Project meeting

European Hardwoods for the Building Sector (EU Hardwoods)

2015-06-25 / FCBA

Hardwood resources in Europe — forecast of resources and roundwood characterization

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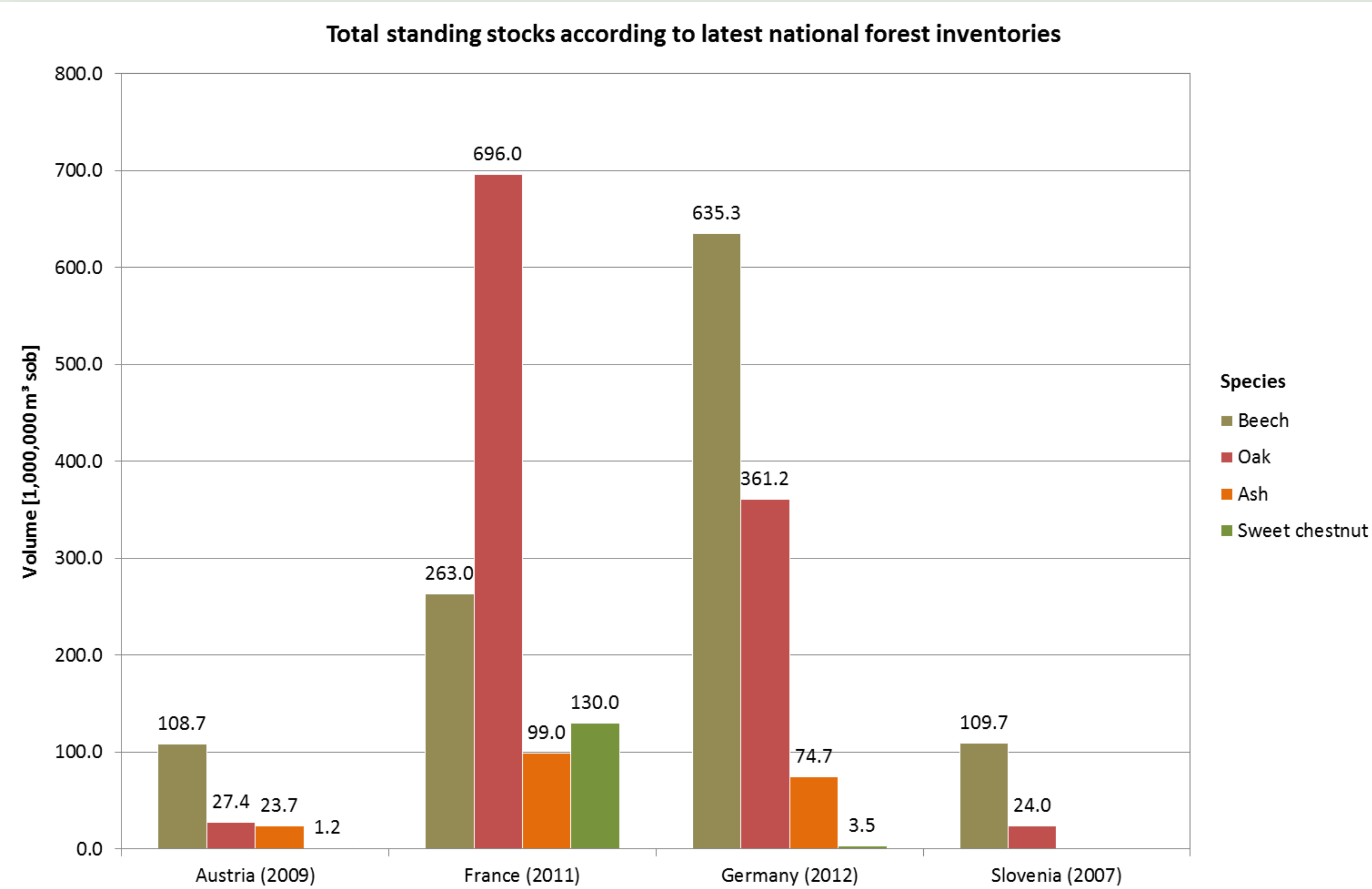
Topics

- Supplement: Hardwood resources in Austria, France, Germany and Slovenia
- Forecast of hardwood resources and harvest in Germany
- Roundwood characterization
- Next steps
- Dissemination

Hardwood resources in Austria, France, Germany and Slovenia



Hardwood resources in Austria, France, Germany and Slovenia

Total stocks (all four countries combined; in million m³)

- Beech: 1,116.7
- Oaks: 1,108.7
- Ash: 197.4
- Sweet chestnut: 134.7

For comparison: Softwood stocks in France and Germany (in million m³)

- *Norway spruce: 1,617.6 (Silver fir: 290.4)*
- *Douglas fir: 184.7*
- *Pines (Scots pine and maritime pine): 1,048.8*

In Germany, the stocks of spruce have decreased by 48.6 M m³ since the previous forest inventory (in 2002), while the stocks of beech and oaks have increased by 57.8 and 50.1 M m³, respectively.

Forecast of hardwood resources and harvest in Germany

The WEHAM model — basic functionality

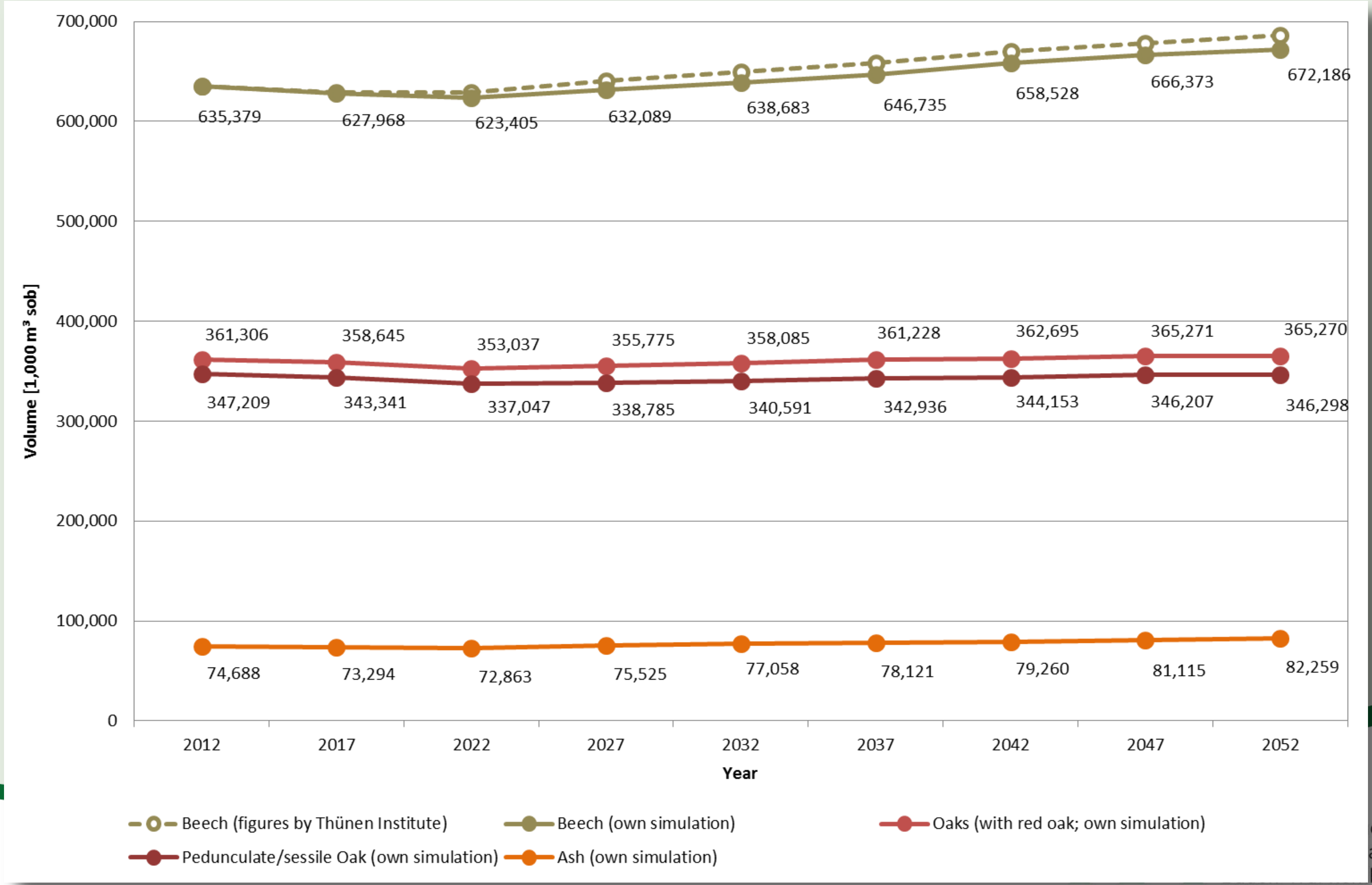
- Specifically adapted to data from the German forest inventory (BWI)
- Single-tree-based simulation of growth and harvest (and mortality); bucking/sorting module
- Input (database): individual trees from forest inventory point sampling; projection to whole forest area
- Simulation governed by a control database containing growth models, parameters of silvicultural treatment, and log bucking/sorting specifications

Restrictions

- Results only valid on a large scale (federal state is the smallest entity for analyses)
- No change of species or change of site conditions modelled
- Bucking/sorting module: standard stem models (diameter/height) used, quality not taken into account (not recorded at inventory)

Forecast of hardwood resources and harvest in Germany

WEHAM prediction of standing stocks according to the official scenario



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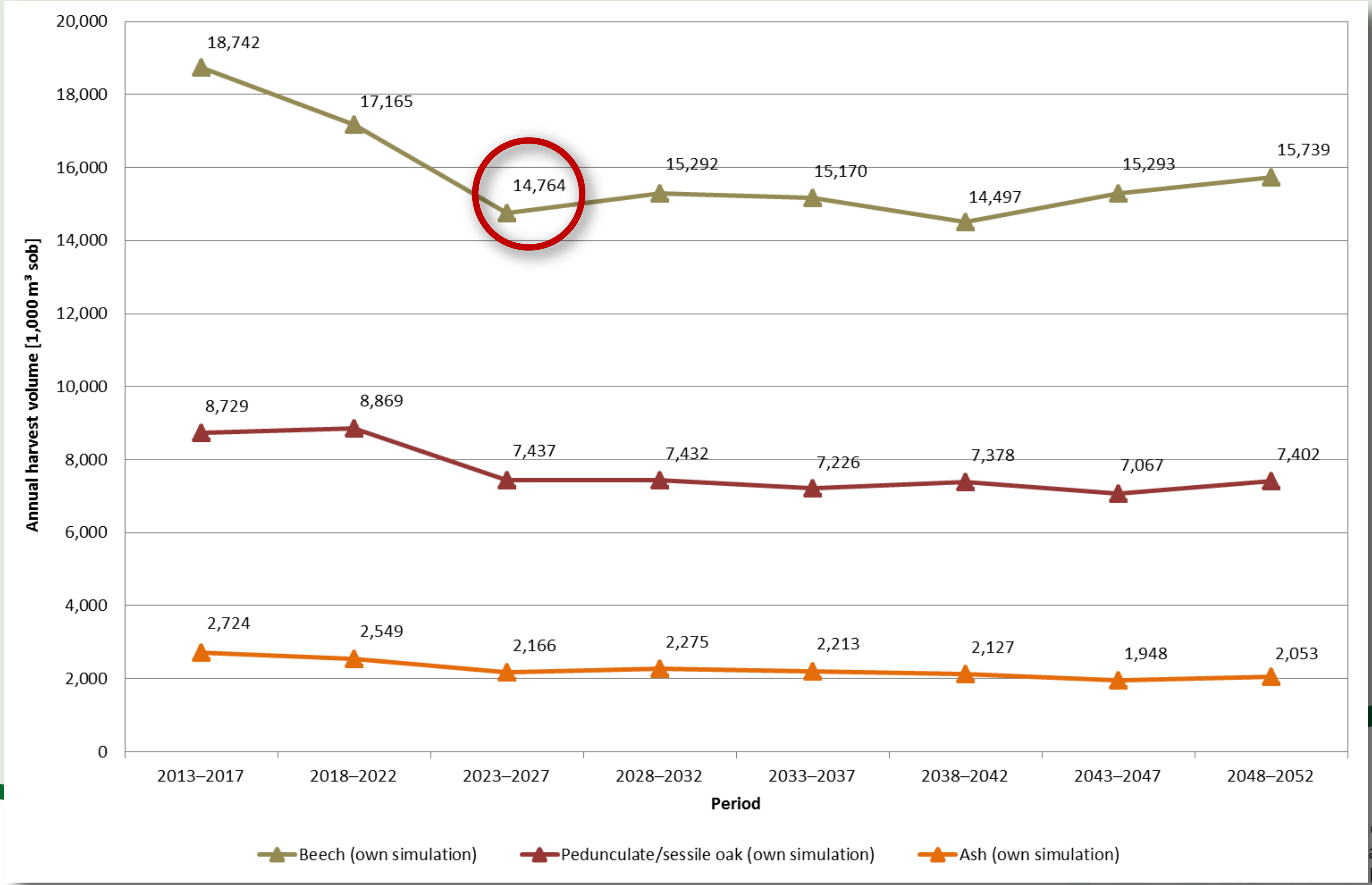
Forecast of hardwood resources and harvest in Germany

WEHAM prediction of annual harvest volumes according to the official scenario



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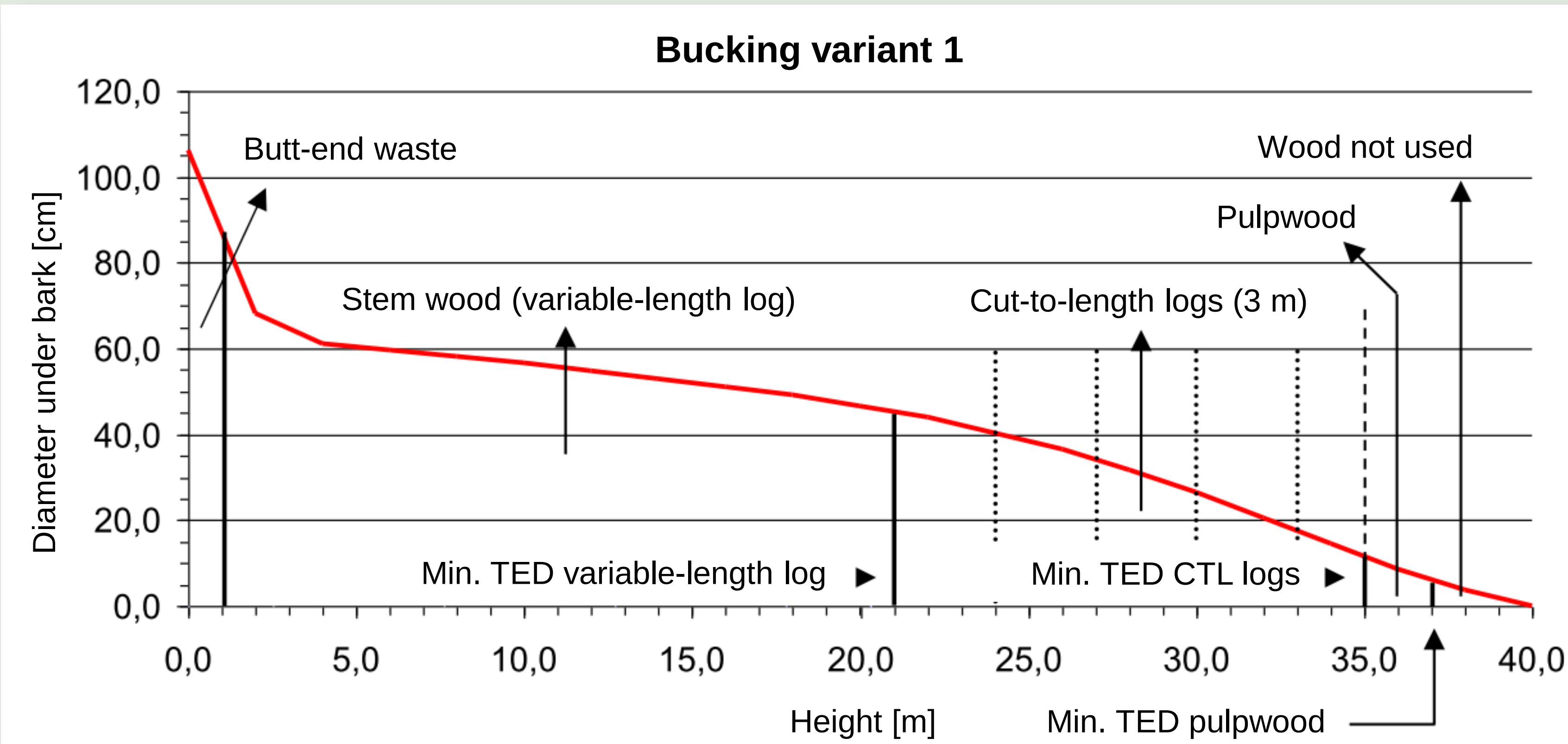
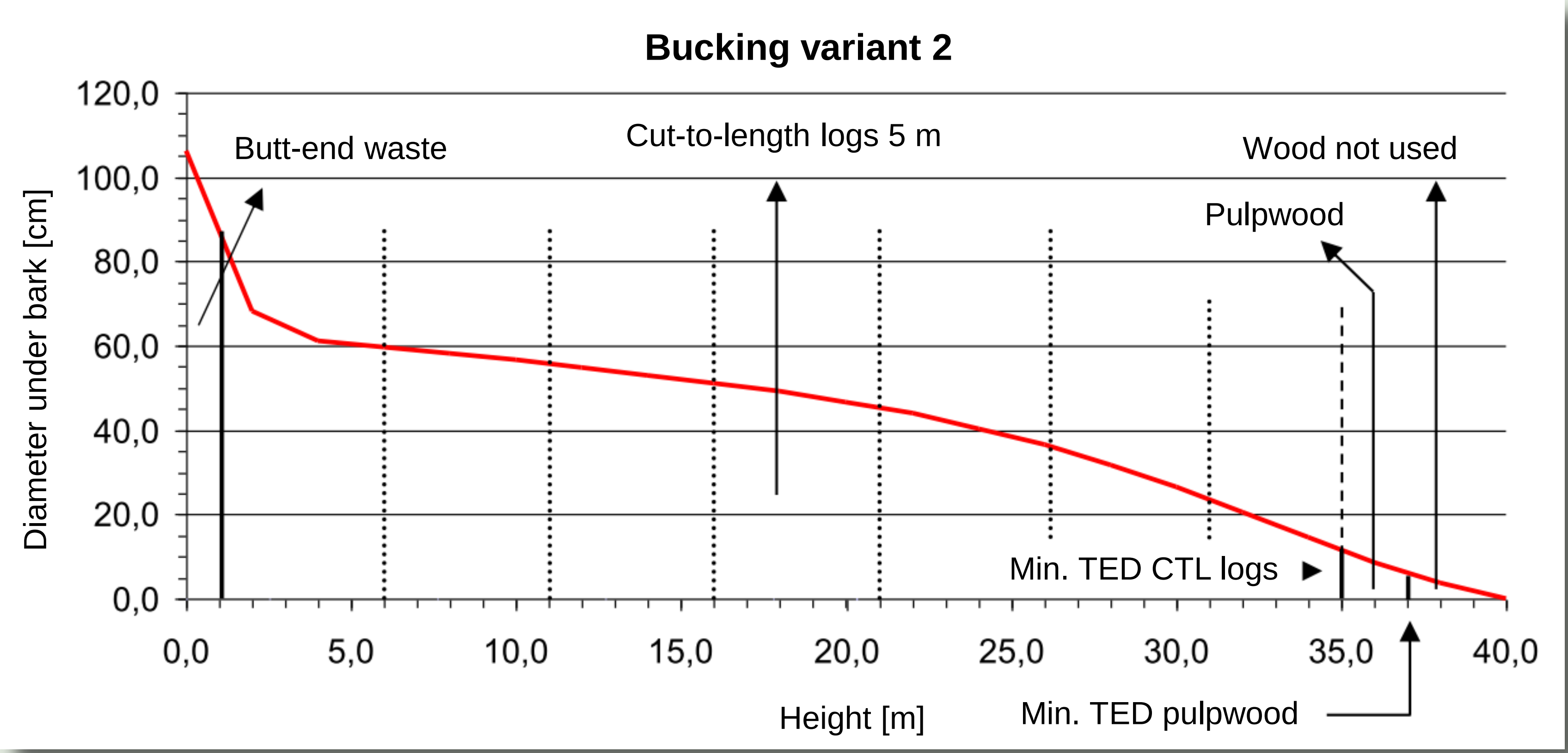
Forecast of hardwood resources and harvest in Germany

Prediction of roundwood supply: Bucking/sorting variants tested



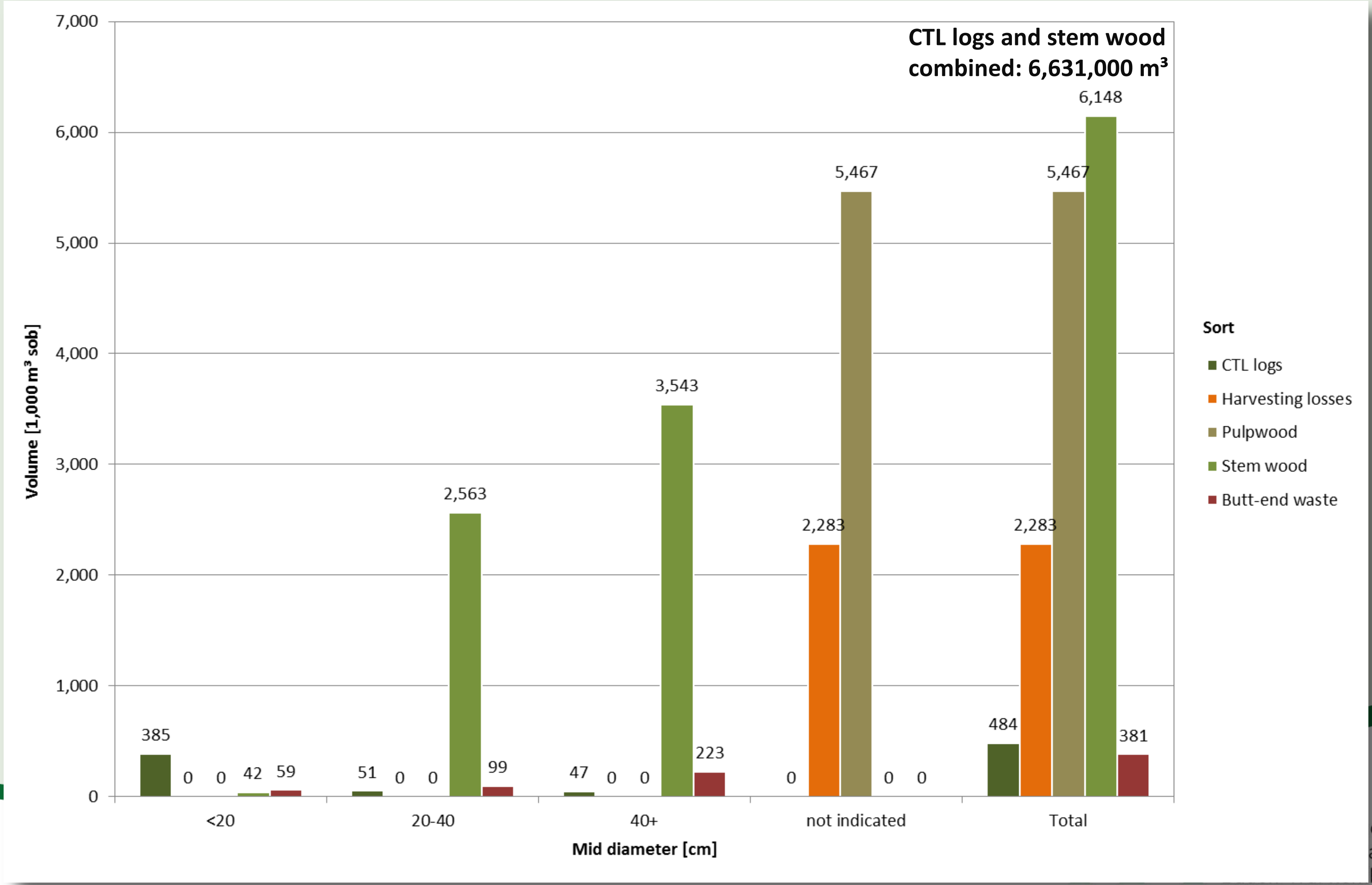
Forecast of hardwood resources and harvest in Germany

Prediction of roundwood supply: Bucking/sorting variants tested



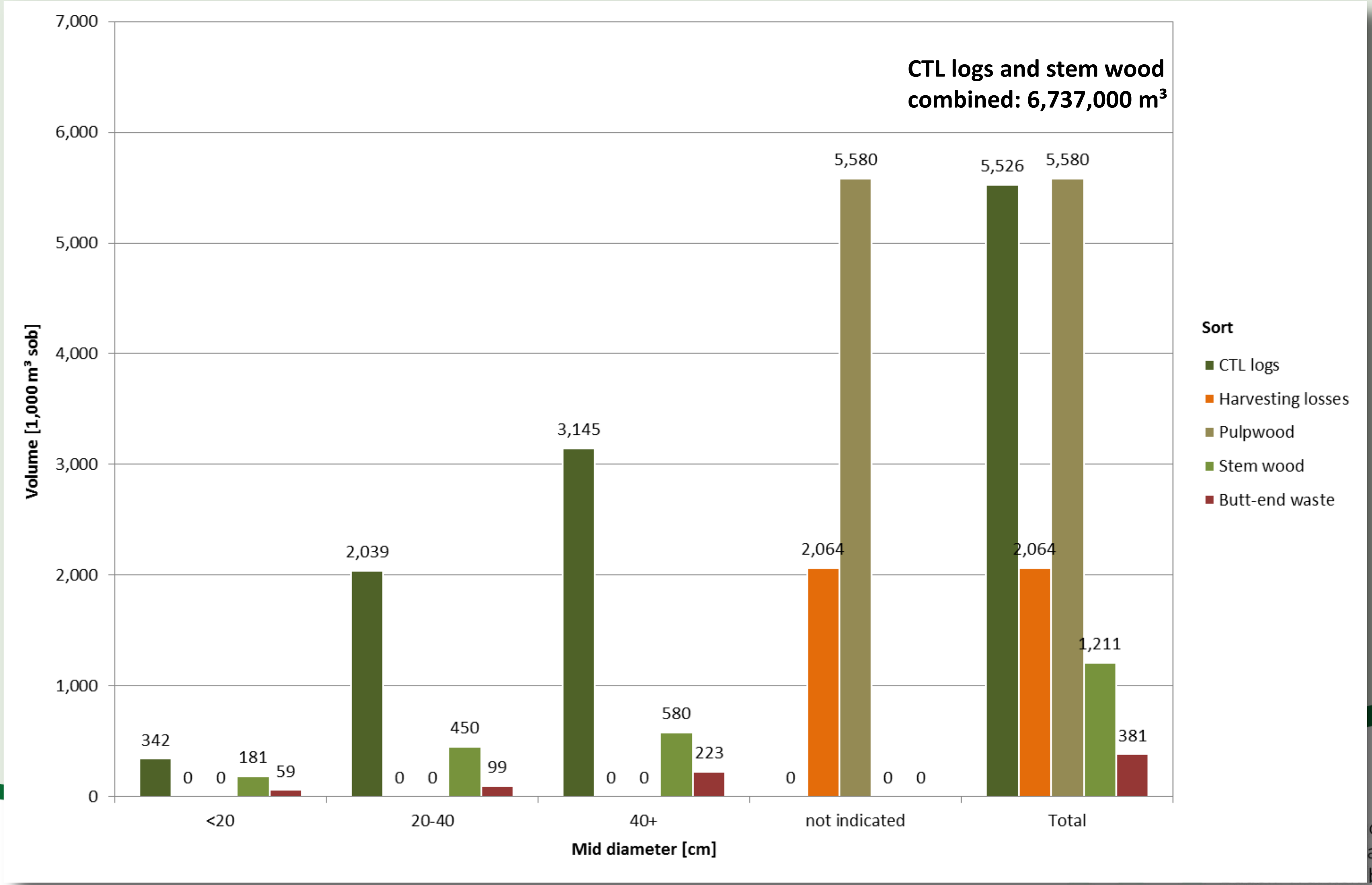
Forecast of hardwood resources and harvest in Germany

Prediction of annual roundwood supply 2023–2027 — Beech; bucking variant 1



Forecast of hardwood resources and harvest in Germany

Prediction of annual roundwood supply 2023–2027 — Beech; bucking variant 2



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Roundwood characterization

Roundwood samples

Species	No. of logs	Mid diameters [cm]	Lengths [m]
European beech (*Fagus sylvatica*)	29	16 – 45	4.02 – 5.08
Sessile/pedunculate oak (*Quercus petraea/robur*)	16	21 – 34	4.13 – 4.50
European ash (*Fraxinus excelsior*)	18	27 – 47	3.39 – 5.06
Sweet chestnut (*Castanea sativa*)	24	17 – 30	3.87 – 4.65




Roundwood characterization

Methods

- Measurement of roundwood features (knots, crook, defects, etc.)
- Roundwood grading according to EN 1316-1:2012 and German standard RVR
- X-ray CT scanning
- Longitudinal frequency measurement (MiCROTEC ViScan) and calculation of log MOE_{dyn}

Roundwood characterization

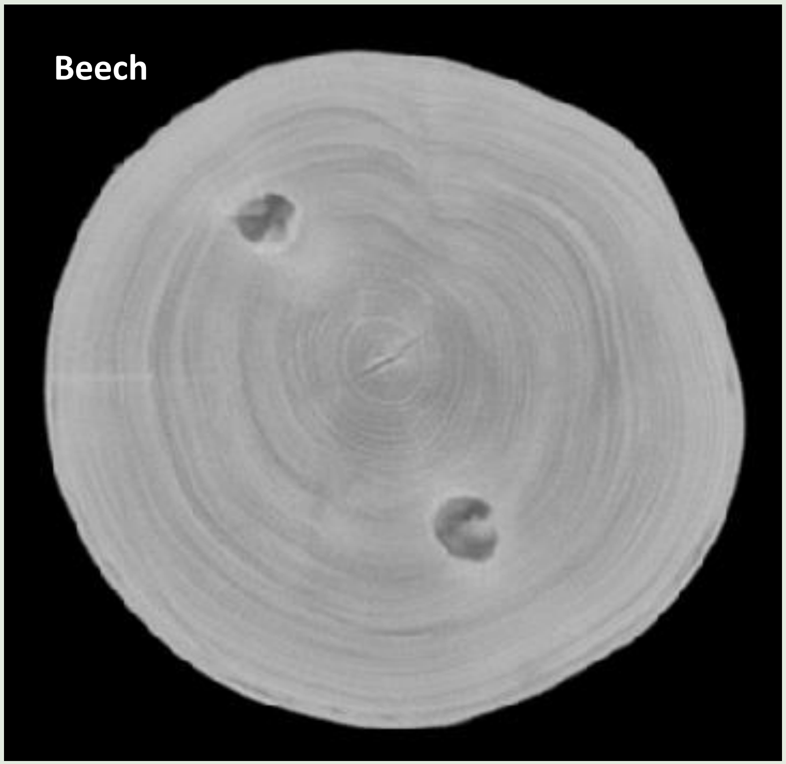
Distribution of log grades

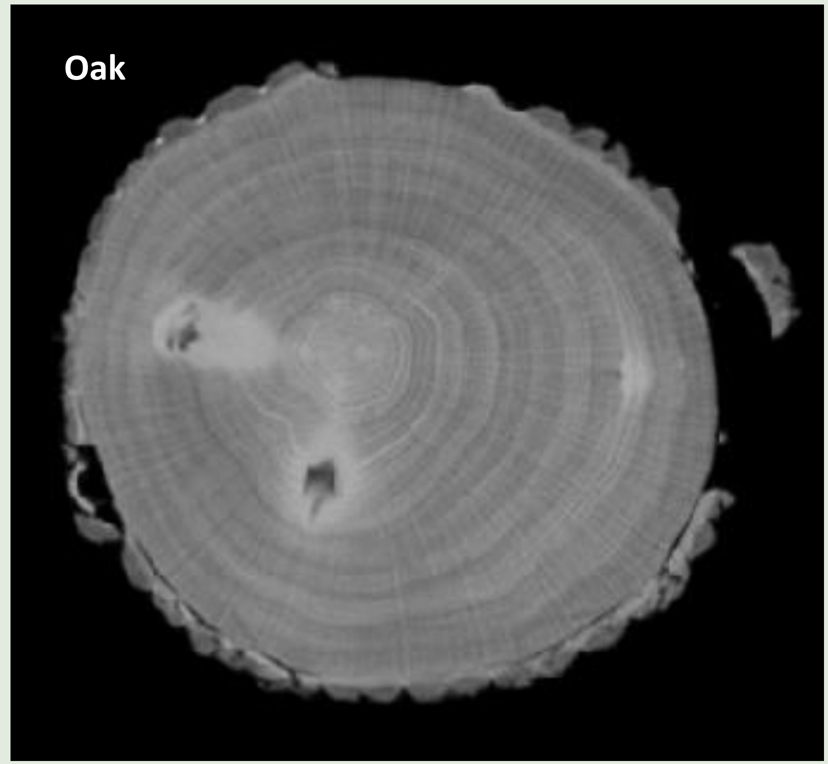
Species	Number of logs in grade (EN 1316/RVR)				
	A	B	C	D	Off-grade
European beech (*Fagus sylvatica*)	0/0	0/0	0/18	25/8	4/3
Sweet chestnut[1] (*Castanea sativa*)	0/0	0/0	2/23	19/1	3/0

[1] Graded according to rules for oak

Roundwood characterization

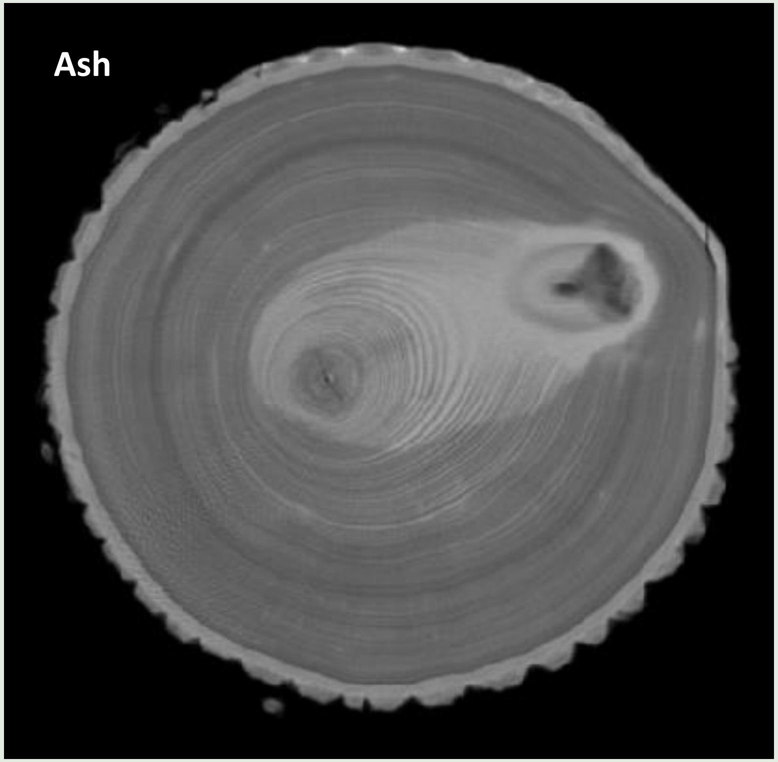
CT images of the hardwood species

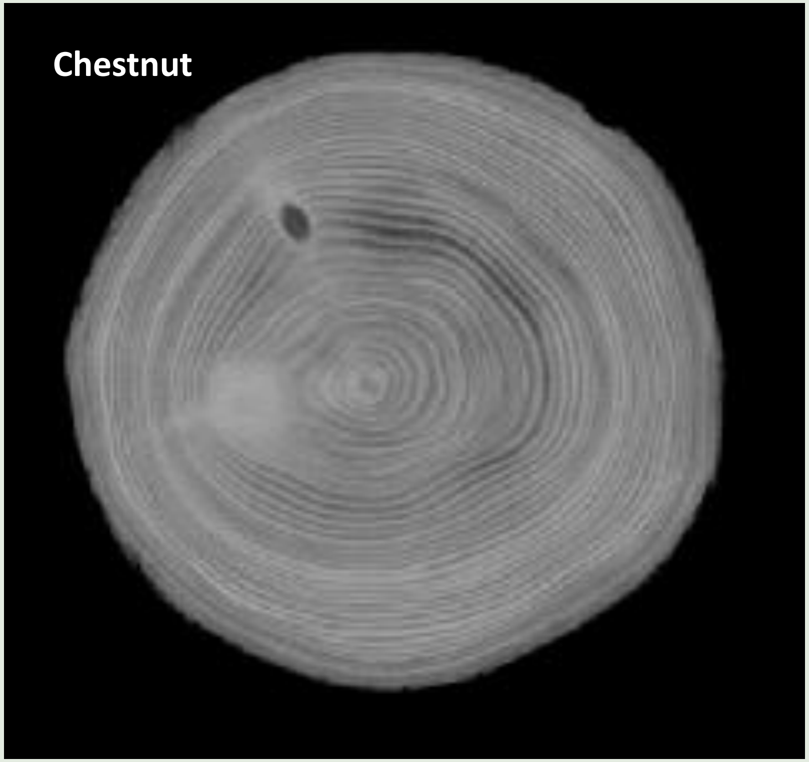




Roundwood characterization

CT images of the hardwood species

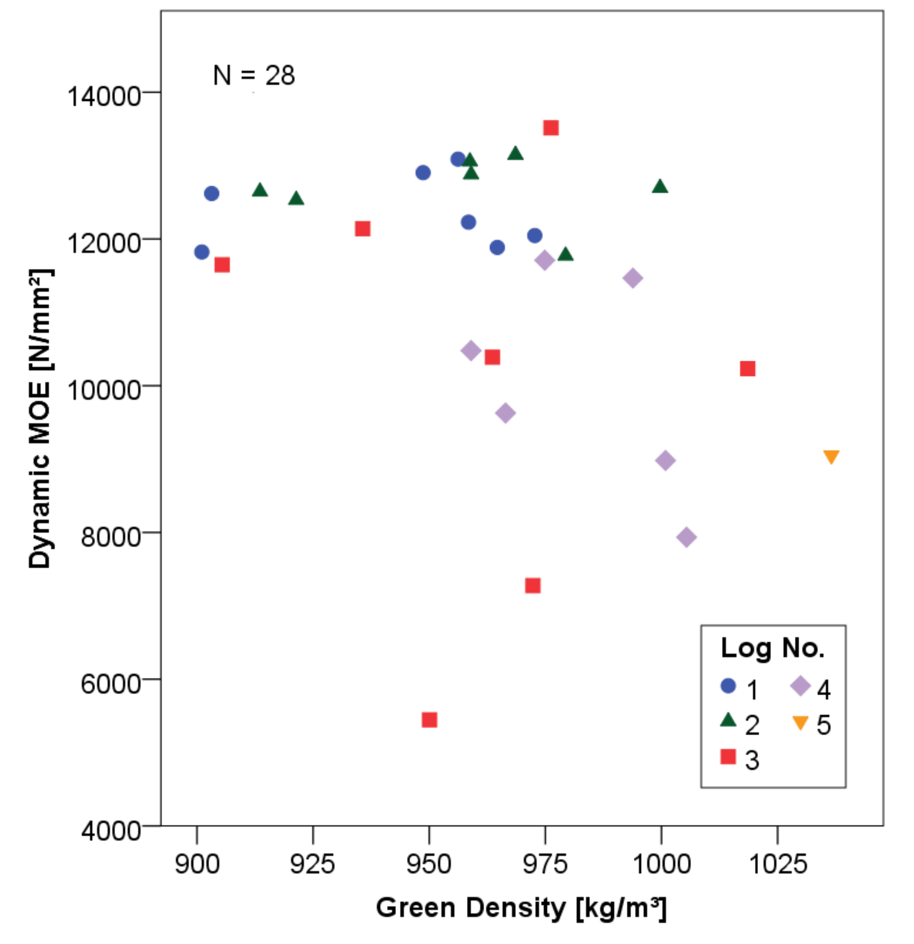


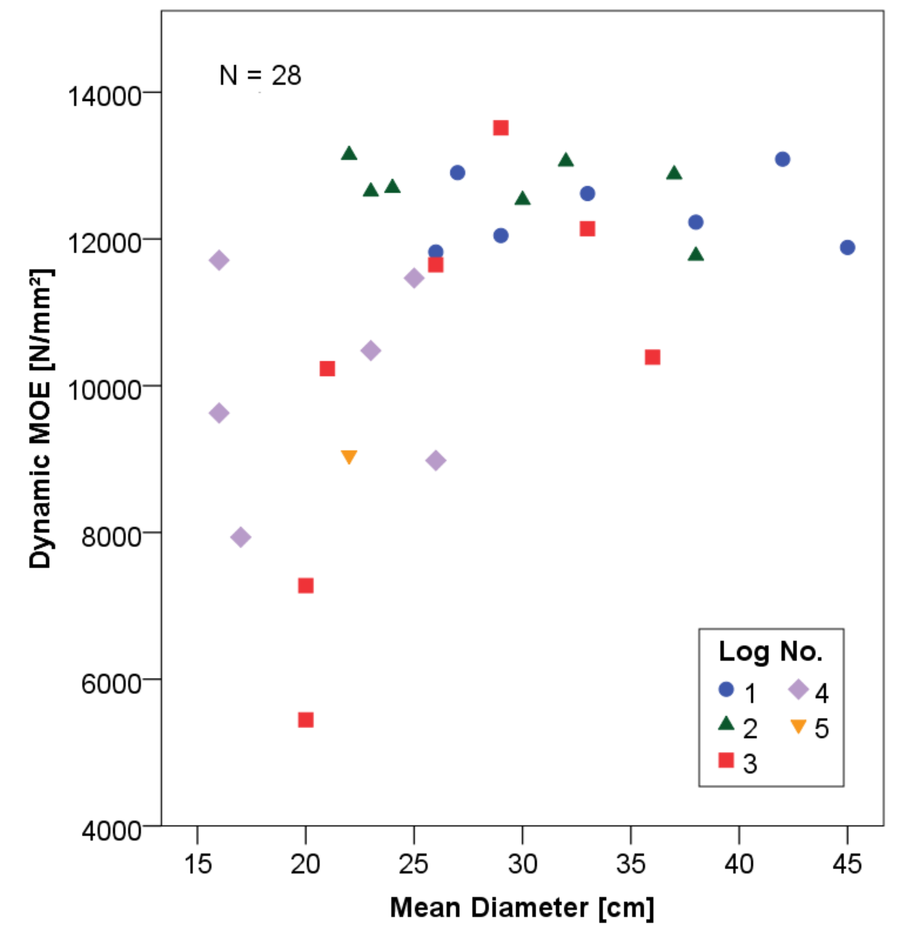


Roundwood characterization

Green density and MOE_{dyn}: beech log sample

Green density: 901.0 – 1,036.6 kg/m³; MOE_{dyn}: 5,446.4 – 13,514.5 N/mm²

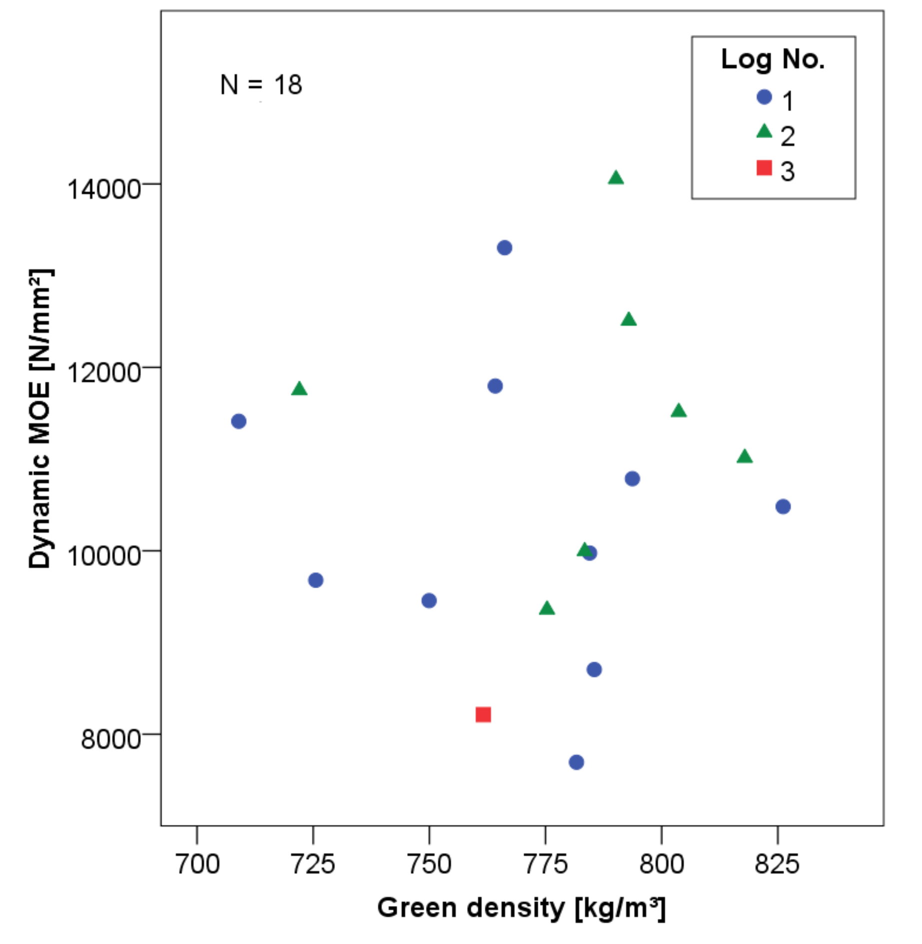


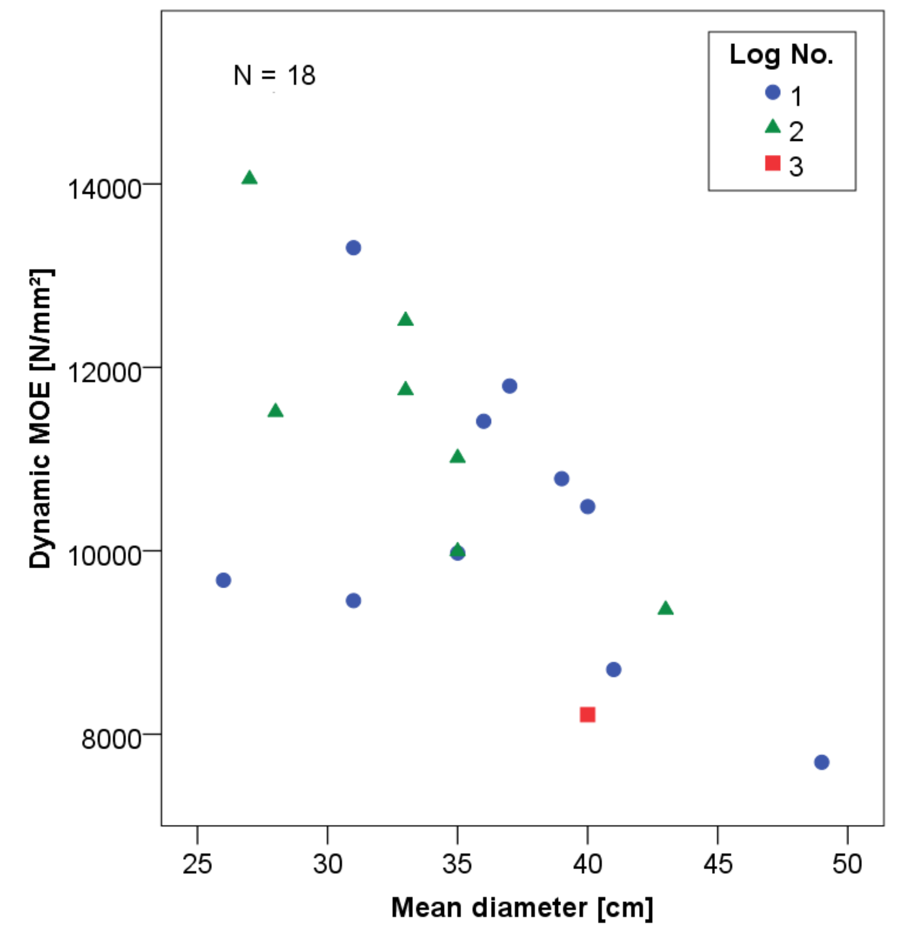


Roundwood characterization

Green density and MOE$_{dyn}$: ash log sample

Green density: 709.0 – 826.2 kg/m³; MOE$_{dyn}$: 7,694.1 – 14,053.2 N/mm²

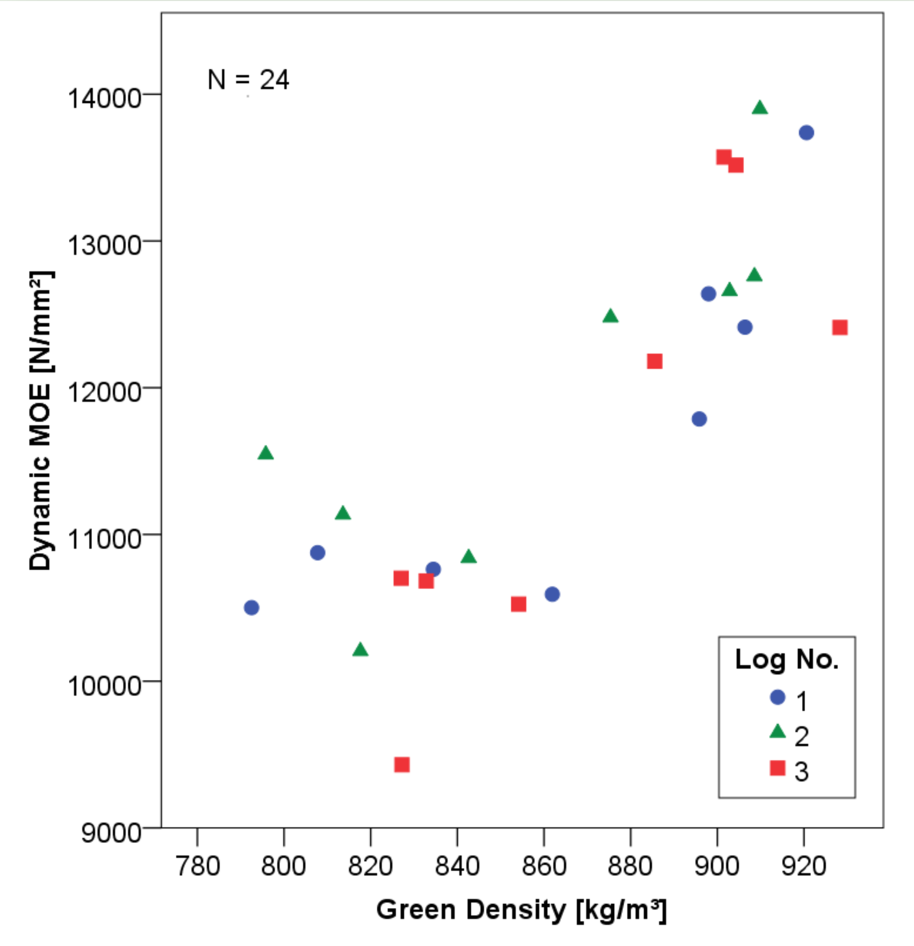


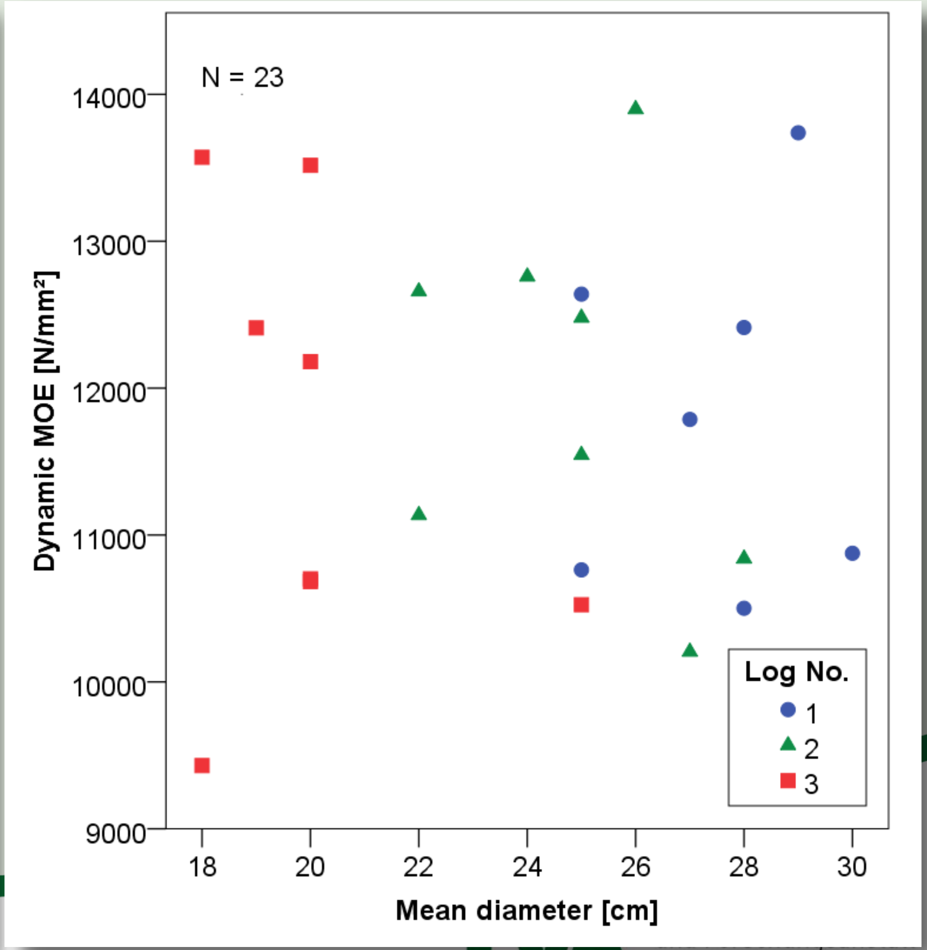


Roundwood characterization

Green density and MOE$_{dyn}$: chestnut log sample

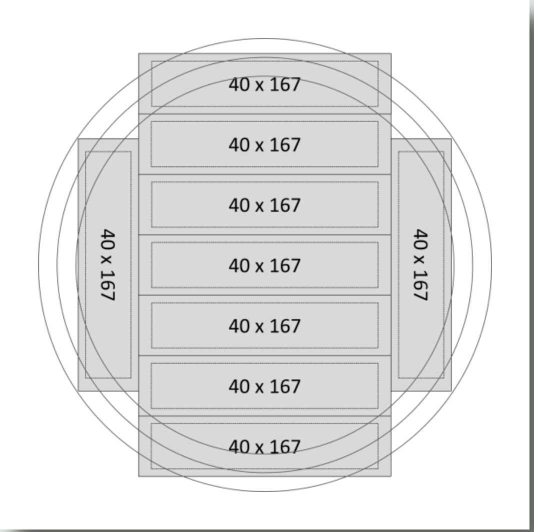
Green density: 792.5 – 928.3 kg/m³; MOE$_{dyn}$: 9,430.2 – 13,898.7 N/mm²



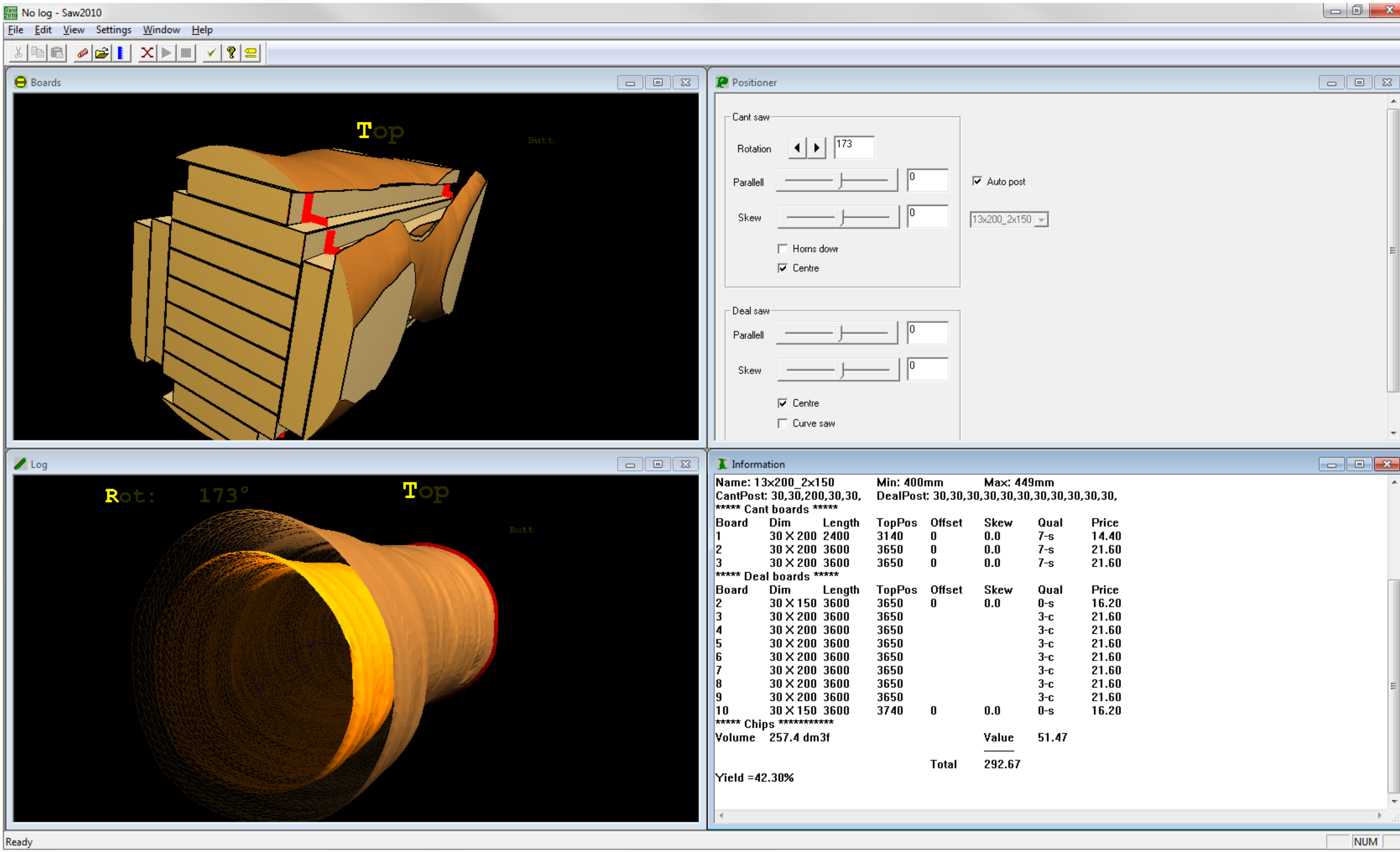


Next steps

- **Sawing of the sample logs**
  - Sawing of lamellas 30 × 150 mm and 30 × 200 mm; fixed set of sawing patterns, selected by top-end diameter; log rotation from sawing simulation (optimization according to outer shape) — if feasible



Next steps


No log - Saw2010
File Edit View Settings Window Help
Boards
Top
Butt
Positioner
Cant saw
Rotation 173
Parallell 0
Skew 0
Horns dowr
Centre
Auto post
13x200_2x150
Deal saw
Parallell 0
Skew 0
Centre
Curve saw
Log
Rot: 173°
Top
Butt
Information
Name: 13x200_2x150 Min: 400mm Max: 449mm
CantPost: 30,30,200,30,30, DealPost: 30,30,30,30,30,30,30,30,30,30,
***** Cant boards *****
Board Dim Length TopPos Offset Skew Qual Price
1 30 X 200 2400 3140 0 0.0 7-s 14.40
2 30 X 200 3600 3650 0 0.0 7-s 21.60
3 30 X 200 3600 3650 0 0.0 7-s 21.60
***** Deal boards *****
Board Dim Length TopPos Offset Skew Qual Price
2 30 X 150 3600 3650 0 0.0 0-s 16.20
3 30 X 200 3600 3650 3-c 21.60
4 30 X 200 3600 3650 3-c 21.60
5 30 X 200 3600 3650 3-c 21.60
6 30 X 200 3600 3650 3-c 21.60
7 30 X 200 3600 3650 3-c 21.60
8 30 X 200 3600 3650 3-c 21.60
9 30 X 200 3600 3650 3-c 21.60
10 30 X 150 3600 3740 0 0.0 0-s 16.20
***** Chips ***********
Volume 257.4 dm3f Value 51.47
Total 292.67
Yield =42.30%
Ready
NUM

Next steps

- **Sawing of the sample logs**
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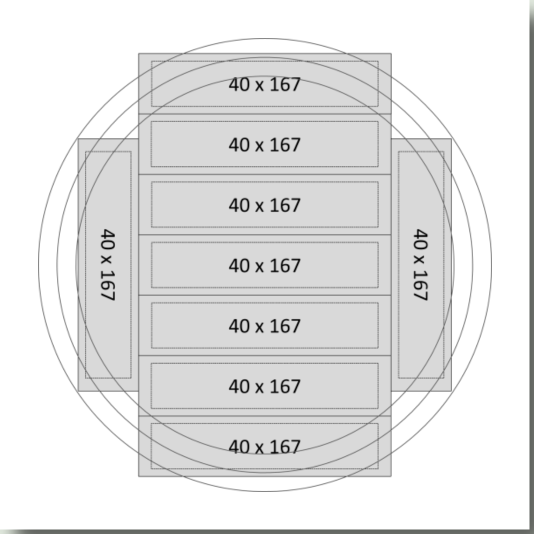
  - Kiln-drying only if required (MC > 30%); edging of sideboards and planing if necessary
  - First log sample to be processed: beech (18 logs)



- **Lamella testing at HFA**
  - Visual strength grading according to DIN 4074-5:2008-12
  - Measurement of board MOE_{dyn} (ViScan)
  - Destructive testing of tensile strength according to EN 408:2012-10
  - ca. 150 lamellas in total (50 – 60 beech lamellas)

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Next steps

- **Testing of (automated) knot detection in CT images**
  - Testing of existing algortithms for softwoods on CT images of oak, ash and chestnut (beech will be most problematic…)
- **Estimation of optimization potential for lamella production**
  - If feasible: Sawing simulations with iteration of log rotation angle; grading of the products according to DIN 4074-5:2008-12
- **Testing WEHAM on inventory data from Austria**
  - W. Russ (BFW) currently working on conversion of the database structure (workshop with department of biometry at FVA held on 5/28)

Dissemination

- Paper on the present evaluation of the beech log sample submitted to the *International Scientific Conference on Hardwood Processing (ISCHP) 2015* (Québec City, 9/15–17)
- Same paper also submitted (this week) to the *19th International Nondestructive Testing and Evaluation of Wood Symposium* (Rio de Janeiro, 9/22–25)

Evaluation of European beech (*Fagus sylvatica* L.) roundwood for improved production of strength-graded lamellas

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ABSTRACT

Declining stocks of softwoods in European forests and, simultaneously, increased use of wood in the building sector which is both desired and anticipated will presumably lead to a future gap in wood supply for the production of glued structural timber. At the same time, increasing stocks of hardwoods such as European beech (Fagus sylvatica L.) with its favourable mechanical wood properties make utilisation of this resource for glued structural timber products a possible alternative. In the first part of a study on the suitability of lower-quality beech logs for the production of strength-graded lamellas for glued structural timber, a sample of 29 logs was evaluated for roundwood properties, including visual roundwood grading, measurement of dynamic modulus of elasticity (MOE) and X-ray computed tomography (CT) scanning. The results did not indicate any significant relationships between the measured roundwood properties. In a subsequent investigation, boards with common dimensions for glulam lamellas produced from the sample logs will be analysed including MOE measurements and visual strength grading. The data from the CT scans are planned to be used in sawing simulations for estimating the potential to optimise log breakdown for glulam lamellas.

1. Introduction

In central European forests there is a trend towards increasing standing stocks of hardwood species while the stocks of softwoods, especially spruce of medium dimensions, has started to decrease substantially. At the same time, an increased utilisation of wood in the building sector is sought and glued structural timber products such as glued laminated timber (glulam) and cross-laminated timber (CLT) are considered efficient construction materials, especially suited for multi-storey buildings. Currently, these products are almost entirely made from softwoods and thus a gap in raw material supply can be expected for the future. A European research project aims to promote the establishment of hardwood glulam and CLT in the building sector by providing the information required for optimised lamella strength grading and glueing as well as harmonised product standards. Within the scope of this project, the possibilities of improving the production of strength-graded hardwood lamellas through roundwood pre-sorting as well as sawing optimisation by means of X-ray computed tomography (CT) log scanning are investigated.

European beech (*Fagus sylvatica* L.) is the most abundant hardwood species in central Europe with standing stocks of 635 M m^3 in Germany (Schmitz et al. 2014) and 263 M m^3 in France (Anonymous 2013). To date, about two thirds of the annual beech wood harvest is used for pulp and paper or as fuel wood with only roundwood of higher grades being allocated to sawn timber production. In this context, production of lamellas for glulam and CLT might be an interesting usage option for beech roundwood of average and lower quality with a higher value creation and the benefit of a more long-term carbon sequestration in buildings.

According to Aicher and Ohnesorge (2011), suitability of beech timber for glulam beams has been investigated since the 1960s and increasingly since the 2000s with different aspects covered such as lamella grading, finger jointing, bonding and the influence of red-heart discoloration. The overall conclusion is that, except for its low natural durability and high swelling/shrinkage factors, beech timber has favourable properties for usage in glued timber products. As Bernasconi (2004), who also reported high mechanical performance for beech glulam, pointed out, the limited availability of strength-graded beech lamellas for glulam production can still be seen as an impeding factor for its implementation.

Thus, efficient allocation of beech roundwood to the production of glued structural timber is required. This in turn warrants characterisation of roundwood representative for the available resource and evaluation of the sawn timber, i.e. glulam lamellas, that this roundwood can be converted into to allow for an estimation of the relationship

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Abstract

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Keywords: CT scanning, MOE measurement, hardwood, structural timber, glulam

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Thank you for your attention!