

# *Influence of Forest Stand Density on Pinus Sylvestris Roundwood Quality in Even-Aged Mixed Scots Pine Stands in Myrtillosa Mel. Mesotrophic Site Type*

Ziedonis Miklašēvičs

Rezekne Academy of Technologies

State Stock Company "Latvijas Valsts Meži" (Latvia's State Forests)

Rēzekne, Latvia

Email: (Ziedonis Miklašēvičs): z.miklasevics@lvm.lv

**Abstract** - Among different development directions for better forest utilization, the purposefully detailed assessment of wood quality as raw material, facilitating improved wood utilization in manufacturing of traditional roundwood products as well as brand new products, proves to be very perspective. Roundwood quality features substantially differ depending on forest stand geographic location, growing site conditions, tending of forest stands and other circumstances [2], [3], [11]. Therefore, the economical estimation of more important tree species in Latvia should not be based only on scientific conclusions made in other countries, so particular research is needed for this purpose. Pine (*Pinus sylvestris*) is the most widespread tree species in Latvia, therefore a research work provided the characteristic of round wood obtained from pine tree stem is an actual point from several aspects, as it is necessary;

- to create early prediction models of roundwood quality;
- to plan harvesting purposes;
- to create the data basis of economically more relevant domestic tree species;
- to provide the further development of roundwood quality assessment methods;
- to estimate the competitiveness of Latvia pine timber in the world market

The main goal of study is to work out the quality characteristic of pine roundwood manufactured in final felling sites depending on timber formation damages- bark abrasion caused side drought.

**Keywords** - bark abrasion, side drought, mature stands, medium aged stands, stands at harvesting age. stands above harvesting age.

## I. INTRODUCTION

In order to ensure sustainable forest management it is very important to know the forest health and viability. The representing quality features like heartwood, sapwood, wood cells e.t.c. characterize the whole tree and its parts. Parametric characteristic of quality features depends on many circumstances. The quality of forest - plantation on the whole and growing trees are mostly affected by growing conditions [5], [6], methods of reforestation [3], [4], tending methods [11], tree bark diseases [1] forest stand density and tree competition [2], [8], [12].

At the same time due to various factors as high forest stand density and natural damage caused by wind-falls and snow breaks a part of forest stands lose their viability and die [11]. Stand damage can be classified according to location as damage to the stem or root system. Stem damage occurs above the root collar while root damage occurs below in the stem or roots "Fig. 1".

The majority of damage to the residual stand occurs during the felling stage when falling trees collide with residual tree stems. The injury can be designed further as a superficial or deep wound depending on its depth. In *Picea abies* stands, damage suffered almost inevitably leads to decay. In *Pinus sylvestris* stands, damage suffered leads to side drought with or without decay "Fig. 2".

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Fig. 1. Stem damage above root collar and root damage caused side drought

*Pinus sylvestris* stands are more resistant to heartwood rot but in case of *Picea abies* the situation Latvia is really serious-almost a quarter of trees have decay

in stem and can be used mostly as energy wood or pulp wood.



Fig.2. Side drought in *Pinus sylvestris* stands with and without decay

Harvesting in Latvia has been regulated by legislation [12], which determine the final felling age and diameter according to tree species and soil quality in forest lands. Current Latvian legislation permits the final felling in *Pinus sylvestris* stands where the trees of the dominant stand have reached the mean age of 101 years or the mean diameter of 35cm.

Nevertheless by observing the instructions provided in the regulatory documents and when final felling in high stands density has been performing, round timber with high volume features have been harvested, e.g. *side drought*, *sweep* e.t.c. which reduce the timber value “Fig. 3”.



Fig.3. The depth (h) limit of side draught (a) according to the roundwood assortment’s quality requirements: 1cm for wood poles (b); 2cm for sawlogs (c)

*Pinus sylvestris* is the most widespread conifer tree specie in Latvia. According to Latvian National Forest Inventory data (2013-2017), pine stands comprise 856.4 thousand ha or 26.5% of the total forest area ([www.silava.lv](http://www.silava.lv); according to forest definition - at least 1000 trees/ha, able to reach the height of 5 m).

4.7% from the total forest area is *Myrtillosa* and 22% is *Hylocomiosa*. The total wood standing volume in *Myrtillosa* stands (age 101>) reaches 310m<sup>3</sup>/ha and 365 m<sup>3</sup>/ha in *Hylocomiosa* stands, where *Pinus Sylvestris* standing volume respectively 206m<sup>3</sup>/ha in *Myrtillosa* and 178m<sup>3</sup>/ha in *Hylocomiosa* [11].

Because forest that grow today will ensure Latvia with forest resources after several decades, therefore, it is especially important that its value is not decreasing.

## II. STUDY GOAL

The main task of forestry is the growing forest with its most important indicator - wood resources stored in living trees. In contrast, timber companies have an additional interest not only in the volume of timber harvested, but mainly in the quality indicators of round timber.

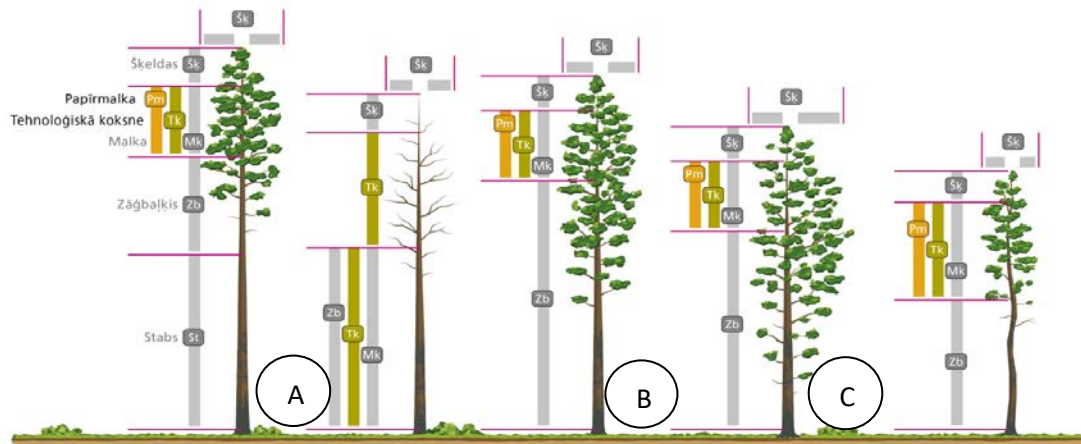


Fig.4. Harvested products from different pine stems types, where: A; B; C -pine stem types; St - wood poles; Zb- saw logs; Pm- pulp wood; TK- technological wood; Mk- fire wood; Šķ-wood chips

## III. MATERIALS AND METHODS

A field study was carried out at the period April - June of 2020 in Zemgale region of Latvia and in energy

Therefore, it is important to predict possible wood defects of growing trees, which may limit the applicability of the produced round timber to high value-added sawn timber, building construction elements, etc. production.

The main goal of study is to work out how the forest stand density at the harvesting age as a most important factor determine Correlation coef  $r=0.66$  at  $r_{0.05}=0.12$  between *Pinus Sylvestris* stock volume and stand density [11] impacts the quality of roundwood assortments and to evaluate the damages of side draughts as timber formation damages caused by wind-falls and snow in high forest stand density felling areas of mesotrophic site type (*Myrtillosa mel.*)

The following objective was set to achieve the study goal:

To clear up the characteristic of timber formation damage – *Side drought* in the commercial part of pine stems (10-15m section, divided in 4 zones) harvested as wood poles “type A. Fig.1” in overstocked young stands with overdue thinning where Scots pine current rotation age are older than 101 years and forest stand density higher than 0.7.

company JSC “Sadales tīkli”. Wood poles which were harvested in *Myrtillosa mel.* forest type where the age of pine stands according to the forest inventory description were more than 105 years old were selected in the investigation. “Table 1.”

TABLE 1

DATA CHARACTERIZED HARVESTING SITE		
Woodland type	Myrtillosa mel.	
Regeneration year	1905	1900
Species	6P3E1B11510E85	9P1E120+B12010E80
Area (ha)	0.70	1.3
Previous management operation isn't registered		

The average age of trees before harvesting in the felling area was determined by drilling 20-25 trees at the

butt swelling using Presler drill and counting the annual rings of increment core.

TABLE 2

DATA CHARACTERIZED HARVESTING SITE AND HARVESTING RESULTS

Harvesting site identification	Area (ha)	Amount (m <sup>3</sup> )	Species	Harvested amount (m <sup>3</sup> )	Stems
493380285996	1.99	969.03	Birtch	31	66
			Spruce	360	946
			Black alder	12	47
			pine	581	584
			Total	985	1643

Traceability of wood poles was ensured. In order to gather information about impact of *side draught* on wood pole's quality parameters, the following approach, methods and data was collected:

- data characterized the wood felling area: coordinates of wood felling area; forest type; growing stock; growth conditions; site quality classes; species composition index and the age of species;
- data characterized the wood pole's visual quality parameters: length of wood pole;

wood pole top, butt diameter and diameters measured with the interval 1m, wood pole diameter at a side draught positions; a side draught position measured from the wood pole butt and a width/number of annual rings characterized the age of injury.

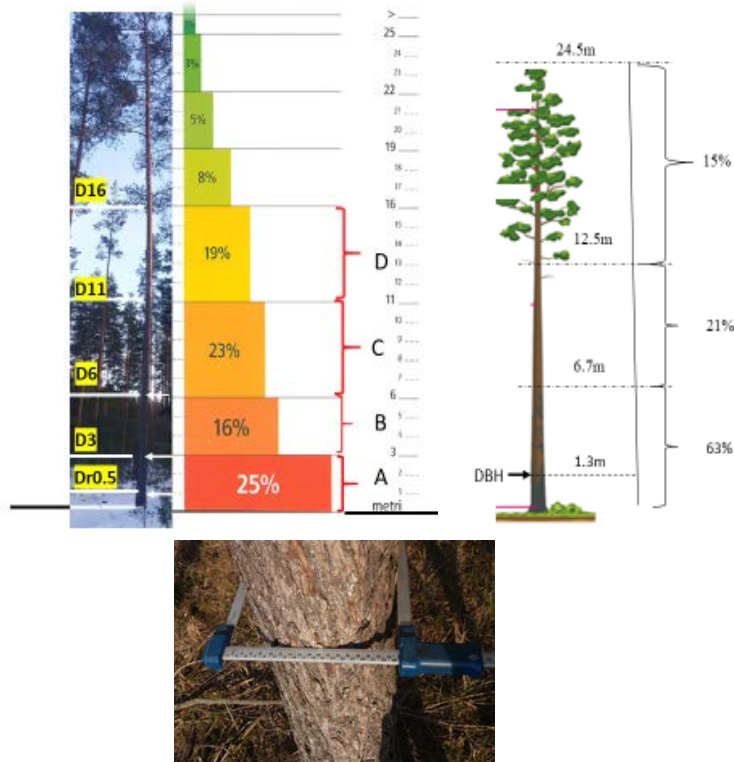




Fig. 5. The methodical distribution of pine stem by volume, zone and by timber value when stem length H- 24,5m, DBH -36cm; H/D=0.68

The methodical scheme of the investigation is given in “Fig. 5”, where the commercial parts of pine stems manufactured as wood poles are divided in 4 zone which represents more than 84% of roundwood value.

The quality control of each of harvested 221 pcs. wood poles “Table 3, 4” was done in harvesting sites and JSC “Sadales tikli” in each stage of technological process.

TABLE 3

HARVESTED AMOUNT OF WOOD POLES

Wood poles length (m)	Pcs/ m <sup>3</sup>	Average 1pcs volume (m <sup>3</sup> )
10	48/22.14	0.5
12	118/72.1	0.689
13	26/20.06	0.768
14	29/24.80	0.852
Total	221/139.1	

The data characterized quality of harvested wood poles are given in “Table 4”.

TABLE 4

THE QUALITY OF HARVESTED WOOD POLES

Quality appreciations	Volume pcs /(m <sup>3</sup> )	% from harvested volume	% from harvested stem
Defect (Curvature)	75/35.02	25.19	32.94
Defect (Side draughts)	38/25.71	18.49	18.19
Corresponds to the quality	108/78.27	56.32	48.87
Total	221/139.1		

The measurement example of side draught characterized parameters is given in “Fig. 6”.

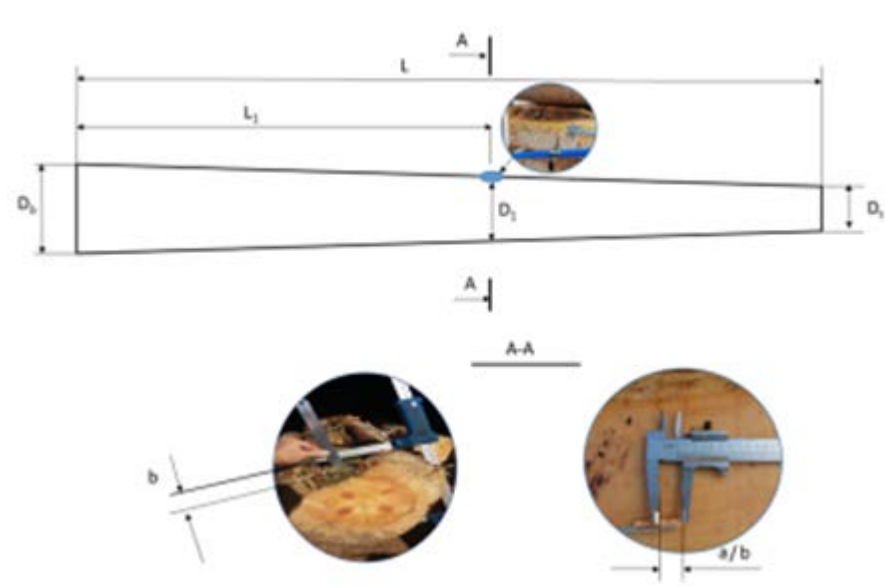


Fig. 6. The measurement example of side draught characterized parameters, where: A, B, C- zone of side draught position place;  $D_1$ -wood pole diameter at side draught position, mm;  $b$ - side draught depth, mm;  $a/b$ - number/thickness of annual rings characterized the age of injury;  $L_1$ - distance of side draught position measured from butt, cm;  $L$ - the length of wood pole, cm;  $D_1$ - the wood pole top diameter, mm;  $D_b/D_{b0.5}$ - the wood pole (from B zone) butt diameter / the wood pole (from A zone) butt diameter measured 0.5m from the butt, mm

#### IV. RESULTS AND DISCUSSION

Harvesting development in Latvia is regulated by Cabinet Regulation No. 935 “Regulations on Tree Felling”, which determines the age and diameter of the main felling according to the dominant tree species and quality. However, following the instructions provided in the regulatory documents and performing felling in forest stands with high density, round timber with an increased amount of wood faults, such as dry sides, curvature is obtained. etc., which reduces the industrial

value of timber. With no or delayed felling of such stands in such harvesting sites, the amount of dead wood increases, which exceeds the natural growth. Respectively, the biological value of the forest stand increases, but the industrial value decreases. Various literature sources [11] indicate that the current growth of wood in mature stands is approx.  $6.5\text{m}^3/\text{ha}$ , in felling age stands approx.  $5.2\text{m}^3/\text{ha}$ . At the same time, the natural growth of the stock in uncultivated stands is close to zero or even negative. The preservation of such stands is in

stark contrast to the tasks of modern forestry - the product produced in logging is defective [9], [14].

According to the methodical requirements the measurement results characterized damages of pine

stems caused by side draughts are given in "Fig. 6", "Table 5".

TABLE 5  
 THE MEASUREMENT RESULTS CHARACTERIZED DAMAGES OF PINE STEMS CAUSED BY SIDE DRAUGHTS

Zone	A	B	C	D
Diameters	Dr0.5 / D1 / D2	D3 / D4 / D5	D6 / D7 / D8 / D9 / D10	D11 / D12 / D13 / D14 / D15
Taper (mm/m) (221 wood poles)				
Average	7.0			
Stdev	0,57			
Median	6.89			
Wood pole diameters (mm) measured according to the methodical requirements (221 wood poles) "Fig. 2"				
Average	301/294/288	287/280/273	267/260/253/246/240	237/231/227/229/223
Stdev	30/30/29	26/26/25	25/25/25/25/25	22/22/21/16/16
Median	295/288/281	287/280/274	267/261/254/248/241	241/234/231/233/227
Wood pole diameters (mm) at side draught positions according to damaged zone (38 wood poles) "Fig. 2"				
Average	300	265	245	211
Stdev	30	42	40	25
Median	290	247	252	207
The depth of side draught (mm) "Fig. 2"				
Average	20.4	22.1	18	17
Stdev	8.6	8.9	4.8	4.1
Median	21	22	18	15.5
The width of annual rings (mm) characterized stem wound age "Fig. 2"				
Average	0.98	1.09	0.91	1.06
Stdev	0.22	0.19	0.15	0.19
Median	1.10	1.15	1.08	1.11
Years before side draught damages (mm)				
Average	20.8	20.2	19.7	16.0

## V. CONCLUSIONS AND RECOMENDATIONS

The results of the study indicated the following:

- About 18.19% of inspected wood poles (pine stands) harvested in felling areas in *Myrtillosa mel.* forest type where the mean age of pine trees were 115-120 years old were damaged by timber formation damages -side draughts.
- About 18.49% from harvested pine stems volume (wood poles ) were rejected due to timber formation damages -side draughts which average depth (mm) exceeds 20mm.
- The data characterized stem wound age shows that the biological value of the pine stand starts to increase, but the industrial value decreases in

mesotrophic site type ( *Myrtillosa mel.*) harvesting sites where the age of stems is more than 100 year.

- There are advisable to raise the issue of reducing the felling criteria (age of the main felling (in years) depending on the quality and average diameter of the stand) in non-cultivated felling stands in felling stands where there is no purposefully created tree stands structure, by evaluating socio-economic and ecological aspects.
- In forests with this kind of management history the application of the current rotation age (101 years) will likely be a grave mistake. The existing management model should be altered.

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