Poplar Wood Density Assessed by X-Ray Densitometry: New Insights for Inferring Wood Quality

by

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The wood density is influenced by:

- Species, variety or clone
- Wood anatomy
- Age (juvenile/mature wood)
- Growth rate
- Growth conditions, including site and culture characteristics
- Seasonal variation of climate

The assessment of the wood density is relevant to:

- Wood technology
- Indices or quality estimations
- Estimations of industrial and commercial profits
- Environmental inferences

Methods to assess wood density

- Gravimetric-volumetric

- Photometric
Measures the light intensity traversing a wood transversal section

- Morphometric
Measures the thickness of the cell wall and the cell lumen size (tracheidograma) (density of the cell wall = 2.56 g cm-3)

- Radiographic
B, gama, and X rays

- High Frequency
Measures the relative variation of density considering the dielectric properties of wood

Wood density by X rays (densitometry)

Established by Polge (1966)

Developed by Lenz (1976) and Schweingruber (1983)

Lenz, O., E. Scar, F.H. Schweingruber. 1976. Metodische Probleme bei der radiographish-densitometrischen Bestimmung der Dichte un der Jahrringbreiten von Holz. Holzforschung 30: 114-123.

Polge, H. 1966. Etablissement des courbes de variation de la densité du bois par léxploration densitométrique de radiographies déchantillons prélevés a la tariere sur des arbres vivants. Ann. Sci. Forest. 23: 1-206

Schweingruber, F.H. 1983. Der Jahrring. Standort, Methodik, Zeit und Klima in der Dendrochronologie. Bern, Haupt, 234 pag.

Densitometry by X rays - Basis

- *Wood samples*
  sampling orientation, dishes, increment cores

- *Extractives remotion*
  resins and other residual substances; soxhlett extractor

- *Sample saw*
  double saw device to obtain uniform thin laths (2 mm)

- *Climatization*
  for 12 hours at 18ºC and 60% atmospheric relative humidity

- *Radiography*
  wood radiographed at 16 kVh, 3 mA and during 5 minutes. Calibration wedge

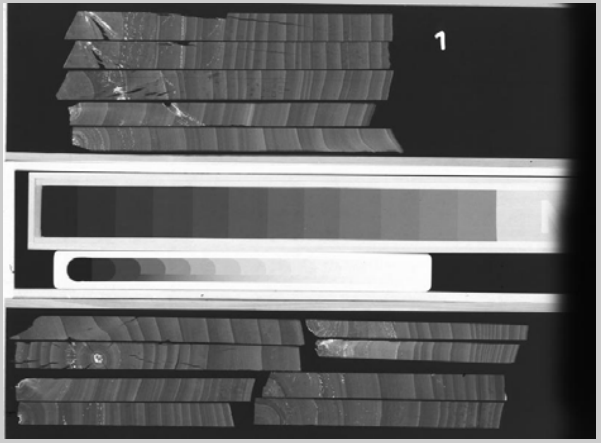
- *Development of X-ray film*
  Automatic procecers (hospitals, radiographic centers)

- *Density measurement* (conversion of the grey levels into physical density values)
  Densitometres, Scanned films, calibration

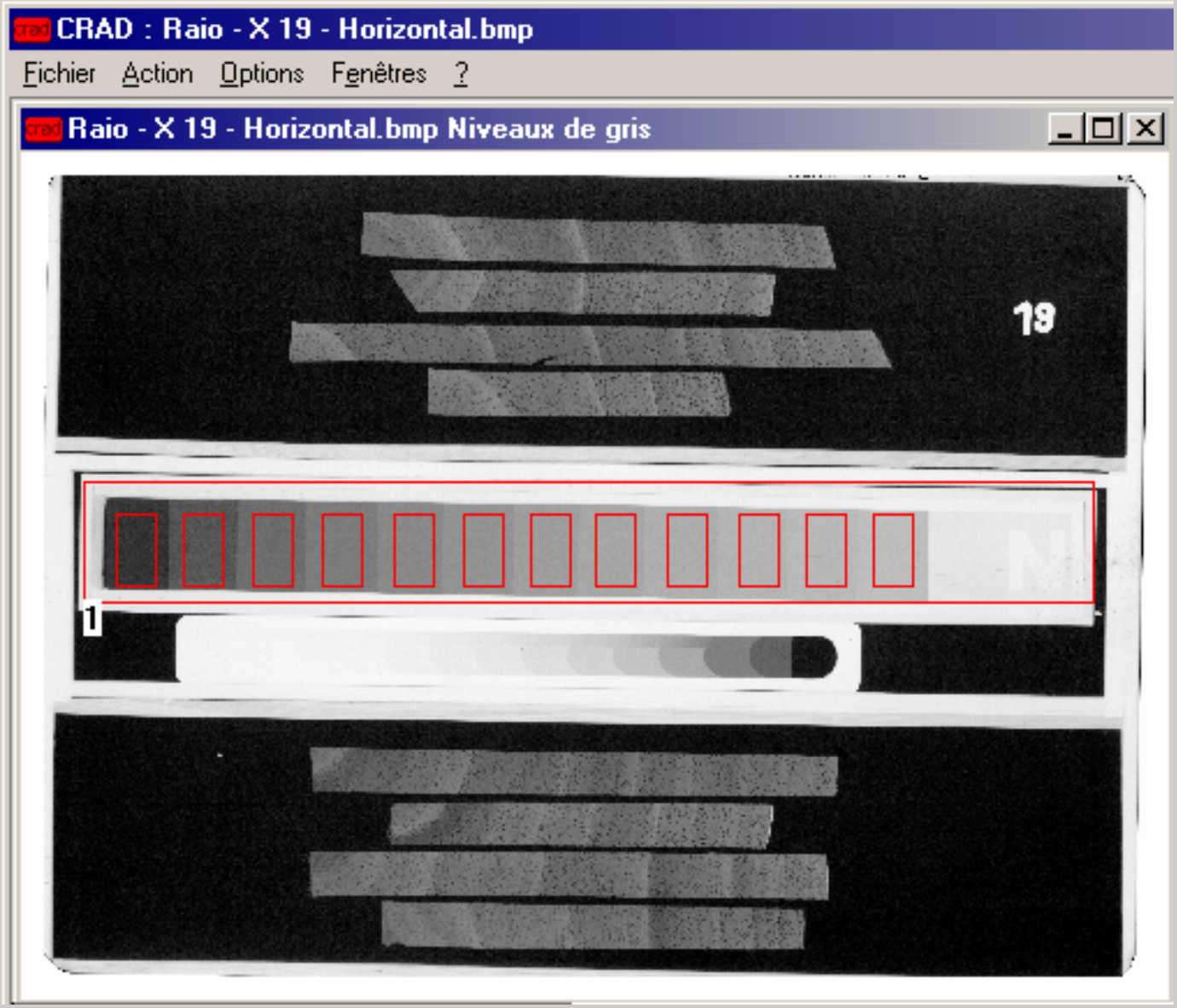
Clone collection considered in this study

Gélrica (42)
Caroliniana grigio (64)
I-78 (51)
I-488 (25)
Conti 12 (23) (figura como 13 en placa radiográfica)
Stoneville-62 (76)
214 (24)
Australia 106/60 (75)
Harvard (58)
Veronese (36)
Guardi (19)
Ge 7-56 Euramericano Libre (211-Lotti)
Ge 57-63 I-214-Libre (214-Lotti)
Ge 21-57 Euroamericano Libre (Colchicina, 225-Lotti)
Ge 139-66 Tremula Boleana x libre (194-Lotti)
Ge 73-63 I-214 libre (219-Lotti)
Ge 88-65 Hamoui x Carolino (199-Lotti)
Ge 9-56 Euroamericano Libre (colchicina) (215-Lotti)
Ge 2-56 Euroamericano Libre (colchicina) (205-Lotti)
Ge 21-57 Euroamericano Libre (colchicina) (225-Lotti)
Ge 16-57 Euroamericano Libre (colchicina) (229-Lotti)
Ge 17-57 Euroamericano Libre (cochicina) (228-Lotti)
Fogolino (14)
Ge 14-57 Euram. Libre (femenino) (224)
Veneciano (22)

Densitometry by X rays - Basis



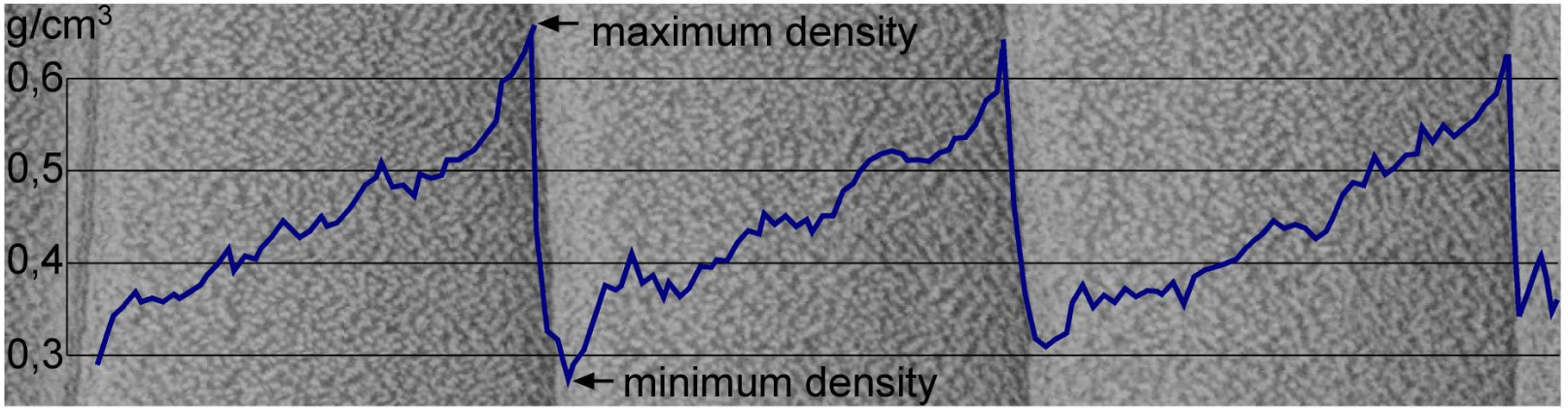
Calibration and selection of areas to measure



Density parameters obtained with CRED

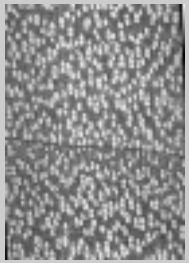
Global density of the sample
Mean ring density
Minimum density
Maximum density
Earlywood density
Latewood density
Ring width
Earlywood width
Latewood width

Density profile of a Poplar wood



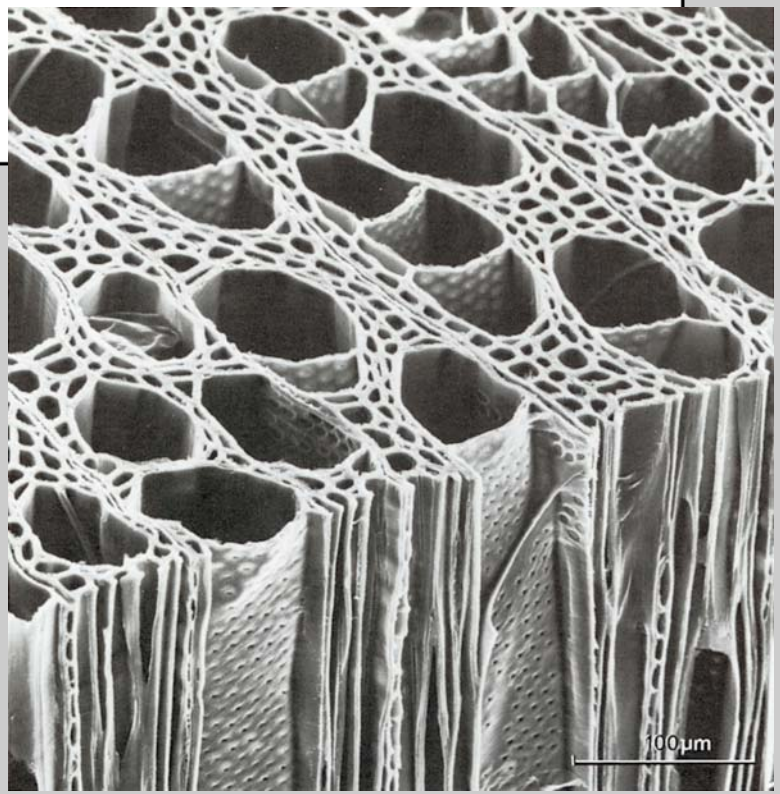
-Small vessel size
- Diffuse-porous
- Growth ring boundary distinct

P. balsamifera

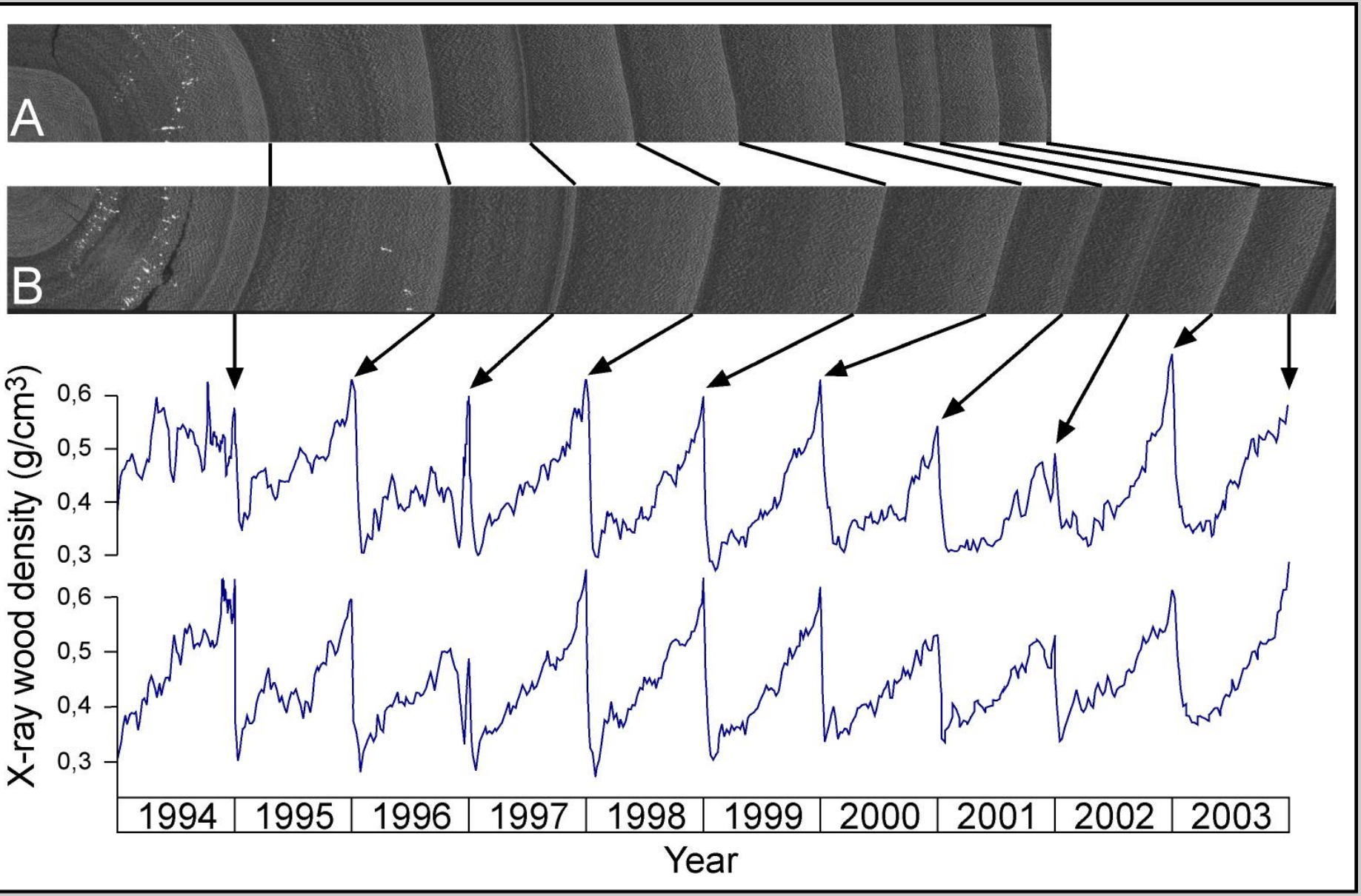


P. angulata

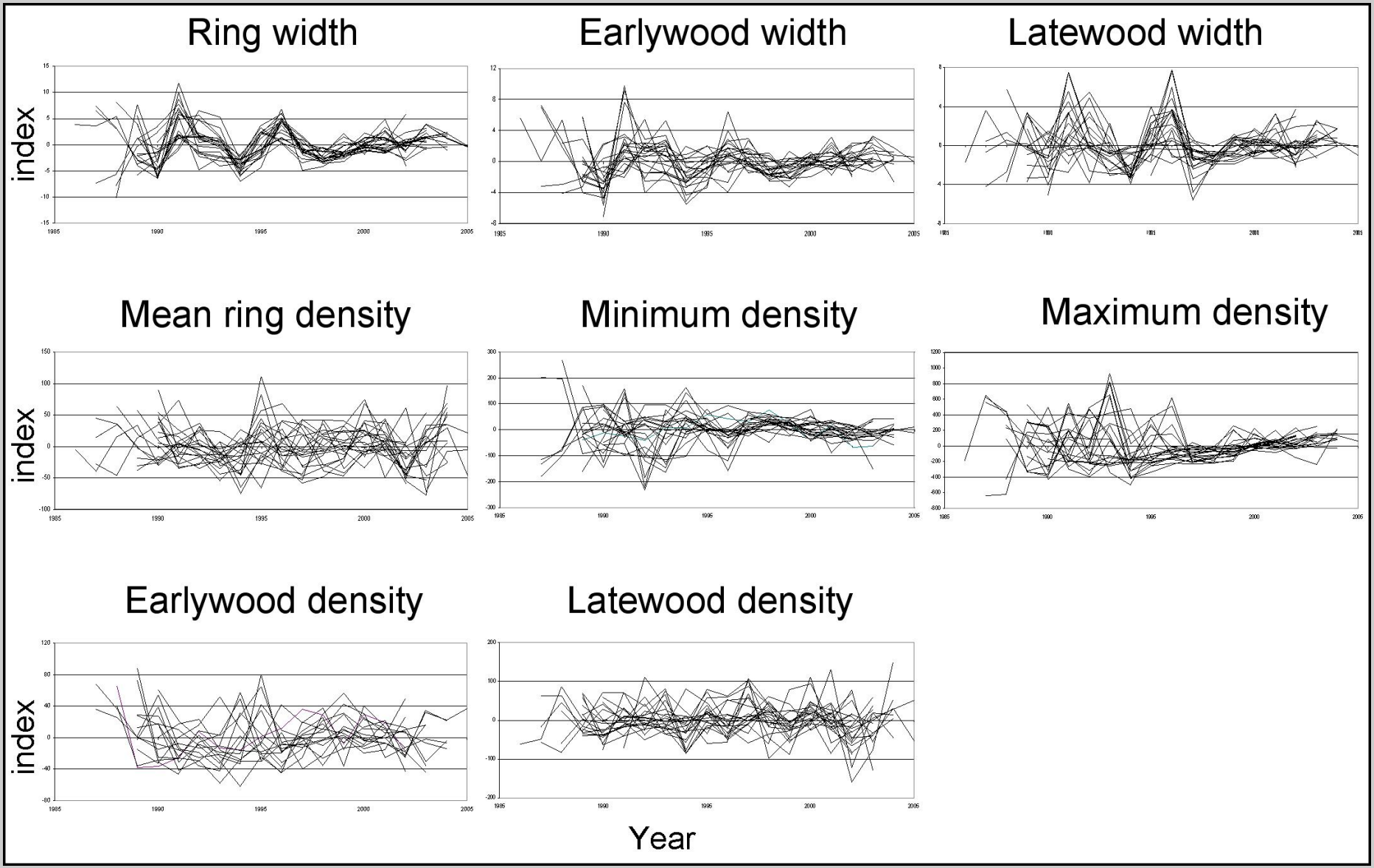
P. tremuloides



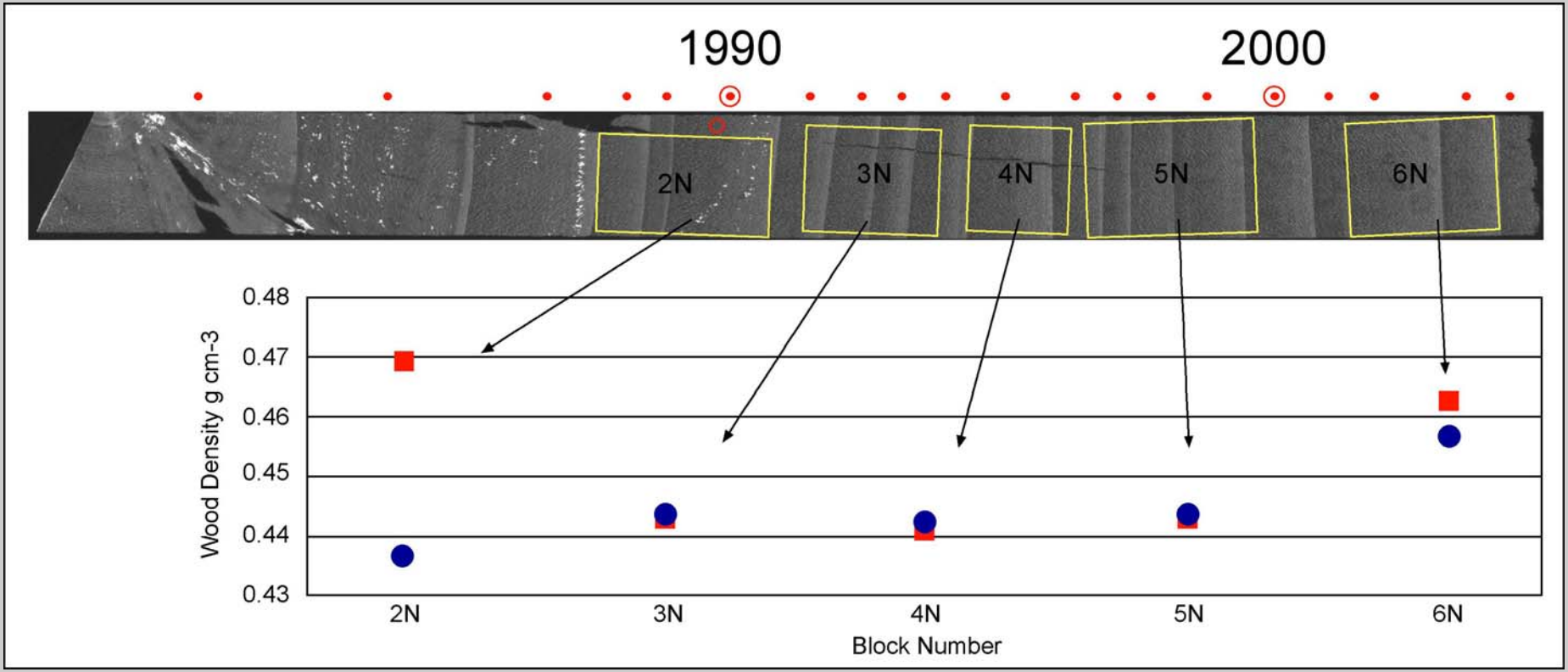
Opposite (north to south) radii density profiles from an Australia 106/60 clone wood sample



Ring width and density parameters from some of the clones analyzed



Comparison between gravimetric/volumetric density data and X-ray density data from the same wood blocks obtained from the clone Conti 12



FINAL REMARKS

The X-rays applied to poplar wood gave promising results as a technique to infer wood quality properties:

a) the densitometric profile clearly identifies the passage from maximum to minimum density zones between adjacent rings,
b) the intra-ring density profile follows a similar incremental progression to those observed in conifer woods,
c) the X-ray density values successfully reproduce the gravimetric/volumetric mean density data values usually found in poplar woods,
d) the X-ray method allows the analysis of density values throughout the complete life-span of the tree, giving a continuous densitometric profile from pith to bark,
e) the method allows densitometric comparisons between radii of the same tree, between trees on the same site and mean density values between sites.

The only limitation of the X-ray method is its relatively high cost and the time it takes. However, we strongly suggest the use of X-ray techniques in density calculations related to poplar wood quality.

Many thanks for your attention!

This research was supported by funding from the Secretaría de Ciencia, Técnica y Posgrado, Universidad Nacional de Cuyo, Grants 06/A279 and 06/A351.