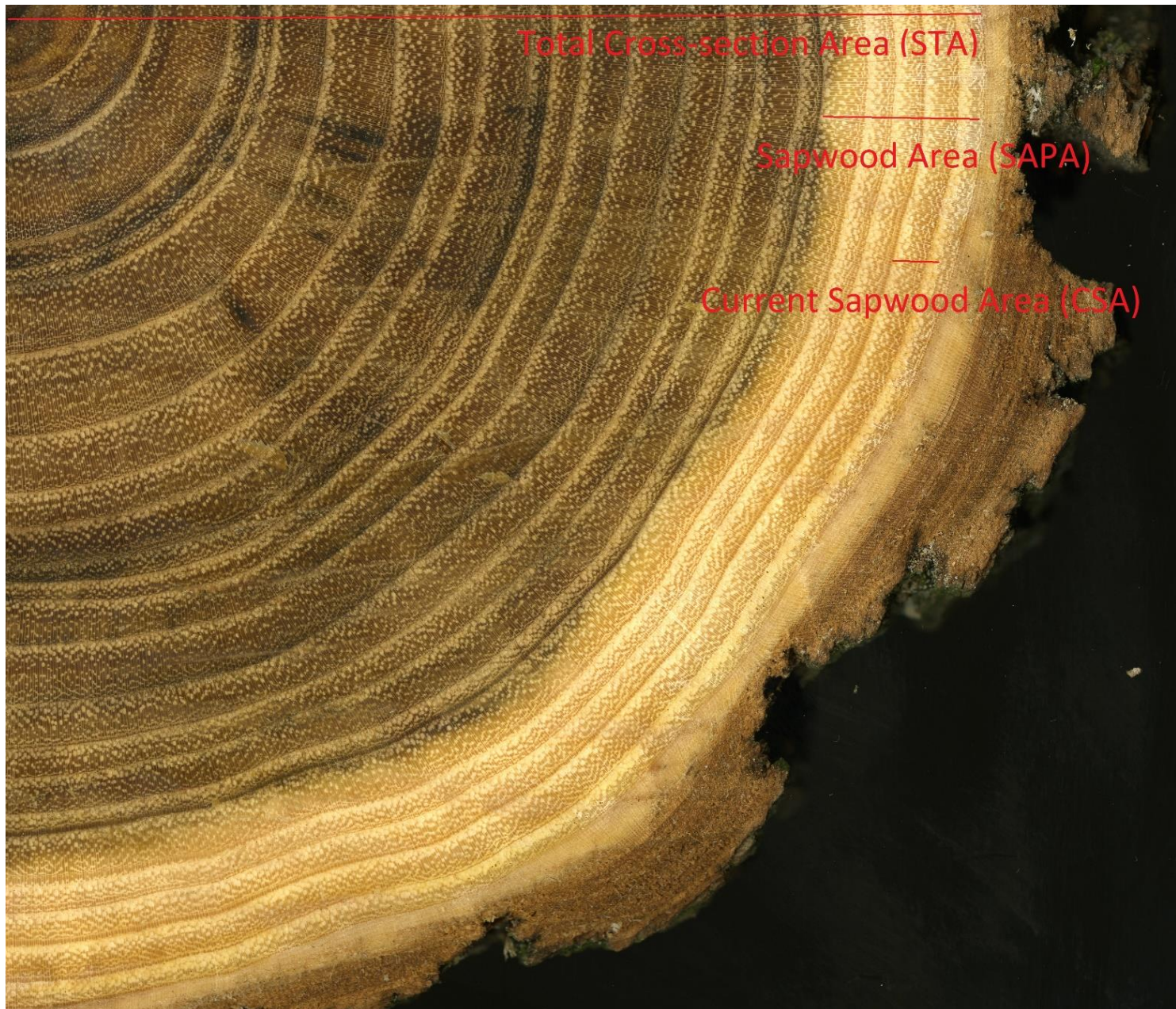
Presentation of Sapwood Area (SAPA), Current Sapwood Area (CSA) and Total Cross-sectional Area (STA).
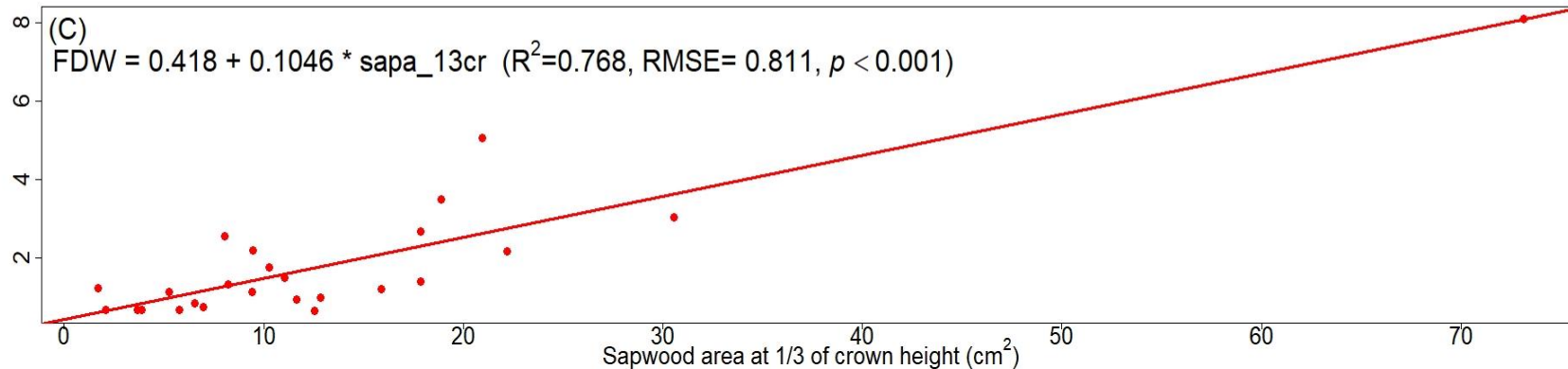
# Relation between Leaf Area and Sapwood Area, Current Sapwood Area and Total Cross-sectional Area



(A) $LA = -1.95 + 0.438 * STA\_mst$ ($R^2$=0.814, RMSE=9.59, $p < 0.001$)

(B) $LA = -7.52 + 2.832 * CSA\_030$ ($R^2$=0.743, RMSE=11.27, $p < 0.001$)

(C) $LA = -7.4 + 0.835 * sapa\_03$ ($R^2$=0.696, RMSE=12.25, $p < 0.001$)

- LA: Leaf Area
- SAPA: Sapwood Area
- CSA: Current Sapwood Area
- STA: Total Cross-sectional area

*Presentation of the best estimator for each variable.

# Relation between Foliage Dry Weight and Sapwood Area, Current Sapwood Area and Total Cross-sectional Area



(A)

$FDW = -0.184 + 0.033 * STA\_mst$ ($R^2=0.812$, RMSE=0.731, $p < 0.001$)

Total crossectional area at mid stem (cm$^2$)

(B)

$FDW = -0.604 + 0.214 * CSA\_030$ ($R^2=0.734$, RMSE=0.859, $p < 0.001$)

Foliar dry weight (Kg)

Current Sapwood area at stump height (cm$^2$)

(C)

$FDW = 0.418 + 0.1046 * sapa\_13cr$ ($R^2=0.768$, RMSE= 0.811, $p < 0.001$)

Sapwood area at 1/3 of crown height (cm$^2$)
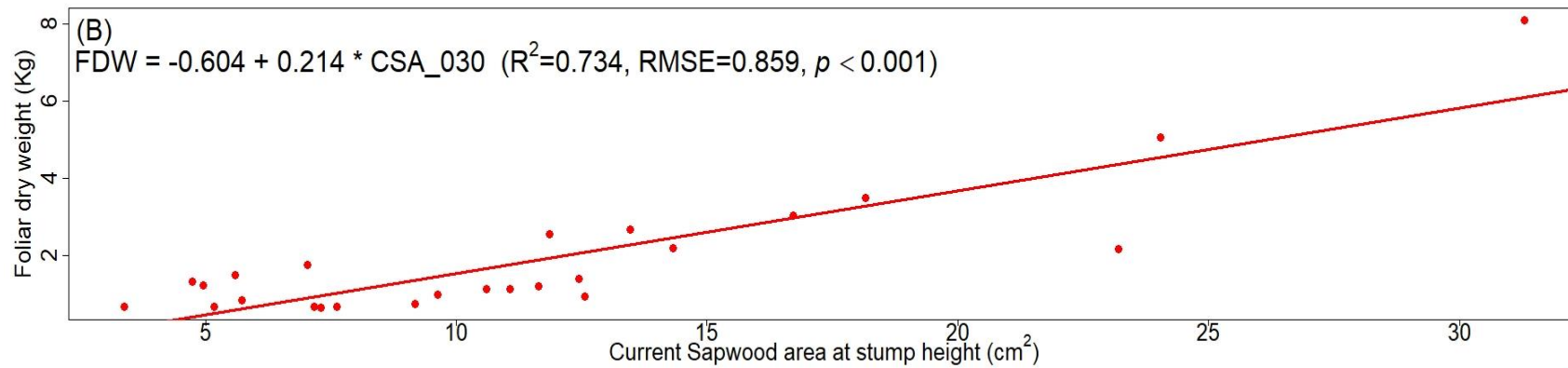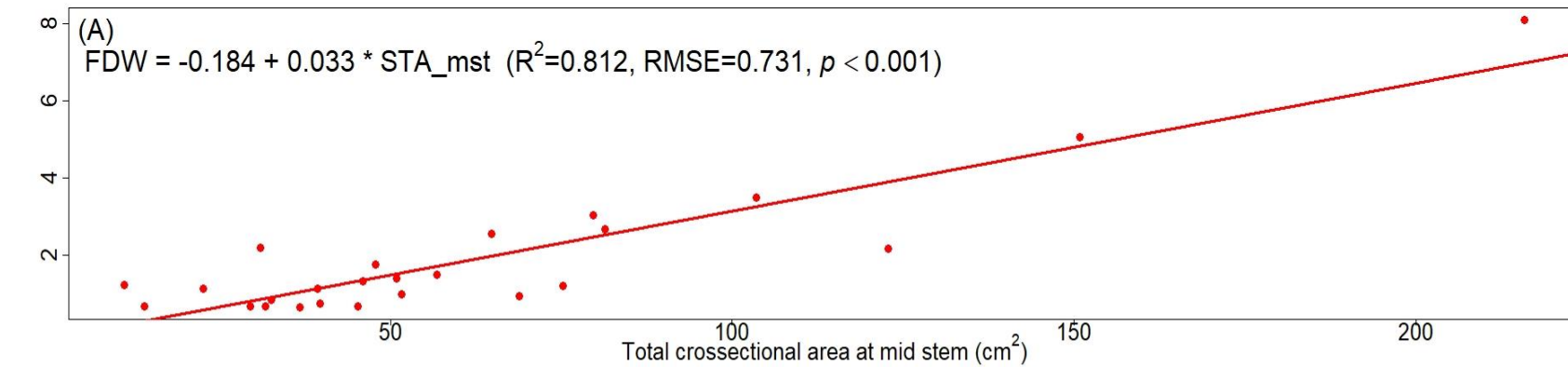
- FDW: Foliage Dry Weight
- SAPA: Sapwood Area
- CSA: Current Sapwood Area
- STA: Total Cross-sectional area

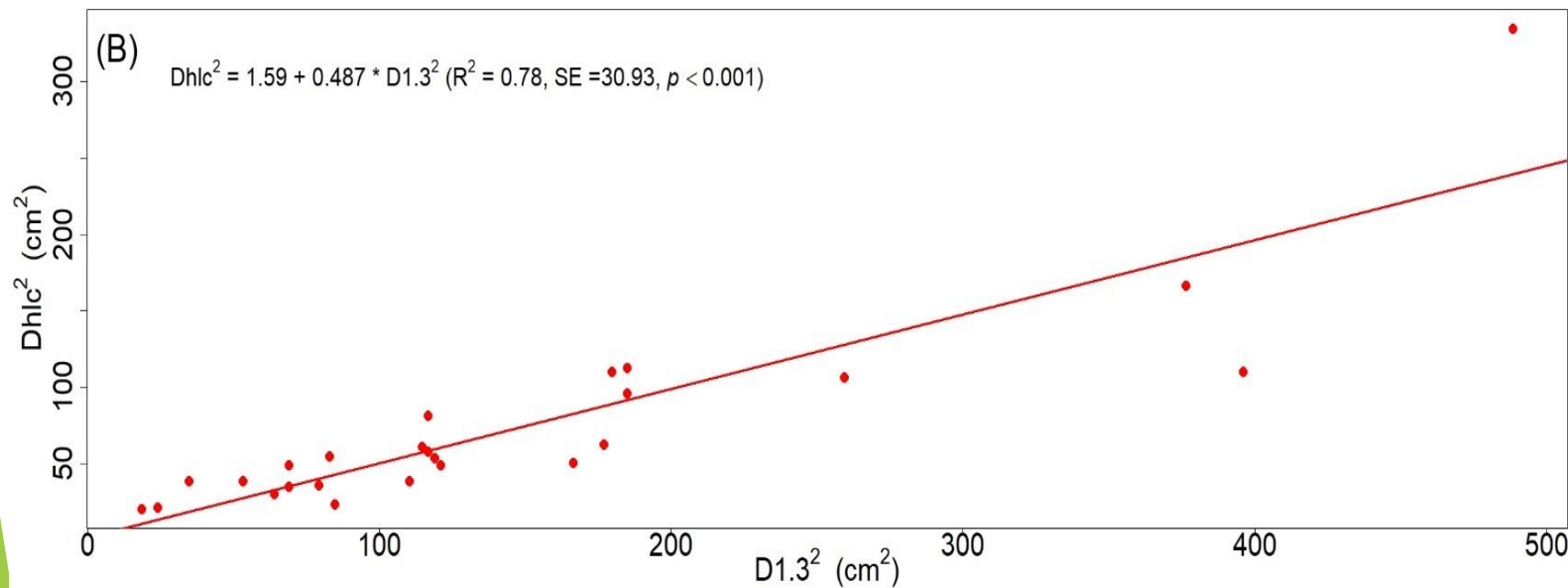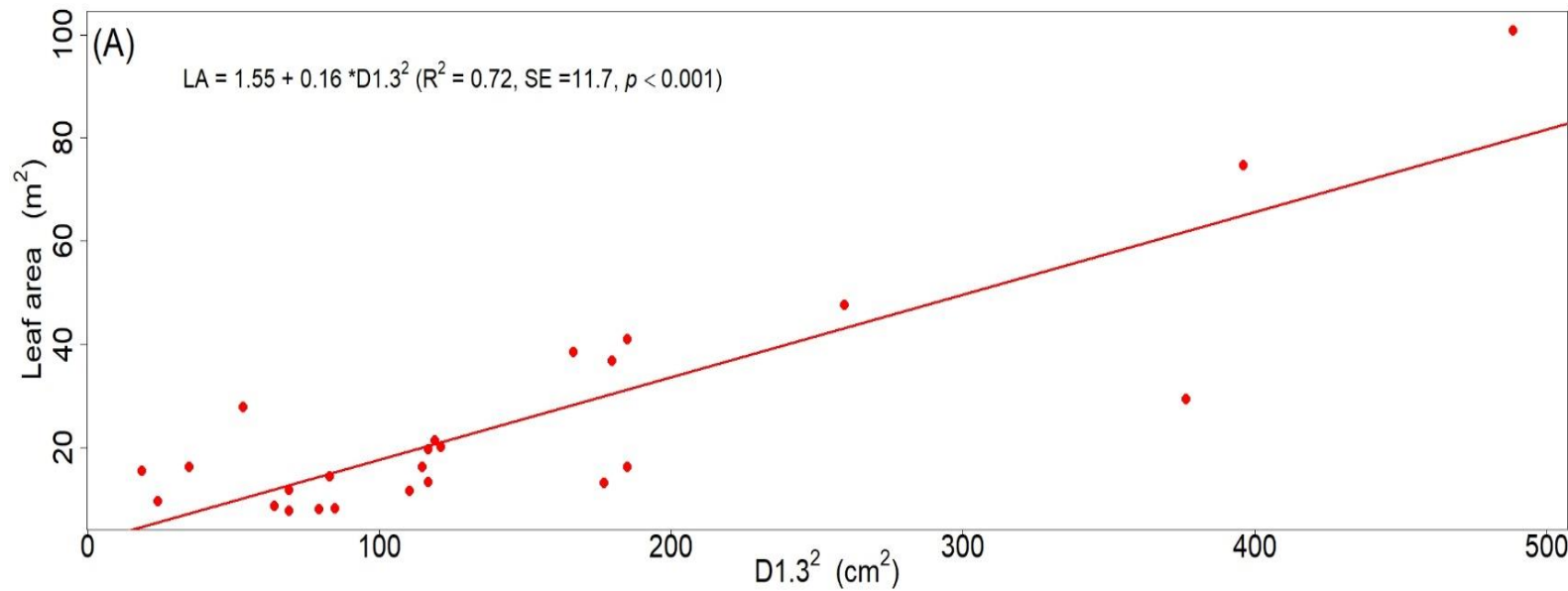*Presentation of the best estimator for each variable.

# Means of ratios of Leaf Area / Sapwood Area, Current Sapwood Area and Total Cross-sectional Area among the six tree height sections.
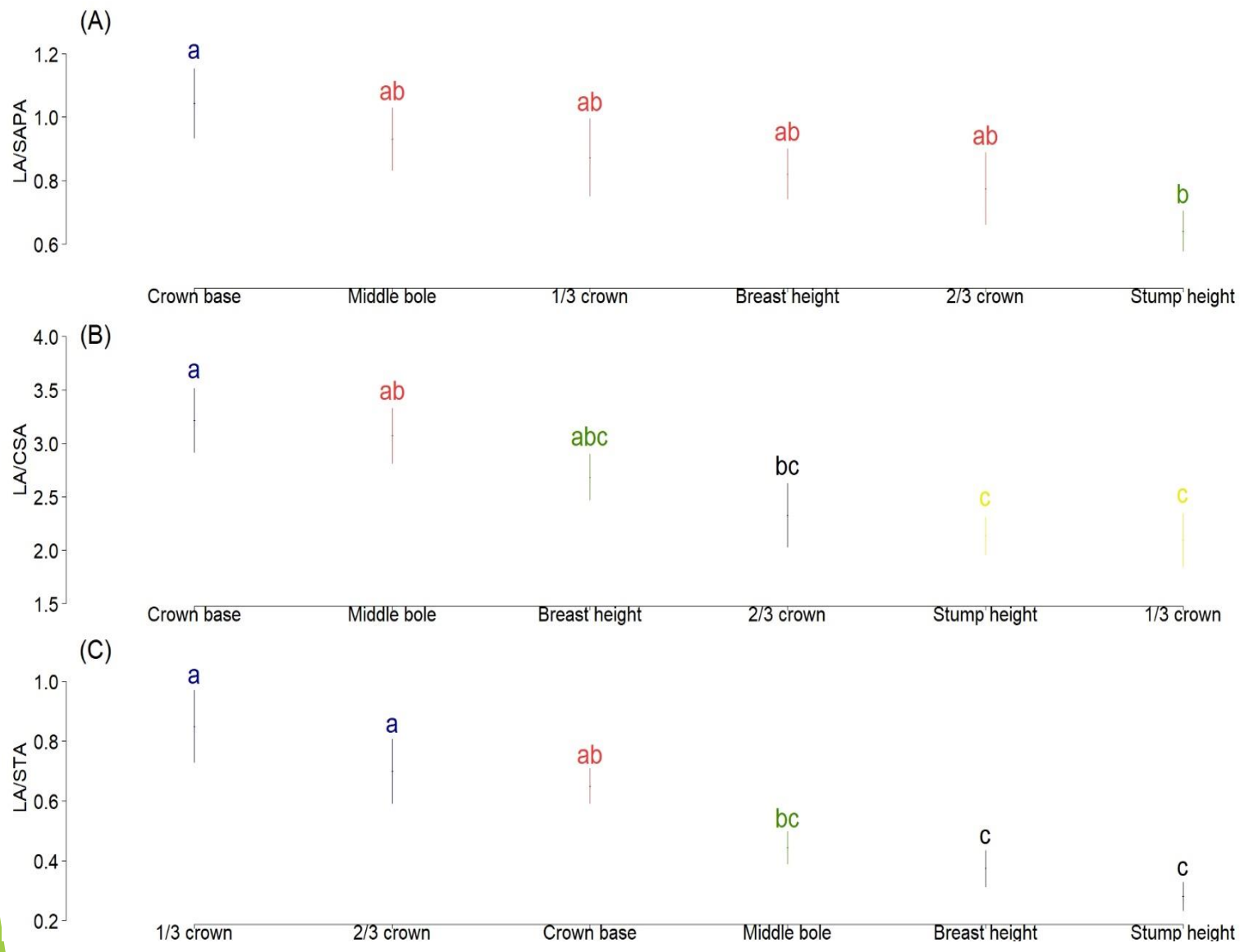


- LA: Leaf Area
- SAPA: Sapwood Area
- CSA: Current Sapwood Area
- STA: Total Cross sectional area

Points indicate the mean ratio per tree section height ± SE. Means with different letters are significantly different according to Duncan's test (P < 0.01).

# Linear relation between Leaf Area and D1.3² and between Dhlc² and D1.3².



(A) $LA = 1.55 + 0.16 * D1.3^2$ ($R^2 = 0.72$, SE = 11.7, $p < 0.001$)

(B) $Dhlc^2 = 1.59 + 0.487 * D1.3^2$ ($R^2 = 0.78$, SE = 30.93, $p < 0.001$)

- LA: Leaf Area
- D1.3²: Square of the diameter at the breast height
- Dhlc²: Square of the diameter at the crown base

# Conclusions

1. The leaf area and the foliage dry weight can satisfactory be estimated from sapwood area and total cross sectional area for black locust in Ptolemaida restored open cast coal mine fields.
2. The Sapwood Area varies across the stem and crown. The best estimator for the calculation of the Leaf Area and Foliage Dry Weight is the Sapwood at the upper 1/3 of the crown.
3. The variable with the highest accuracy for estimating Leaf Area and Foliage Dry Weight is the Total Cross-sectional Area in the middle of the stem.
4. The ratio of Leaf Area / Sapwood area did not present the typical variation across the tree. This typical variability was found only in the ratio of Leaf Area / Total cross-sectional area.
5. Satisfactory models were developed to estimate Leaf Area by $Dhlc^2$ and $D1.3^2$. The calculation of Dhlc via D1.3 is also possible with the help of a strong estimation model.

# Thank you for your attention!