

THE MEASUREMENT OF ROUNDWOOD
Methodologies and Conversion Ratios

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THE MEASUREMENT OF ROUNDWOOD Methodologies and Conversion Ratios

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Disclaimer

The opinions and statements in this book are the author's and not those of present or past employers. Every effort was made to present accurate information from the best sources available, but this information should not be used in lieu of specific information sources or local knowledge when physical risk, issues of legality, or damages (financial or otherwise) could occur.

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The author encourages any of you who wish to contribute information, make comments and suggestions, or have questions to contact him at: Roundwood@safe-mail.net

Foreword

Estimating the contents of roundwood is fundamental to forest products industries. Tree boles are irregular geometric solids with varying taper rates, making estimation of product quantities a formidable task. The wide array of products of possible interest – many of which involve converting highly irregular roundwood into regular dimensions – adds further complexity to the undertaking. Product specifications are subject to change, and manufacturing methods are variable and are undergoing constant evolution. Hence, it is not surprising that a bewildering span of metrics and methods for assessing roundwood has been promulgated.

While it would seem a relatively simple matter to estimate the probable product yield from roundwood, a wide variety of possible products must be considered. Furthermore, many primary forest products are bought and sold on a weight basis, as well as on volume measure, thus necessitating a thorough understanding of weight-to-volume relationships.

In the case of lumber, for example, the various dimensions of boards that may be produced from a log, variation in the equipment used in producing lumber, skills of various operators, and inherent variability in the logs makes for a multifarious estimation problem. In addition, the application of the log scaling procedures often varies by locality, with different definitions for obtaining scaling diameter and length. Scaling straight, sound logs is problematical, but many pieces have defects, which further complicates an already onerous job. Value depends on log quality or grade, as well as log volume and product quantity, thus adding yet another tangled layer to the knotty problem of assessing roundwood.

For many regions of the world, there is no industrial association or government agency with control over the measurement of roundwood. Therefore, it is essential that the various measurement standards and methods be clearly described and compiled in a readily available source. Because of the puzzling array of log rules, the difficulty of converting between different rules and units of measure and the scattered and incomplete documentation of the many assessment methods being applied

by the forest products industry, pulling the material together in a logical and coherent manner under a single cover is a daunting endeavour.

Matthew A. Fonseca accepted the challenge of systematically summarizing a plethora of information on measuring roundwood with this volume entitled *The Measurement of Roundwood: Methodologies and Conversion Ratios*. In this ambitious effort, he summarizes the basic concepts, commonalities and differences of the principal log rules. He covers methods for measuring log yard inventories and mill usage volume, discusses measuring log quality, gives information on roundwood weight and general physical properties, details metrics of lumber recovery as well as plywood/veneer recovery, and ends with information on metrics of wood chips and other residue recovery from logs. This comprehensive volume on the metrics of roundwood includes coverage from major timber-producing regions of the world. With the increasing globalization of the forest products industry, having a ready reference to help sort through the maze of metrics and methods applied to assessing roundwood is certain to prove highly beneficial to foresters and forest products specialists.

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Abbreviations

–	missing data
'	foot
"	inch
# or n	number
<	less than
>	greater than
√	square root
@	at
BC	British Columbia
BD	bone-dry
BDMT	bone-dry metric tonne
BDT	bone-dry ton
BDU	bone-dry unit
bf	board foot
BTU	British thermal unit
C	Celsius
ccf	cunit
cm	centimetre
CO ₂	carbon dioxide
CT	computer tomography
CTL	cut-to-length log processor
CV	coefficient of variation
D	large-end diameter
d	small-end diameter
DBH	diameter at breast height
dia.	diameter
dm ³	cubic decimetre
F	Fahrenheit
EXP	antilog of natural logarithm
ft ²	square foot
ft ³	cubic foot
GJ	gigajoules
GTS	green target size

H	height
JAS	Japanese agricultural standard
kg	kilogram
L	length
lb	pound
LF	lineal foot
LL	long log
LN	natural logarithm
LRF	lumber recovery factor
m	metre
m ²	square metre
m ³	cubic metre
mbf	1000 board feet
MBTU	1000 BTU
MDF	medium density fibreboard
mc	moisture content
mm	millimetre
msf	1000 square feet $\frac{3}{8}$ " basis
MT	metric tonne
ns	not specified
OR	overrun
OSB	oriented strand board
PC	personal computer
PLE	prior load expansion
PNG	Papua New Guinea
Rt	revised t value
rw	random width
S	segment
SD	standard deviation
SE	sampling error
SG	specific gravity
SL	short log
spp	species
t	ton
UR	underrun
USFS	United States Forest Service
VRF	veneer recovery factor
W	width

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1 Introduction

The ability to measure roundwood quantity and quality, and to predict product yields is of great importance to forest industries. In most areas, the cost of logs is the single largest operating expense that a forest product manufacturing company incurs. Despite the need for insight into roundwood metrics, it remains an area that is difficult to understand due to counterintuitive trends, complicated and inconsistent measurement logic, tremendous variability between regions, species, products, sizes, age classes, and the misnomers that exist regarding the units of measure. Further complicating one's ability to understand roundwood measurement is the proprietary nature of the industry: roundwood trade and conversion is highly competitive, and knowledge of roundwood metrics is often seen as a competitive advantage, not to be disseminated.

Beyond the obvious need for accurate volume and quality information on roundwood is the need to be able to use that information to make predictions, appraisals and forecasts, and conduct strategic analysis into core strengths and alternative scenarios that could provide improved efficiency and realization. This book has been written with the primary design to guide and provide reference to resource and manufacturing managers, professionals, analysts and log-scaling organizations. It is hoped that the data on product recovery will give the reader a good basis of understanding of the drivers that affect product recovery, and provide procedures and recommendations to implement or improve accounting procedures for measuring roundwood and product recovery.

Another intent of this book is to include a listing of comprehensive conversion ratios for log volume to weight, product volumes, and between various log-scaling methods. While there are few exact and universal conversions due to the variable physical characteristics of logs and inconsistencies in measurement methods, every effort has been made to obtain specific and accurate conversion ratios, and to present them with the necessary qualifiers.

In order to accomplish the stated aims, the following categories of roundwood metrics are covered:

Log scaling. Fifteen basic scaling methods utilized for the measurement of roundwood from various geographic regions around the world were chosen based on significance and availability of information. There is also an appendix table (Table A.1.B), which provides a brief description of ten more scaling methods. The key conventions used in these log scales are summarized, and relative volume trends compared to each other via a modelled log population in order to provide approximate conversion factors from one method of scaling to another. Because in many regions logs are scaled and traded by means other than physically measuring diameters and lengths, other methods of log scale are discussed, such as weight, stacked measure and the use of electronic scanning with necessary linkages provided to develop conversion ratios. As statistical sampling is a very common component used with log measurement systems, basic statistical methods and general guidance to methods and applications of different types of sample scale systems are discussed and diagrammed.

Log yard inventory management. Methods of measuring and managing log yard inventories are presented, discussed and tied together with the associated statistical methods. The use of weight, stacked measure, count, scaled and 'book determined' inventory methods are covered. Accounting procedures for reconciling inventory to usage and delivery volumes are discussed and illustrated with examples.

Measuring log grade and manufacturing quality. Relevant log characteristics which indicate the quality of products that can be produced are listed, and log manufacturing errors, which destroy value, are discussed in terms of accounting for these errors.

Roundwood weight and physical characteristics. Many systems of scaling, inventory and payments for transport and harvesting of timber, are dependent on weight. Weight-to-volume ratios are a key parameter for understanding costs and efficiency levels related to the conversion of trees into forest products. It is difficult to do meaningful realization analysis without understanding weight ratios, and this is especially true given the current trend toward purchasing wood and paying for timber harvest via weight. Weight is a key parameter along with bone-dry weight, which is critical to understanding value and making good allocation decisions for pulpwood and the manufacture of residual wood products. This book also includes a list of published weight-to-volume ratios and bone-dry weights for many worldwide commercial timber species in the form of raw logs. Bark content is shown for most major North American and some European timber species.

Product recoveries from roundwood. The key drivers that determine lumber, veneer, plywood, chip and residual wood fibre recovery from roundwood are discussed and diagrammed. Effects such as log size and

characteristics, products manufactured, physical properties of wood, milling efficiency and log-scaling method used are quantified and reflected through graphs and tables, which show estimated recovery ratios within product lines, scaling methods and small-end diameter. The associated methods of measuring products are covered and quantified, including cubic content, board foot, surface measure and bone-dry measure. Product recovery from residual wood fibre such as composite panels, pulp and paper, and wood energy are covered briefly.

As stated earlier, every attempt has been made to present accurate information. But as with any information on variable subject matters such as the weight of wood, scaling method, conversion factors and recovery ratios, the reader needs to be aware that the listed data may not be reflective of every situation. It is best to obtain conversion ratios specific to the intended population; nevertheless, much of the content of this book exists because this is not always possible, nor is it always necessary.

Much of the matter in this book has been accumulated over many years by the author in his professional capacity, and much of it has come from published information on the subjects discussed. Official sources, such as Forest Services and Forest Ministries, and mensuration organizations provided much of the previously published information contained herein. There is undoubtedly a 'North American bias' in content as it is an important region in terms of the sheer size of the forest sector; it has many old and complicated systems of measure, and it is also where the author obtained his experience. Readers are encouraged to utilize the publications, papers and websites listed in the reference for further research.

Finally, it should be said that the forest products industry, while always accepting of new technology, is also steeped in tradition, and sometimes resistant to change. Many of the complexities contained in this book on understanding and managing roundwood are due to old systems of measurement that no longer apply well to the current state of forestry and the timber industry (particularly in North America). It is the author's hope that support for improved accuracy, simplification and harmonization of systems will eventually bring about an end to using systems, some of which have been utilized for more than 150 years and which no longer provide the users with much value.