THE WOODLAND WORKBOOK

FOREST MEASUREMENT

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Measuring Timber Products Harvested from Your Woodland

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Contents

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Managing woodland property offers you the opportunity to harvest a variety of products, depending on timber quality and quantity, harvest economics, and market availability. Among these products are saw logs (for lumber or plywood), peeler logs (for plywood), pulpwood, fuelwood, poles, piling, and posts.

Knowledge of measurements used in the wood products industry can help you make management and marketing decisions that ultimately will increase financial returns from your woodlot.

This publication describes measurements used to buy and sell timber products. You can get more information from OSU Extension agents, consulting foresters, timber product buyers, state service foresters, USDA Forest Service foresters, and the staff of log scaling and grading bureaus.

Fundamentals of measurement

The type of timber product determines its unit of measurement. You sell saw logs by board feet, cubic feet, or weight; pulpwood by weight; and poles by board feet or linear feet.

Log scaling and grading bureaus provide independent measurement and standardized rules for the buyer and seller. Log measurement rules may vary among major regions of the United States.

In the Pacific Northwest, saw logs are measured by the Scribner log rule, which estimates volume in board feet, based on the small-end log diameter and the log length. For pole and piling sales, board-foot volume is estimated using top diameter, length, and circumference or large-end diameter.

Special tables (some of which are in this publication), tools, and experience are necessary to make accurate estimates of log quality and quantity. Table 1 outlines measurement units for some common wood products. See also *Tools for Measuring Your Forest* (Bowers 2008).

Measurement units

The first step in measuring forest products is to define the units. Here are the ones you'll use most often.

Table 1. Common forest products and their measurement units.

Product	Measurement units
Saw logs and peeler logs	Board foot Scribner Log grades, export grades Cubic feet Weight
Poles and piling	Diameter, circumference, or large-end diameter Length Surface characteristics
Fuelwood	Cord Weight
Pulpwood	Weight Cord

Board foot

This is the most common unit of measurement for saw logs and peeler logs. Visualize a board foot as a board 1 inch thick by 1 foot wide by 1 foot long (figure 1):

Bd ft = [thickness (in) x width (in) x length (ft)] ÷ 12 in

For example, a plank 2 inches by 8 inches by 24 feet contains 32 board feet:

(2 x 8 x 24) ÷ 12 = 32

Board-foot volume usually is expressed in 1,000 board feet (MBF).

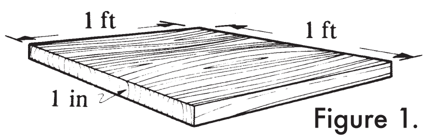


Figure 1. Board foot.

Cubic foot

A cubic foot is a solid piece of wood 1 foot wide, 1 foot thick, and 1 foot long (figure 2). Cubic feet give a more accurate log volume estimate than board feet. A high degree of accuracy results from the consistent measurement of the solid wood content of a log, regardless of its size.

The cubic foot is used primarily to measure pulpwood volume, but there is growing interest in using it for saw log measurement.

Wood fiber volume measurements include the following:

- The cunit—100 cubic feet of solid wood (CCF)
- The cubic meter (m^3)—35.314 cubic feet, the standard log volume measure for most of the world other than the United States

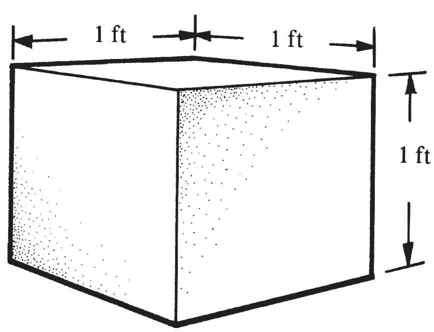


Figure 2. Cubic foot.

Cord

A cord is the amount of wood in a neat stack 4 feet wide by 4 feet high by 8 feet long (128 cubic feet). It is the most common U.S. measurement of pulpwood and fuelwood.

A cord rarely exceeds 90 cubic feet of solid wood. (The bark and empty spaces between the pieces of wood make up the rest of the space). The amount of actual wood depends on the size and shape of pieces, the presence and thickness of bark, and the method of stacking.

One variation is the *rick* or *short cord*—a stack of wood 4 feet high and 8 feet long, which is made up of pieces that are less than 4 feet long. A *face cord* has pieces averaging 16 inches long and measures 42 cubic feet or one-third of a cord:

(4 ft x 8 ft x 16 in) ÷ 12 in = 42

Linear measurements

Use feet and inches in selling specialty products such as poles, piling, fence posts, mine props, railroad ties, car stakes, or hop poles. Sell each product by the piece. In these cases, length and strength are more important than actual volume.

Weight

Weight is becoming more prevalent as an estimate of volume, particularly when you sell logs that are small, expensive to measure, uniform in diameter, taper, and length, and that are low in value.

When you sell logs by weight, sample scale your log loads periodically. Sample scaling involves weighing and scaling a load of logs to determine a board-foot-to-weight conversion.

Sample scaling assures you a fair price because conversions are affected by species (wood density), log size, moisture content, and the amount of sapwood and heartwood. (Sapwood has more moisture and thus is heavier.) As weight per board foot increases the value per MBF increases, as long as the price per pound is constant.

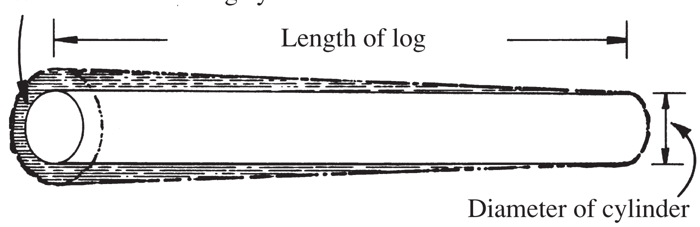


Figure 3. The scaling cylinder.

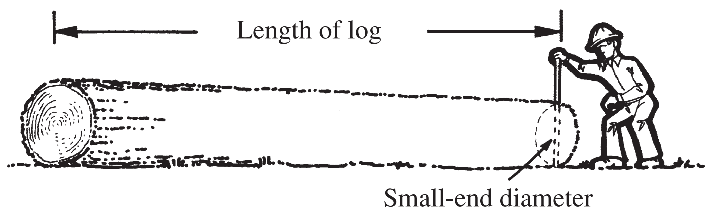


Figure 4. Measuring small-end diameter and length is needed to determine board-foot volume.

Measuring logs

Board-foot log rules

In the majority of cases, you sell logs by the board foot. The log rules used to convert log size into board feet are a standard measure of volume determined by custom and agreement. They estimate the lumber volume you can cut from a log.

Because logs taper and are not square, board-foot log rules take into account the width of the saw blade (kerf) and the slabs cut from a log to square it and trim the ends.

Since 1825, more than 50 different log rules have been devised and used in the United States and Canada. Only a few remain in use today. None predicts exact lumber recovery except when nearly cylindrical logs are sawed according to a particular rule. Buyers and sellers must be aware of log rules' limitations in business transactions.

In 1846, J.M. Scribner devised the log rule that is used most often in the Pacific Northwest. He diagrammed 1-inch boards to scale within cylinders of various sizes, allowing 0.25 inch for kerf.

Scribner decimal C is a modification of the rule. It rounds values to the nearest 10 board feet and drops the final digit. For example, if Scribner volume is 503, Scribner decimal C is 50. Scribner volume tables used in the industry are rounded. So, a log with 504 board feet would read 500.

There is no taper allowance, so the rule normally underestimates volume for logs more than 16 feet long. Wood outside the scaling cylinder (figure 3) increases as taper and length become greater. The amount of wood product (lumber or veneer) that can be cut from the area outside the scaling cylinder is called overrun. Overrun is expressed as follows:

$$\% \text{ overrun} = \left[\frac{\text{(bd ft lumber} - \text{bd ft net log scale)}}{\text{bd ft net log scale}}\right] \times 100$$

The amount of overrun that occurs when a measurement is less than the actual lumber volume cut is a significant factor to consider when you measure long logs with a high degree of taper.

Improved sawmill efficiency, narrow saw kerf, and the use of slabs of wood cut from outside the scaling cylinder also influence the chances for overrun.

Log scaling

The purpose of log scaling is to provide a uniform method of log volume measurement that is acceptable to buyer and seller. Scalers measure logs in a consistent manner, using standardized volume tables and log rules. Log sellers, purchasers, and log scaling and grading bureaus employ scalers.

In most situations, scalers are certified by a log scaling and grading bureau, such as the Columbia River Log Scaling and Grading Bureau. The company buying the wood either employs the scaler or contracts with the bureau for scaling services. Although in the first case the scaler is paid by the mill and in the second by the scaling bureau, in both cases the scaler must be certified. Also, all scalers are monitored by bureau check scalers at regular intervals to ensure proper log evaluation. See *Official Log Scaling and Grading Rules* and its supplement (Northwest Log Rules Advisory Group 1997).

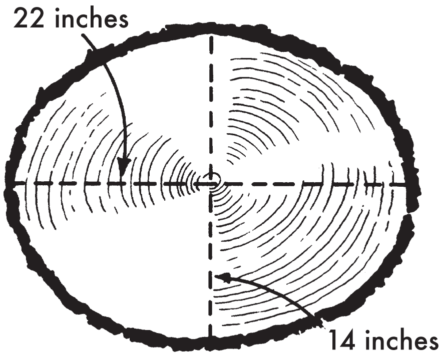


Figure 5. Method of measuring the diameter of oval logs: add 22 to 14 and divide by 2; the diameter is 18 inches.

Board-foot volume

Scalers determine Scribner board-foot volume by measuring log diameter and length. They measure the diameter inside the bark at the small end of the log (figure 4). The rule assumes that the log is a cylinder with its diameter equal to the small-end diameter. The result is the scaling cylinder in figure 3.

When measuring oval logs, scalers determine the diameter by averaging the long- and short-diameter measurements (figure 5).

Scalers measure log lengths in 1- or 2-foot multiples, depending on mill and log scaling and grading bureau policy. A trim allowance is required for all logs to compensate for damage to the ends during logging and for squaring log ends at the mill.

Table 2 outlines scaling guidelines for western and eastern Oregon. As the table shows, logs scaled east of the Cascades use different length, diameter, and trim rules than logs scaled west of the divide. Always contact your buyer or mill before you cut because minimum length and diameter requirements, species preferences, and trim allowances may vary.

When you know log length and diameter, you can use log volume tables to determine gross board-foot volume (figure 6). A complete set of tables is available from log scaling and grading bureaus.

You can estimate net volume once you deduct the volume lost to defects. See the section on defects (page 7) for more information on defect deductions.

Selling logs by weight

It's becoming more common to sell small conifer logs and pulp logs by weight. Here are some factors to consider when you are deciding whether to sell by weight or board-foot log rules.

Board-foot rules are not adequate for trees with a high degree of taper (for example, those that grow in the open). The seller must decide whether to cut short logs for less $/MBF, longer logs for more $/MBF, or to sell by weight.

When you sell small logs by weight, you eliminate the problem of underestimating board-foot volume of long, tapering logs. Maximizing weight per log is important, so cut top diameters as small as possible (frequently, 5 inches).

Because specific log lengths are not critical when selling by weight, when compared to cutting for board-foot volume, you reduce cutting time.

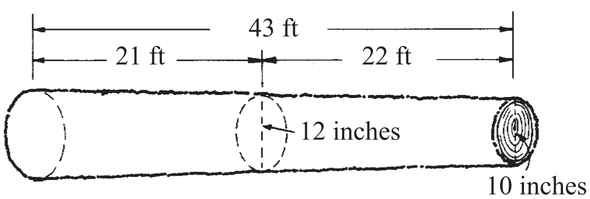
Changes in moisture content, species mix, log size, and timber location can influence the number of board feet per pound and the log truck's carrying capacity. (See appendix A for information on log truck carrying capacities.)

Table 3 lists some conversion factors for some of the more common species that landowners might consider selling on a weight basis. These conversions are generalizations only. Give careful consideration to the preceding factors that influence weight–volume ratios.

Table 2. Western and eastern Oregon scaling practices.

Scaling units	Western Oregon	Eastern Oregon
Length	1- or 2-ft multiples; depends on mill's scaling policy.	1- or 2-ft multiples; depends on mill's scaling policy.
Maximum length	Logs scaled as one log up to 40 ft—longer logs scaled in segments as nearly equal as possible.	Logs scaled as one log up to 20 ft—longer logs scaled in segments as nearly equal as possible.
Segmenting logs with unequal lengths	If a log is more than 40 ft and segmenting results in unequal lengths, the segment with the smaller top diameter is considered longer.	If a log is more than 20 ft and segmenting results in unequal lengths, the segment with the larger top diameter is longer.
Segment diameters for logs that measure more than maximum length	Diameters increase 1 inch per 10 ft of log length.[a]	Take the difference between the two end diameters, except for butt logs.[b]
Diameter	Drop fractions over the full inch.	Round off fractions to the nearest inch.
Trim allowance	Use a maximum of 12 inches for logs scaled in l-ft multiples.[c] Use a minimum of 8 inches for logs scaled in 2-ft multiples.[d]	Normally, 5 to 6 inches allowed per segment.[e]

[a] To illustrate, assume you have a log 43 ft long with a 10-inch top (see drawing below). It would segment into a 21-ft log with a 12-inch top and a 22-ft log with a 10-inch top (remember the practice noted in the "Segmenting logs" section of the table above). Total log volume would be the sum of these two segments.



[b] The Forest Service also has tables for determining log taper (difference between large- and small-end diameters) that you can use to estimate segment diameters.

[c] For instance, a 33-ft l-inch log would be scaled as 33 ft, as would a 33-ft 11-inch log. However, a 33-ft log with no trim would be scaled as a 32-ft log.

[d] For logs measuring more than 40 ft, an additional 2 inches of trim is required for each additional 10 ft.

[e] Thus, an 18-ft log would need a minimum trim of 5 to 6 inches, and a 33-ft log would need 10 to 12 inches.

Cubic-foot volume

Log rules based on mathematical formulas determine cubic foot volume. In the Pacific Northwest, the most commonly used rule is the Smalian formula.

Large-end diameter, small-end diameter, and log length are necessary for determining cubic foot volume (figure 7). Guidelines for determining length and trim allowances are similar to board-foot log rules; however, you will round diameters to the nearest whole inch.

The Smalian formula is as follows:

cubic volume =
$$[0.005454 \times (D^2 + d^2) \times \text{segment length}] \div 2$$

where D = large-end diameter and d = small-end diameter.

Suppose you have a log 20 feet long that measures 16 inches on the large end and 12 inches on the small end. What is the cubic volume? Inserting the numbers into the formula, you get the following:

cubic volume =
$$[0.005454 \times (256 + 144) \times 20] \div 2, \text{ or } 21.8 \text{ cu ft}$$

Figure 6. Scribner log rule, gross board-foot volume.

Len. (ft)	Top diameter (in) 4	5	6	7	8	9	10	11	(A)→ 12	13	14	15	16	17	18
4	0	0	0	10	10	10	10	10	20	20	30	40	40	50	50
5	0	10	10	10	10	10	20	20	20	30	40	40	50	60	70
6	0	10	10	10	10	10	20	20	30	40	40	50	60	70	80
7	0	10	10	10	10	10	20	30	30	40	50	60	70	80	90
8	10	10	10	10	10	20	30	30	40	50	60	70	80	90	110
9	10	10	10	10	10	20	30	30	40	50	60	80	90	100	120
10	10	10	10	10	20	20	30	40	50	60	70	90	100	120	130
11	10	10	10	20	20	20	30	40	50	70	80	100	110	130	150
12	10	10	10	20	20	30	40	40	60	70	90	110	120	140	160
13	10	10	20	20	20	30	40	50	60	80	90	120	130	150	170
14	10	10	20	20	20	30	40	50	70	80	100	120	140	160	190
15	10	20	20	20	20	30	50	60	70	90	110	130	150	170	200
16	10	20	20	30	30	40	60	70	80	100	110	140	160	180	210
17	10	20	20	30	30	40	60	70	80	100	120	150	170	200	230
18	10	20	20	30	30	40	60	80	90	110	130	160	180	210	240
19	10	20	20	30	40	50	70	80	90	110	140	170	190	220	250
20	10	20	20	30	40	50	70	80	100	120	140	180	200	230	270
21	10	20	30	30	40	50	70	90	100	130	150	190	210	240	280
22 ←(B)	10	20	30	40	40	50	80	90	(C)→ 110	130	160	200	220	250	290
23	20	20	30	40	40	60	80	100	110	140	160	200	230	270	310
24	20	30	30	40	40	60	90	100	120	150	170	210	240	280	320
25	20	30	30	40	50	60	90	100	120	150	180	220	250	290	330
26	20	30	30	40	50	60	90	110	130	160	190	230	260	300	350
27	20	30	30	40	50	70	100	110	130	160	190	240	270	310	360
28	20	30	30	50	50	70	100	120	140	170	200	250	280	320	370
29	20	30	40	50	50	70	100	120	140	180	210	260	290	330	390
30	20	30	40	50	60	70	110	130	150	180	210	270	300	350	400
31	20	30	40	50	60	70	110	130	150	190	220	280	310	360	410
32	20	30	50	60	70	90	120	140	160	190	230	280	320	370	430
33	20	40	50	60	70	100	130	150	160	200	240	290	330	380	440
34	20	40	50	60	70	100	130	150	170	210	240	300	340	390	450
35	20	40	50	60	80	100	130	160	170	210	250	310	350	400	470
36	20	40	60	60	80	100	140	160	180	220	260	320	360	420	480
37	30	40	60	70	80	110	140	170	180	220	260	330	370	430	490
38	30	40	60	70	80	110	140	170	190	230	270	340	380	440	510
39	30	40	60	70	90	110	150	180	190	240	280	350	390	450	520
40	30	40	60	70	90	120	150	180	200	240	290	360	400	460	530

Adapted with permission from *Official Rules for the Following Log Scale and Grading Bureaus: Columbia River, Grays Harbor, Northern California, Puget Sound, Southern Oregon* (Northwest Log Rules Advisory Group 1982).

A Small-end diameter (inside bark) is 12 inches.
B Log length to the nearest foot is 22 feet.
C Board-foot volume is 110 board feet (the point where the columns for length and diameter intersect).

Table 4 gives log scale conversion factors for board feet and cubic feet. Use it to compare board- and cubic-foot volumes as log diameters increase.

This is helpful for converting one scale to another. A log scaled in western Oregon with a top diameter of 12 inches has 4.5 board feet per cubic foot or 221 cubic feet per 1,000 board feet. Because logs are scaled differently in eastern and western Oregon (table 2), that same log scaled in eastern Oregon has 5.5 board feet per cubic foot or 182 cubic feet per 1,000 board feet.

As log diameters increase, you can expect a greater number of board feet per cubic foot.

If you have the options of selling saw logs by board feet, cubic feet, or weight, how do you know the best method of measurement? If you know the prices for each method of measurement, you can use the information in tables 3 and 4 to make this decision.

Situation: Suppose you have some Douglas-fir saw logs that are approximately 10 inches in scaling diameter (westside scaling rules). You have the option of selling the logs for $600/MBF, $80/ton, or $125/cunit (100 cubic feet). What is the best method of sale, assuming hauling costs are constant?

To answer this question, use the following equation to convert the price by weight to price by MBF:

$/MBF = $/ton x weight-volume conversion factor x cu ft/MBF

We already know that we have been offered $80 per ton. Using table 3, we see that the weight–volume conversion factor for Douglas-fir is 0.028. Table 4 gives us the cubic foot/MBF westside Scribner scale, which is equal to 253 (10-inch log diameters). Plugging numbers into the equation gives us the following:

$80 x 0.028 x 253 = $567

Now, we need to compare cubic feet (cunits) to MBF. Looking at table 4, we see that logs with a 10-inch scaling diameter have a 3.96 ratio of board foot (Scribner) to cubic foot, or 253 cubic feet per MBF. (Note: If we divide MBF by the cu ft/1,000 bd ft figure, we get the bd ft/cu ft ratio found in the second column of table 4.) Thus, our cunit ratio already is computed for us. The next step is to multiply the cunit price by the ratio:

$125 x 3.96 = $495

In summary, our $80/ton offer converts to $567/MBF. Our cunit offer is $125, which converts to $496/MBF. Our final offer is $600/MBF. According to the figures, $600/MBF is the best offer.

Table 3. Factors for converting weight–volume ratios.

Douglas-fir	0.028
Western hemlock	0.029
Ponderosa pine	0.026
Red alder	0.023

Defects

Disease, insects, and tree characteristics can cause natural defects in logs, reducing their usable board-foot volume (figure 8). To deduct for defect, scalers limit the flaw(s) to a particular section or quadrant of the log and determine the amount of wood loss.

Table 4. Approximate board-foot and cubic-foot conversions.

Westside Scribner scale[a]			Eastside Scribner scale[b]		
Log diameter (in)	Bd ft per cubic ft (gross)	Cubic ft per 1,000 bd ft	Log diameter (in)	Bd ft per cubic ft (gross)	Cubic ft per 1,000 bd ft
6	3.32	301	6	3.59	279
8	3.41	293	8	4.44	225
10	***3.96***	***253***	***10***	***5.03***	***199***
12	***4.52***	***221***	***12***	***5.50***	***182***
14	5.00	200	14	5.89	170
16	5.41	185	16	6.25	160
18	5.75	174	18	6.57	152
20	6.03	166	20	6.87	146
22	6.26	160	22	7.16	140
24	6.45	155	24	7.44	134
26	6.62	151			
28	6.75	148			
30	6.86	146			

Note: Shaded entries are those used as examples in the text (Jim Cahill, research forester, timber quality, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, Portland, Oregon, personal communication).

[a] Logs measured using westside Scribner scaling rules.

[b] Logs measured using eastside Scribner scaling rules.

Defect types are as follows:

- Flaws inside the log
- Flaws outside the log
- Flaws in crotches (forks in trees where trunks split to form double tops)
- Curvature of the log
- Excessive knots

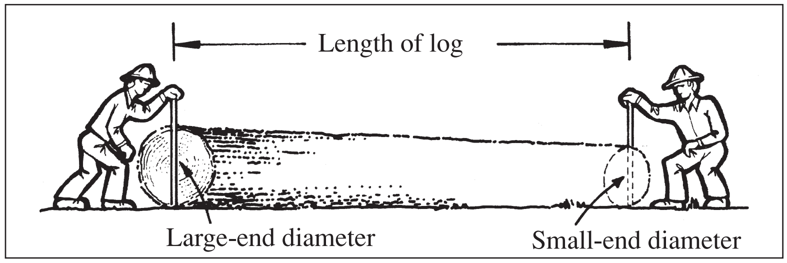


Figure 7. Determine cubic volume by measuring small- and large-end diameters and length, then use table 3.

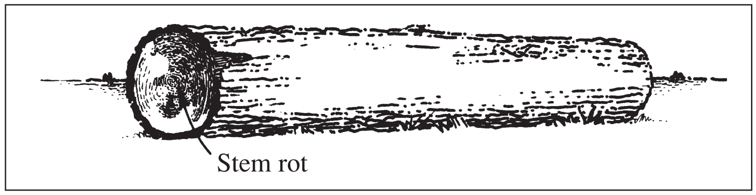


Figure 8. Rot in a log can reduce usable board-foot volume and must be deducted from gross board-foot volume.

The type of defect deduction depends on the kind of defect and its location. Scalers deduct from diameter, length, or volume, thereby reducing a log's net scaled volume. They do not deduct for defects out-side the scaling cylinder.

Defects such as sapwood rot, pitch rings, wind or sun check (cracks in wood), roughness, and heart checks reduce the diameter of a log. Sweep, crook, spangle, excessive butt rot, conk rot (from a wood-destroying fungus), split, and other advanced decay reduce log length. Defect deductions also can come in the form of mechanical (human-caused) damage. Defects such as breakage, stump shot, buckers break, and slabs are examples. They usually result in length deductions.

Log grading

Log quality varies from property to property. As quality increases, the benefits of selling logs by grade also increase.

Camp run refers to a mix of saw log or better quality logs purchased at the same price. However, as log quality improves and size increases, it's more common to sell logs at a different price for each log grade.

Grading logs takes a high degree of skill and experience. Table 5 lists some specifications for several species.

Scaling tickets

Scalers make out tickets at a log scaling facility, which usually is at a mill. Each ticket has six copies, which the scaler distributes to the log scaling organization, seller, buyer, logger, and trucker (with one copy left as an extra).

A scale ticket is made out for each load of logs delivered to a mill. It's issued to anyone who sells logs for pulp, saw logs, or veneer logs; it is the official and legal document that states how much wood the seller delivers. We've reproduced a partial scale ticket showing logs measured by the Scribner scaling system (figure 9). Understanding what is in a scale ticket will help you understand who scaled your logs, how they were evaluated, how deductions were made, and the net volume for which you will be paid.

Following is a detailed explanation of what's included in the upper and lower parts of a scaling ticket. (Some parts of the ticket are not explained because they won't apply to operators of smaller woodlots.)

The upper part of scaling ticket and table

To: The name of the buyer (usually the mill) or the location of the logs when they are scaled.

From: The seller's name (usually yours, if you're selling logs to a mill).

Sel Loc: Where the logs are being scaled.

Brand: The registered identification of the seller or party delivering the logs. Register a log brand through the State of Oregon; you will need a diagram of the brand. In western Oregon, you need a registered log brand to transport logs on highways; in eastern Oregon, you don't.

Sale: The name of the timber sale, if applicable.

Paint: Whether or not paint is being used to mark the ends of the logs. Sales on public lands require transported logs to be painted on at least one end.

Trucker: The individual and/or company who is delivering the logs.

Ticket #: Each scale ticket is numbered for additional tracking and identification.

Sample Group: Notifies the scaler which sample scale group to employ if the landowner is selling on a sample scaling basis.

Taper: How the taper in logs is being measured if lengths greater than 20 feet eastside or 40 feet westside are being delivered. In western Oregon, standard taper is 1 inch of diameter per 10 feet of log length. In eastern Oregon, taper is calculated by taking the difference between the two end diameters, except for butt logs.

Scaler #: The individual who is measuring the logs.

Time (PT): When the logs were measured (Pacific Time).

Seq: The sequence of the logs as they are being measured.

Log #: The mill's inventory number.

Sort: Determines on which decks or where the logs will be stored and/or sold.

Butt Dia: The butt diameter of the log being measured. Butt diameters are taken only when cubic scaling is used.

Len: Length of the measured log.

Dia: Diameter of the log.

Deduct L&D: Log defect resulting in material not suitable for the production of lumber or veneer is recorded in length (feet) and diameter (inches).

Gr: The assigned grade of the log, expressed in code.

Sp: The species of tree from which the log was cut.

Scribner Gross & Net: The total volume of the log being measured and the volume of the log after deductions have been included by applying Scribner Decimal C scaling rules. The net scale is the volume for which the seller will receive payment.

Cubic Merch: The cubic volume of wood judged to be suitable for the production of lumber and/or veneer after deductions have been included by applying the Pacific Northwest Cubic Rules for private wood and the National Forest Cubic Rules for public timber sales.

The lower part of scaling ticket

Species: All tree species included in the load of logs that were measured. The two-digit number to the left of a species' name is its code; e.g., Douglas-fir is 02.

Gross: The total volume of the logs measured on the load.

Net: The total log volume considered suitable for lumber and veneer; often called "merch."

Logs: The total number of logs transported by truck, water, or other method.

Chargeable: The total log volume for which the seller will be paid.

% Def: Percentage defect; that is, how much of the wood was rotten or otherwise not suitable for lumber or veneer production.

Avg Len & Dia: The average length (gross) and diameter (gross) of the logs measured.

Pcs/MBF: The number of logs (pieces) on the load required to accumulate a volume of 1,000 board feet.

NW Rules Merch: Summary of cubic volume according to Northwest rules cubic system.

Columbia River Log Scaling & Grading Bureau
P.O. Box 7002, Eugene, OR 97401
Phone (541) 342-6007

Date: 02/14/02
Page: 1

To:	WD SMITH	Certificate:	812-11, 704
	Raft/Deck: F68	Ticket #:	776-18650 ( )
		Weight Load #:	
From:	17280/BC /AC BROWN/SONS	Unit #:	
	Raft/Deck: Sort:	Sample Group:	
		District:	
		Taper:	STANDARD
Scl Loc:	3020/	Scaler #:	5150/
Brand:	8210/OC OVER 1 IN BOX	Time:	07:46
Sale:			
Paint:	NO PAINT		

Trucker: /HEN 17 / Truck

Seq	Log #	Sort	Butt Dia.	Len	Dia	Deduct L	Deduct D	Gr	Sp	S	Scribner Gross	Scribner Net	Cubic Merch
1	0003411	F68	19	34	17			29	02		390	390	49
2	0003410	F68	15	34	15			29	02		300	300	36
3		F68	26	34	11			32	02		150	150	103
4		F68	19	34	18	2		29	02		450	430	24
5		F68	23	34	13			29	02		210	210	62
6		F68	24	30	13			29	02		180	180	84
7		F68	30	17	16	5		29	02		170	120	137
8		F68	31	34	16	3		29	02		340	310	139
9		F68	12	34	13			29	02		210	210	10
10	0003410	F68	20	34	13			29	02		210	210	57
11	0003411	F68	26	34	13			29	02		210	210	94

Species	Gross	Adj Gross	Net	Logs	Chargeable	% Def	Avg Len	Avg Dia	Pcs/MBF
02 DOUG FIR	4710		4600	11		2.3	32.9	14.1	10.3
Totals	4710		4600	11		2.3	32.9	14.1	10.3

N W R U L E S C U B I C

Gross	Merch	Chips	Cull	Logs
849	795	54		11

* * * E N D T I C K E T * * *

Figure 9. Scaling ticket.

Table 5. Log grades.[a]

Species and grade	Minimum gross length (ft)	Minimum gross diameter (in)	Required standards for quality, log surface, and minimum merchantable volume
Special mill (all species except western redcedar)	17	16	Logs will produce high-quality dimension lumber or C- and D-grade veneer. Sound, tight knots and knot indicators no greater than 1.5 inches allowed, but not more than one/ft of log length. Minimum annual ring count is six/inch.[b,c,d,e]
Douglas-fir			
No. 1 peeler[f,g]	17	30	Logs produce A- and B-grade veneer and high-grade lumber. Log surface at least 90% free of knots and defects. Minimum annual ring count is eight/inch. No more than two knots allowed.
No. 2 peeler	17	30	Logs produce A- and B-grade veneer and high-grade lumber. Surface must be at least 75% clear of knots. Minimum annual ring count is eight/inch. No more than two knots allowed.
No. 3 peeler	17	24	Logs produce A- and B-grade veneer and high-grade lumber. Limited to knot indicators with diameters no greater than 1.5 inches. No more than one knot indicator/ft of log length. Minimum annual ring count is six/inch. No more than two knots allowed.
No. 1 sawmill[h]	16	30	Logs will produce B-grade and better lumber. Log surface should be 90% clear. Minimum annual ring count is eight/inch.
No. 2 sawmill	12	12	Logs produce dimension lumber or C- and D-grade veneer. Sound and tight knots, diameters no greater than 2.5 inches. Minimum volume is 60 bd ft net scale.
No. 3 sawmill	12	6	Logs produce dimension lumber or C- and D-grade veneer. Sound and tight knots, diameters no larger than 3 inches. Minimum volume is 50 bd ft net scale.
No. 4 sawmill	12	5	Logs do not meet No. 3 sawmill requirements (diameter or net volume) but produce at least 33.33% of gross volume in merchantable lumber. Minimum volume is 10 bd ft net scale.
Hemlock/fir			
Peeler logs	17	24	Logs produce high-grade veneer or B-grade and better lumber. No more than two knots allowed.
No. 1 sawmill	16	24	Logs produce B-grade and better lumber. At least three quadrants free of knots or knot indicators.
No. 2 sawmill	12	12	Logs produce construction or better lumber. Sound, tight knots; diameters no greater than 2.5 inches. Minimum volume is 60 bd ft net scale.
No. 3 sawmill	12	6	Defects prevent No. 2 grade, but logs suitable for standard or better lumber. Sound, tight knots; diameter no greater than 3 inches. Minimum volume is 50 bd ft net scale.
No. 4 sawmill	12	5	Logs do not meet No. 3 log requirements but produce at least 33.33% of gross volume in merchantable lumber. Minimum volume is 10 bd ft net scale.

[a] This table does not list all grade requirements or all species. It is not intended to substitute for official log scaling and grading rules, which the log scaling and grading bureaus publish and the timber industry accepts as standard.

[b] C- and D-grade veneer are inferior to A- and B-grade veneer.

[c] Dimension lumber is yard lumber that measures 2 inches or more but is less than 5 inches thick—such as two-by-fours.

[d] Knot indicators are scars on the bark surface indicating a grown-over limb.

[e] Sound and tight knots contain no decay and are firmly fixed in the log.

[f] A No. 1 log is superior in quality to No. 2; No. 2 is superior to No. 3; No. 3 is superior to No. 4; etc.

[g] Peeler logs are usually “peeled” with a wood lathe to produce the veneer used to make plywood.

[h] Sawmill grade logs usually are milled to manufacture lumber.

Table 5. Log grades (continued).[a]

Species and grade	Minimum gross length (ft)	Minimum gross diameter (inches)	Required standards for quality, log surface, and minimum merchantable volume
Red alder			
No. 1 sawmill	8	16	Logs produce No. 1 shop and better lumber. Log surface at least 75% clear of knots.
No. 2 sawmill	8	12	Logs produce No. 1 shop and better lumber. Log surface at least 50% clear of knots.
No. 3 sawmill	8	10	Logs produce No. 2 shop and better lumber. Must exceed 33.33% in merchantable lumber.
No. 4 sawmill	8	5	Logs do not meet minimum gross diameter or net volume (which prevents grading them as No. 3) but do produce at least 33.33% of gross volume in merchantable lumber. Minimum volume is 10 bd ft net scale.
Ponderosa and sugar pine			
Peeler logs	17	30	Logs produce A-grade veneer and high-grade lumber. Log surface 100% clear of knots. Minimum annual ring count is eight/inch.
No. 1 sawmill	16	30	Logs produce D-grade select and better lumber. Log surface 90% clear of knots. Minimum annual ring count is eight/inch.
No. 2 sawmill	12	24	Logs produce D-grade select and better lumber. Log surface 75% clear of knots. Minimum annual ring count is eight/inch.
No. 3 sawmill	12	24	Logs produce shop-grade and better lumber. Log surface 50% clear of knots. Spacing allows 6 ft between knot whorls, 3 ft between staggered knots. Annual ring count is eight/inch.
No. 4 sawmill	12	12	Logs produce No. 2-grade common and better lumber. Knots on log surface allowed up to 2.5 inches diameter. Larger knots are spaced as in No. 3 logs.
No. 5 sawmill	12	6	Logs produce No. 3-grade common and better lumber.
No. 6 sawmill	12	5	Logs do not meet No. 5 requirements (neither diameter nor minimum volume) but produce at least 33.33% of gross volume in merchantable lumber.
Special services (all species)			
Utility (pulp) logs (UC)	12	2	Logs produce 100% of adjusted gross volume in firm-usable pulp chips. Maximum deductible defect is 50% of gross volume.
Peeler cull	8	12	Logs do not meet requirements for peeler or sawmill grade but are suitable for rotary cutting. Knot diameter usually cannot exceed 3 inches. Maximum deductible defect is 50% of gross scale.
Special cull (SC)	8	16	Logs do not meet requirements for peeler or sawmill grade but are suitable for rotary cutting. Knot diameter usually cannot exceed 2.5 inches. Maximum deductible defect is 50% of gross scale.

[a] This table does not list all grade requirements or all species. It is not intended to substitute for official log scaling and grading rules, which the log scaling and grading bureaus publish and the timber industry .accepts as standard.

Exporting logs

You might consider selling saw logs and peeler logs on the export market when the price is higher for export logs than for domestic logs (figure 11). Countries such as Japan, China, and Korea purchase Douglas-fir, western hemlock, grand fir, Sitka spruce, western redcedar, and Port-Orford-cedar.

Domestic log grades are used along with additional "sorts" to meet each country's specific requirements for log diameters, lengths, and qualities.

There are variations in the grades each country accepts, but a general rule is logs should be relatively clean (few or small knots), straight, and free of rot, and have a ring count of at least six rings per inch.

Long logs (26 to 40 feet) are standard and preferred. Export brokers are knowledgeable about log specifications and can help you evaluate the export market.

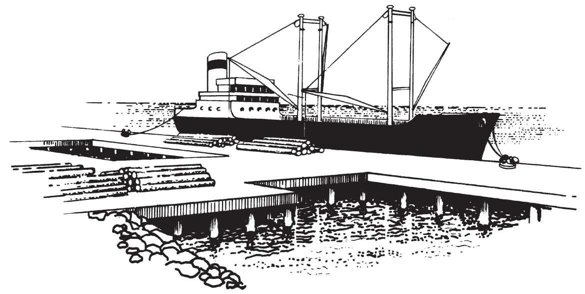


Figure 11. Although board-foot-volume measurement of export logs is similar to domestic methods, export log buyers use a modified grading system, influenced by the particular requirements of the importing country.

Measuring other products

Poles and piling

Barkie (unpeeled) poles and piling are products you can grow profitably on a small woodlot. Mill pole prices can be substantially higher than saw log prices, especially when you sell longer poles and piling (greater than 40 feet).

Specifications for poles and piling are detailed, exacting, and often confusing (see appendix B). The method of measurement may vary from area to area. Buyers are familiar with measurements and can help you determine the quality and quantity of poles and piling on your property.

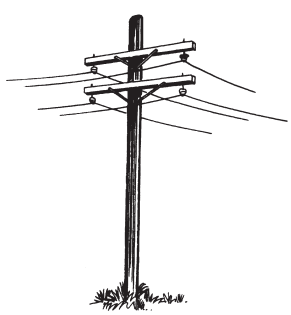


Figure 10. The value of poles, a high-quality product, depends on species, length, top diameter, and either circumference 6 feet from the butt or butt diameter.

Pole specifications

Poles should be straight, uniform, and sound (figure 10). You can't cut them from rough, defective trees. Length and strength are more important than actual volume. Here are some requirements:

- Cut poles from live trees.
- Buck ends square and allow the required amount (usually 12 inches) beyond the length for trim.
- Allow a minimum 1 inch of sapwood.
- No knot can be more than 3 inches across. The total sum of knot diameters in a 1-foot section of the log can't be more than 8 inches.
- Trim knots flush. Decay in knots isn't allowed.
- Insect holes must measure 0.625 ($^1/_{16}$) inch or less. Surface scarring is allowed, but all other insect damage is prohibited.
- No side or top rot is allowed. Butt end decay is allowed in redcedar, but it must not exceed 10 percent of the butt area.
- Sap stain is allowed if there is no wood disintegration.
- Trees must be stringline straight (that is, a straight line from the center of the butt end to the center of the top end should lie within the body of the pole).
- There can be no more than 1 inch of taper per 10 feet of log length.

Table 6. Estimating board-foot volume of poles or piling.[a]

Pole length (ft)	Approximate Scribner bd ft volume for top diameter (inside bark)						Pieces/ load	Linear ft/load
	6"	7"	8"	9"	10"	11"		
25	30	40	50					
30	40	50	60				35–70	1,500
35	50	60	80	100				
40	60	70	90	120	150			
45	70	90	120	140	190		18–27	1,000
50		100	140	160	210	260		
55			150	180	230	280		
60			190	220	290	340	12–15	800
65			210	250	310	370		
70			230	270	350	400		
75			240	290	360	430	8–10	650
80			290	360	440	540		
85			320	390	490	570	6–7	525
90			400	490	590	690		
95			420	520	610	720	5	475
100			450	550	660	760	4	400

[a] These volumes are based on poles cut in combinations of log lengths—either one, two, or three lengths. You might obtain a higher volume by segmenting the poles in different combinations of log lengths, although the table does provide a checkpoint. For example, you could scale a 60-ft pole with a 9-inch top as two 30-ft logs yielding 220 bd ft or as a 20-ft and a 40-ft log yielding 230 bd ft.

Piling specifications

These are similar to pole requirements, but piling logs allow for less taper. However, rules on sweep and swell are more exact because of the tremendous shock piles undergo during driving. (*Swell* is the flared-out end of a butt log or a large bump on a log, and *sweep* is a crook in a tree or log.) Two piling requirements are as follows:

- Trees must be stringline straight.
- Cut piling above any butt swell, and show uniform taper from end to end.

Determining prices

The species, size, and class of a pole determine its price. Each *pole* class has a minimum top diameter and a minimum circumference (measured 6 feet from the butt). See appendix B.

Pole companies may measure the diameter of the large end of a pole instead of the circumference outside the bark. Check with your local company for its requirements.

Knowing pole prices derived from length and circumference or large-end diameter is critical to make these sales really profitable. Prices can improve dramatically when top diameter increases just 1 inch or length increases by one 5-foot increment.

Piling logs are separated into either class A or B, depending on the minimum circumference (measured 3 feet from the butt) and minimum top diameter (see appendix B).

Markets, transportation and logging costs, and management objectives can influence your decision to cut poles and piling instead of saw logs. Using table 6, you can convert pole sizes to board-foot volume and use the results as a guide for deciding whether to sell poles or saw logs.

The objective of table 6 is to help you find the equivalent saw log price per thousand board feet (MBF) for a given pole price. Refer to the information in the table to determine the saw log price of, for example, a 60-foot pole with a 9-inch top and a price of $155.

First, divide the pole price ($155) by the board-foot volume (220), which you obtain by finding the intersection of 60 in the pole-length column and 9 in the top-diameter column in table 6. Multiply this figure by 1,000 to calculate $/MBF. Your equation is as follows:

$155 ÷ 220 bd ft x 1,000 = $705/MBF

Suppose the pole has a 10-inch diameter. This increases the board-foot volume from 220 to 290, and

$155 ÷ 290 bd ft x 1,000 = $534/MBF.

If the $/MBF for the pole is greater than the value on the saw log market, it's probably wise to sell as a pole instead of a saw log. Remember to consider logging and transportation costs when comparing saw logs and poles. Remember, too, that the method of figuring $/MBF here does not reflect price by log grade.

Posts

Posts range from 6 to 12 feet long with 2- to 8-inch diameters on the small end (figure 12). They contain sound, straight wood with closely trimmed knots.

Posts usually are made from Douglas-fir, western hemlock, western redcedar, Port-Orford-cedar, and incense-cedar on the west side of the Cascades. Douglas-fir, western larch, and lodgepole pine are the primary species east of the Cascades.

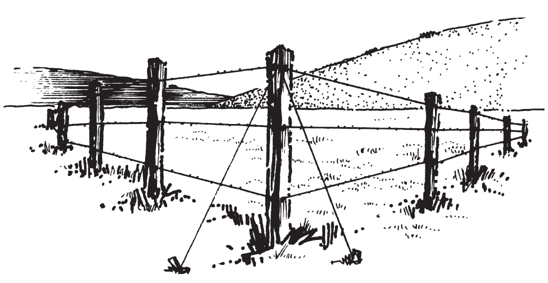


Figure 12. Sold by the piece, posts must be made from straight, sound wood and from a durable species.

Figure 13. The standard cord or cubic-foot volume is used to measure fuelwood.

Posts made from large, old-growth cedar may be treated with a wood preservative. Small, round posts contain a high percentage of sapwood and normally are pressure treated or cold soaked with a preservative to assure long life. Small, round posts that are pressure treated are made almost exclusively from Douglas-fir west of the Cascades and from lodgepole or ponderosa pine east of the Cascades.

Pulp

You can sell small logs, both hardwood and conifer, and large, defective conifer logs as pulp or chip logs. They provide added income when market demand and distance to market are favorable.

Western hemlock, grand fir, spruce, lodgepole pine, Douglas-fir, ponderosa pine, red alder, and cottonwood commonly are used for pulpwood, although not all mills use all species. You can chip the wood on site with a portable chipper or haul it in log form to the mill.

Although there is some market for dirty chips (logs chipped with bark intact), most buyers manufacture clean chips from debarked logs. Logs that show charring from fire are unacceptable for pulp, but they can be chipped for hog fuel (wood residue for electric or steam generation).

Fuelwood

Firewood usually is sold by the cord. Both conifers and hardwoods are popular. Conifers usually are less dense and provide less total heating value per unit of volume. Table 7 lists the approximate weight per cord and Btu's per pound for some Northwest species.

You can determine the amount of cordwood in a stack by multiplying height by width by length, then dividing by 128 cubic feet. For example, the number of cords in a stack of firewood 8 feet wide by 6 feet high by 10 feet long is 3.8 cords:

8 x 6 x 10 = 480

480 ÷128 = 3.75
or 3.8 cords

The number of board feet in a cord varies with the average diameter of the wood and the amount of solid wood in the cord. If the wood pieces in a cord average 8 inches in diameter, there are about 90 cubic feet of solid wood and
307 board feet in a cord (table 4, westside):

90 cu ft x 3.41 bd ft per cu ft = 307 bd ft

As the average diameter increases, the board-foot volume per cord increases. For a general estimate of cordwood volume in a young Douglas-fir stand, see appendix D.

Table 7. Fuelwood weight per cord and relative heat.

Species	Weight[a]	Btu's/lb[b]	Btu's/cord (millions)
Black cottonwood	2,363	7,130	16.8
Willow	2,630	6,580	17.3
Red alder	2,812	6,460	18.2
Bigleaf maple	3,262	6,795	22.2
Oregon ash	3,713	6,630	24.6
Pacific madrone	4,388	6,560	28.8
Black oak	3,825	6,750	25.8
Tanoak	4,500	6,700	30.2
Oregon white oak	4,838	6,560	31.7
Black locust	4,646	6,700	31.1
Western redcedar	2,160	7,880	17.0
Grand fir	2,498	6,710	16.8
Sitka spruce	2,700	6,540	17.7
Lodgepole pine	2,768	6,960	19.3
Ponderosa pine	2,700	7,380	19.9
Western hemlock	3,038	6,880	20.9
Douglas-fir	3,308	7,460	24.7
Western larch	3,510	7,400	26.0

[a] Approximate weight, lb/cord (90 cu ft solid wood), for air-seasoned wood with 20% moisture content. Adapted from *Oregon Hardwood Timber* (Overholser 1977) and *Wood Handbook* (USDA 1974).

[b] At 20% moisture content. Adapted from *How to Estimate Recoverable Heat Energy in Wood and Bark Fuels* (Ince 1979).

Some final notes

This publication reviews the measurement of timber products commonly harvested from small woodlands in Oregon. There are other forest products that have market potential, including railroad ties, hop poles, trolling poles, shakes and shingles, boom and bumper logs, oak wine barrel stock, burls, arrow stock, mine props, and car stakes, as well as floral greenery, mushrooms, and cascara bark. Your county Extension agent or local buyers can provide information on these products.

As a woodland owner, you may have a diverse number of products available to sell to maximize your tree farm revenues. Your ability to recognize the quality and quantity of forest products and to market them effectively depends not only on your knowledge of measurements and marketing but also on a flexible tree farm management plan tailored to your objectives.

Appendices

Appendix A. Log truck carrying capacities.

Truck	Log truck range per truck (bd ft)[a]	Net weight (lb)	Log length (ft)	Average bunk log length (ft)
Self-loader	2,000–4,500	44,000	17–43	32
Regular long logger	3,200–6,000	50,000	28–52	36
Mule train	4,500–6,500	52,000		20
truck			12–26	
trailer			17–34	

[a] Low volumes are for timber with a high degree of taper, or small logs. Midrange volumes are for older, second-growth timber. High volumes are for large logs.

Appendix B. Pole and piling dimensions.[a]

Unpeeled Douglas-fir poles							
Class	1	2	3	4	5	6	7
Min. top diameter inside bark	9"	8.5"	8"	7"	6.5"	6"	5"
Length of pole (ft)	Minimum circumference up 6 ft outside bark (in)[b]						
25	38.5	36.5	34.5	32.5	30.5	28.0	26.5
30	42.0	39.5	37.5	35.0	33.0	30.0	28.5
35	45.0	42.5	40.0	37.5	35.0	32.5	30.5
40	48.0	45.5	43.0	39.5	37.0		
45	50.5	47.5	44.5	41.5	38.5		
50	53.0	49.0	45.0	42.5			
55	54.0	51.0	47.5				
60	55.5	53.0	49.0				
65	57.0	54.0	50.5				
70	58.5	55.5	52.5				
75	61.5	58.0	53.5				
80	63.0	58.5	55.0				
85	64.5	60.5	56.5				
90	66.0	62.0					
95	67.0	63.0					
100	68.5	65.0					

Unpeeled Douglas-fir piling				
	Class A		Class B	
Length	Min. butt circ. @ 3' outside bark	Min. top diameter inside bark	Min. butt circ. @ 3' outside bark	Min. top diameter inside bark
Under 40'	52"	9.5"	45.5"	8.5"
50–52'	52"	9.5"	45.5"	7.5"
53–72'	52"	8.5"	48.5"	7.5"
73–92'	52"	7.5"	48.5"	6.5"
More than 92'	52"	6.5"	48.5"	5.5"

Diameter–circumference conversion					
Dia.	Circ.	Dia.	Circ.	Dia.	Circ.
4"	12.56	10"	31.40	16"	50.24
5"	15.70	11"	34.54	17"	53.38
6"	18.84	12"	37.68	18"	56.52
7"	21.98	13"	40.82	19"	59.66
8"	25.12	14"	43.96	20"	62.80
9"	28.26	15"	47.10	21"	65.94

[a] Reproduced with permission from *Poles and Piling* (Washington State University Extension 1977). The “Diameter–circumference conversion” section is reproduced courtesy of Cascade Pole Co., Tacoma, Washington.

[b] Allows for average bark. Heavy bark may reduce pole class by one.

Appendix C. Weight of wood (in approximate pounds per cubic foot) at different moisture levels.[a]

Species	Moisture content (% ovendry weight) 0%	20%	100%	Moisture content (% total weight) 0%	20%	50%
Coast Douglas-fir	28	34	56	28	35	56
Interior Douglas-fir[b]	29	34	57	29	36	57
Western hemlock	26	31	52	26	32	52
Ponderosa pine	23	28	46	23	29	46
Sitka spruce	23	28	46	23	29	46
Red alder	23	28	46	23	29	46

[a] Adapted from *Conversion Factors for the Pacific Northwest Forest Industry* (Institute of Forest Products 1978).

[b] Douglas-fir found in California and in all Oregon and Washington counties east of, but adjacent to, the Cascade summit.

Appendix D. Approximate cordwood volume for young Douglas-fir.[a]

d.b.h. (in)	Total height of tree (ft): 30	40	50	60	70	80	90	100	110	120	130	140	150
	Cords per tree												
6	0.02	0.03	0.04	0.05	0.06	0.07							
8	0.05	0.07	0.08	0.10	0.12	0.14	0.15						
10	0.08	0.11	0.13	0.16	0.19	0.21	0.23	0.26	0.29	0.31			
12	0.12	0.16	0.19	0.23	0.26	0.30	0.33	0.36	0.41	0.44			
14	0.16	0.20	0.25	0.30	0.35	0.40	0.45	0.49	0.54	0.59	0.64	0.70	
16		0.26	0.32	0.38	0.45	0.51	0.57	0.62	0.67	0.74	0.80	0.88	0.90
18			0.40	0.48	0.55	0.62	0.70	0.77	0.83	0.90	0.98	1.07	1.17
20			0.48	0.57	0.68	0.75	0.83	0.92	0.98	1.07	1.17	1.28	1.39
22			0.57	0.66	0.76	0.86	0.96	1.05	1.13	1.24	1.35	1.46	1.60
24				0.76	0.87	0.98	1.08	1.17	1.27	1.39	1.50	1.63	1.79

[a] Reproduced with permission from *Your Trees—A Crop* (Sullivan, no date). The tree is used to a 4-in top. Cordwood is assumed to be cut in 8-ft lengths.

Example: If a tree is 12 in d.b.h. and 70 ft tall, you can expect to cut about 0.26 cord. You will need 3.8 trees for each cord:

$$\frac{1 \text{ cord}}{0.26 \text{ cord}} = 3.8$$

For more information

References

Bowers, S. 2008. *Tools for Measuring Your Forest*. EC 1129. Corvallis, OR: Extension Service, Oregon State University.

Ince, P.J. 1979. *How to Estimate Recoverable Heat Energy in Wood and Bark Fuels*. Forest Products Lab General Technical Report 29. Madison, WI: Forest Products Lab, USDA Forest Service.

Institute of Forest Products. 1978. *Conversion Factors for the Pacific Northwest Forest Industry*. Seattle, WA: College of Forest Resources, University of Washington.

Northwest Log Rules Advisory Group. 1982. *Official Rules for the Following Log Scale and Grading Bureaus: Columbia River, Grays Harbor, Northern California, Puget Sound, Southern Oregon*, 6th ed. Yamhill, OR: Northwest Log Rules Advisory Group.

Northwest Log Rules Advisory Group. 1997. *Official Log Scaling and Grading Rules.* Northwest Log Rules Advisory Group. Eugene, OR: Northwest Log Rules Advisory Group.

Northwest Log Rules Advisory Group. 1997. *Supplement to Official Log Scaling and Grading Rules.* Eugene, OR: Northwest Log Rules Advisory Group.

Overholser, J.L. 1977. *Oregon Hardwood Timber*. Research Bulletin 16. Corvallis, OR: Forest Research Lab, Oregon State University. http://hdl.handle.net/1957/7899.

USDA. 1974. *Wood Handbook*. USDA Agriculture Handbook 72. Washington, DC: USDA.

Sullivan, M.D., ed. No date. *Your Trees—A Crop*. Portland, OR: Industrial Forestry Association.

Washington State University Extension. 1977. *Poles and Piling*. EB 689. Pullman, WA: Washington State University Extension.

Further reading

Avery, T.E., and H. Burkhart. 2001. *Forest Measurements*. New York, NY: McGraw-Hill.

Briggs, D.G. 1994. *Forest Products Measurements and Conversion Factors: With Special Emphasis on the U.S. Pacific Northwest*. Contribution 75. Seattle, WA: Institute of Forest Resources, University of Washington.

Dilworth, J.R. 1988. *Log Scaling and Timber Cruising.* Corvallis, OR: Oregon State University Bookstores.

Husch, B., T.W. Beers, and J.A. Kershaw Jr. 2002. *Forest Mensuration*. New York, NY: Wiley.

The Woodland Workbook comprises some 60 publications prepared by Oregon State University Extension foresters specifically for owners and managers of private, nonindustrial woodlands. Workbook publications contain information of long-range and day-to-day value for anyone interested in wise management, conservation, and use of woodland properties. Publications are available for purchase separately. For information about how to order, and for a current list of titles and prices, contact the OSU Extension Service office that serves your county. Or, visit the Extension Web site at http://extension.oregonstate.edu/.

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