Extension Circular 1127
April 1984

The Woodland Workbook

Forest Measurement

Measuring Timber Products Harvested From Your Woodland

Contents

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 will ultimately increase financial returns from your woodlot.

This publication outlines the measurements used for buying and selling timber products. You can obtain additional information from OSU Extension agents, consulting foresters, timber product buyers, state service foresters, USDA Forest Service foresters, and staffs 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 or weight, pulpwood by cubic feet or weight, and poles by linear feet.

Log scaling and grading bureaus provide independent measurement and standardized rules for the buyer and seller. Log measurement rules may vary between major regions of the U.S.—the method of measurement depends on regional policies and timber type.

In the Pacific Northwest, saw logs are measured according to the Scribner log rule, which estimates volume in board feet, based on the small-end log diameter and log length.

You sell pulpwood logs by cubic feet, which usually requires determining both log-end diameters and length. And you use top diameter, length, and circumference or large-end diameter in pole and piling sales.

Special tables (some of which are contained 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 EC 1129, *Tools for Measuring Your Forest,* "For further reading," page 17.)

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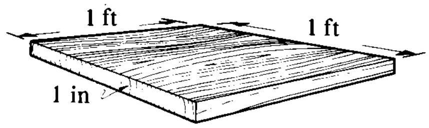


Figure 1.—*Board foot*

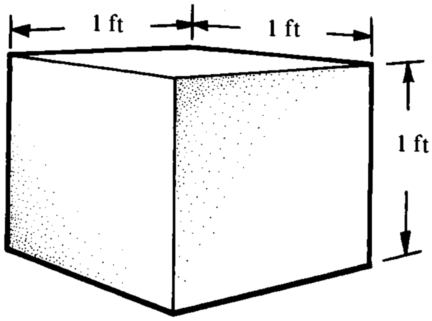


Figure 2.—*Cubic foot*

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	Cubic feet Weight Cord

Measurement units

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

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 (see figure 1).

$$\text{Bd. ft} = \text{thickness (in)} \times \text{width (in)} \times \text{length (ft)}/12 \text{ in}$$

For example, a plank 2 inches by 8 inches by 24 feet contains 32 board feet. Board-foot volume is usually expressed in 1,000 board feet (MBF).

Cubic foot

This is a solid piece of wood 1 foot wide, 1 foot thick, and 1 foot long (see 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 has been used primarily to measure pulpwood volume, but there is a growing interest in using it for saw log measurement.

Wood fiber volume measurements include the *cunit,* 100 cubic feet of solid wood (CCF), and the cubic meter (m^3), 35.314 cubic feet, the standard log-volume measure for most of the world.

Cord

This is the amount of wood in a neat stack 4 feet wide by 4 feet high by 8 feet long (128 cubic feet). Nationally, it is the most common pulpwood and fuelwood measurement.

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 piling.

One variation is *the face or short cord*—a stack of wood 4 feet high and 8 feet long, made up of pieces that are less than 4 feet long. A face cord with pieces averaging 16 inches long measures 42 cubic feet (4 ft $\times$ 8 ft $\times$ 16 in/12 in) or one-third of a cord.

Linear measurements

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

Weight

This 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 low in value.

When you use weight, *sample scale* your log loads periodically. This involves weighing and scaling a load of logs to determine a board-foot/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, thus is heavier). As weight per board foot increases, the value per MBF increases, as long as the price per pound is constant.

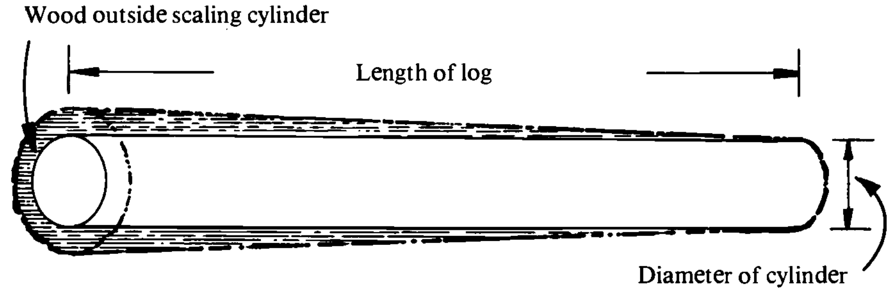


Figure 3.—*The scaling cylinder*

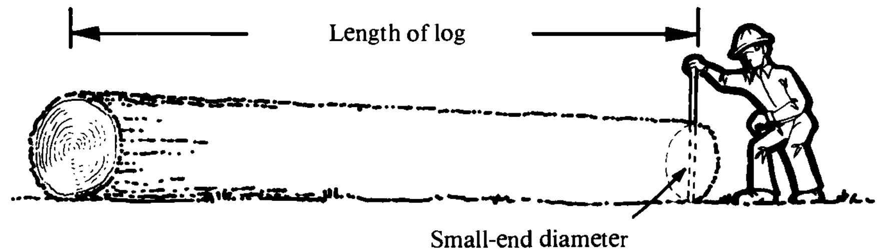


Figure 4.—*Measuring small-end diameter and length is needed to determine board-foot volume.*

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 predict exact lumber recovery except when near-cylindrical logs are sawed according to a particular rule. Buyers and sellers must be aware of their limitations in business transactions.

In 1846, J. M. Scribner devised the log rule that is used most often in the Pacific Northwest. He diagramed 1-inch boards to scale within cylinders of various sizes, allowing ¼ 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.

There is no taper allowance, so the rule normally underestimates volume for logs more than 16 feet long. Wood outside the scaling cylinder (see figure 3) increases as taper and length become greater.

Thus, the amount of overrun from a measurement that is less than the actual lumber volume cut becomes 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.

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 (see 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 (see figure 5). Logs scaled in water require only one vertical measurement because of the difficulty in taking two measurements.

Scalers measure log lengths in 1- or 2-foot multiples, depending on mill and log scaling and grading bureau policy. Loggers add a trim allowance to 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,

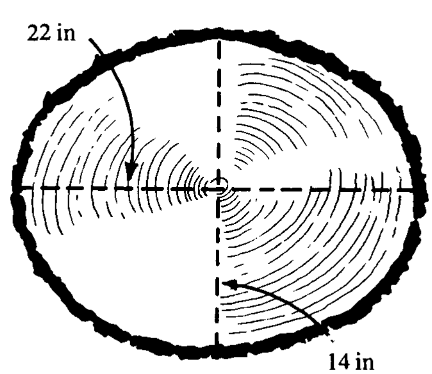
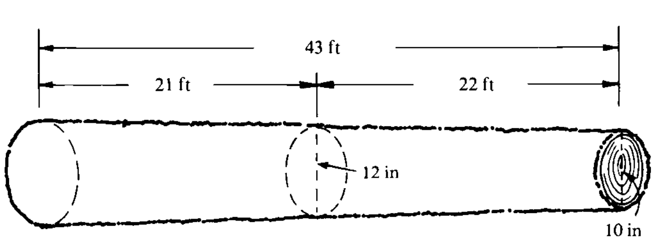


Figure 5.—*Method of measuring the diameter of oval logs: add 22 to 14 and divide by 2, for an 18-inch diameter.*

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 as near equal segments as possible.	Logs scaled as one log up to 20 ft—longer logs scaled in as near equal segments as possible.
Segmenting logs with unequal lengths	If a log is over 40 ft and segmenting results in unequal lengths, the segment with the smaller top diameter is considered longer.	If a log is over 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 in per 10 ft of log length.[a]	Estimate log taper and use U.S. Forest Service tables.[b]
Diameter	Drop fractions over the full inch.	Round fractions off to the nearest inch.
Trim allowance	Use a maximum of 12 in for logs scaled in 1-ft multiples.[c] Use a minimum of 8 in for logs scaled in 2-ft multiples.[d]	Normally, 5 to 6 in allowed per segment.[e]

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



[b] The Forest Service 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 1-in log would be scaled as 33 ft, as would a 33-ft 11-in 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 in of trim is required for each additional 10 ft.

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

diameter, and trim rules than logs scaled west of the divide. Always contact your mill before you cut—length 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 (see figure 6). A complete set of tables is available from log scaling and grading bureaus. Each mill has its own log-length preferences and its own specifications for minimum length, diameter, trim, and species.

You can estimate net volume once you deduct the volume lost to defects. See the section on "Net volume" (page 10) for a step-by-step calculation of net volume and the one on "Defects" (page 7) for more information on defect deductions.

Selling logs by weight

It is becoming more common to sell small conifer 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). Cut these trees into short logs to increase the scaled volume, or cut them long and sell them by weight.
- It might be to your advantage to sell defective trees and trees with crooked butts and snowbreak by weight, to avoid the defect deductions used with log rules.

Top diameter (inches)

Lgth.	4″	5″	6″	7″	8″	9″	10″	11″	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′	10	20	30	40	40	50	80	90	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
Lgth.	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″	16″	17″	18″

Figure 6.—*Scribner log rule, gross board-foot volume. Adapted, with permission, from* Official Rules for the Following Log Scale and Grading Bureaus: Columbia River, Grays Harbor, Northern California, Puget Sound, Southern Oregon, Yamhill, *6th ed. (January 1, 1982); developed and revised by the Northwest Log Rules Advisory Group; $4.00 a copy from the bureau nearest to you.*

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 length and diameter meet).*

- 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; cut top diameters as small as possible (frequently, 4 inches). Because specific log lengths are not critical when selling by weight, you reduce cutting time.

If you sell logs by delivered weight, and are paid on a bd. ft/weight basis, work with the log purchaser to establish a sampling interval that accounts for differences in the relationship between weight and board-foot volume. Changes in 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.)

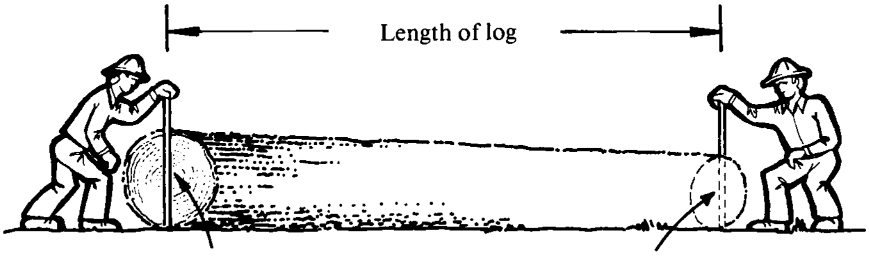


Figure 7.—*Determine cubic volume by measuring small- and large-end diameters and length; then use table 3.*

Table 3.—*Volume factors for calculating cubic-foot volume*[a]

Diameter (in)	Volume factor	Diameter (in)	Volume factor	Diameter (in)	Volume factor
4	.09	13	.92	22	2.64
5	.14	14	1.07	23	2.89
6	.20	15	1.23	24	3.14
7	.27	16	1.40	25	3.41
8	.35	17	1.58	26	3.69
9	.44	18	1.77	27	3.98
10	.55	19	1.97	28	4.28
11	.66	20	2.10	29	4.59
12	.79	21	2.41	30	4.91

[a] Personal communication, Thomas D. Fahey, research forester, timber quality, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Ore.

Cubic-foot volume

Log rules based on mathematical formulas determine cubic-foot volume. In the Pacific Northwest, there is no general agreement on a standard formula or precise procedure for scaling logs in cubic feet. Two commonly used rules are Bruce's rule and the Smalian formula.

Large-end diameter, small-end diameter, and log length are necessary for determining cubic-foot volume (see 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.*

Table 3 gives the volume factors for various diameters. Using this information and the following formulas, you can calculate cubic-foot volume.

Formulas A and B are based on elements of Bruce's rule and Smalian's formula.

Formula A. Multiply your *small*-end volume factor by ¾ the log length. Multiply your *large*-end volume factor by ¼ the log length. Add your two answers together for cubic volume.

(SEVF × ¾ LL) +
(LEVF × ¼ LL) = cubic volume

Formula B. Add your *small*-end volume factor to your *large*-end volume factor. Multiply your answer by ½ the log length. This is your cubic volume.

(SEVF + LEVF) × ½ LL = cubic volume

There are three key steps to follow when using the formulas:

1. Determine small- and large-end diameters.
2. Find the volume factor for both diameters.
3. Use formula A for butt logs and formula B for all other logs.

Let's work through an example using both formulas. Imagine you have a log with an 8-inch small-end diameter and an 11-inch large-end diameter. It's 32 feet long, so it breaks down into 24 feet at ¾ log length, 16 feet at ½ log length, and 8 feet at ¼ log length.

Checking table 3, you see the 8-inch diameter has a volume factor of .35 and the 11-inch diameter has a volume factor of .66. Using formula A, you work out this equation for butt logs:

(.35 × 24 ft) + (.66 × 8 ft) = ? cu ft

This breaks down into:

.35 × 24 ft = 8.4, and
.66 × 8 ft = 5.3.

So, 8.4 + 5.3 = 13.7 cu ft.

Let's also calculate formula B:

(.35 + .66) × 16 ft = ? cu ft

You break this down into:

1.01 × 16 ft = 16.2 cu ft.

You've determined that your log measures 13.7 cubic feet if it's a butt log and 16.2 cubic feet if it's not.

Table 4.—*Approximate board-foot and cubic-foot conversions (italicized entries are those used as examples in the text)*[a]

West-side Scribner scale[b]			East-side Scribner scale[c]		
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			

[a] Personal communication, Jim Cahill, research forester, timber quality, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Ore.
[b] Logs measured using west-side Scribner scaling rules.
[c] Logs measured using east-side Scribner scaling rules.

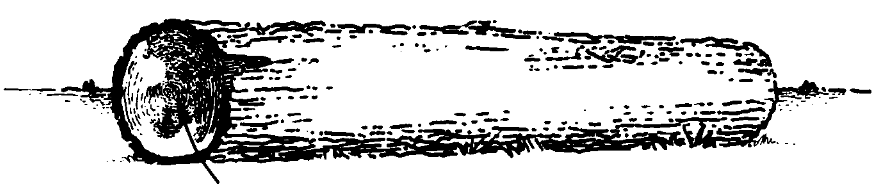


Figure 8.—*Rot in a log can reduce the usable board-foot volume—and must be deducted from the gross board-foot volume.*

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. The 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.

Defects

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

Defects are classified as:

- 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; and
- excessive knots.

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

Defects such as sapwood rot, pitch near the surface of the log, wind or sun check (cracks in wood), roughness, pitch rings, and heart checks reduce the diameter of a log. Breakage, sweep, crotch, excessive butt rot, conk rot (from a wood-destroying fungus), split, and other advanced decay reduce log length.

Log grading

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

Logs are not always graded. "Camp run" refers to an ungraded mix of logs purchased at the same price. However, as log quality improves and size increases, it is 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.

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. No knot indicators allowed. Sound, tight knots no greater than 1½ in allowed, but not more than 1/ft of log length. Minimum annual ring count, 6/in. [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, 8/in.
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, 8/in.
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 1½ in. No more than 1 knot indicator/ft of log length. Minimum annual ring count, 6/in.
No. 1 sawmill[h]	16	30	Logs will produce B-grade and better lumber. Log surface should be 90% clear. Minimum annual ring count, 8/in.
No. 2 sawmill	12	12	Logs produce dimension lumber or C- and D-grade veneer. Sound and tight knots, diameters no greater than 2½ in. Minimum volume, 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 in. Minimum volume, 50 bd. ft net scale.
No. 4 sawmill	none	none	Logs do not meet No. 3 sawmill requirements (diameter or net volume), but produce at least 33⅓% of gross volume in merchantable lumber.
Hemlock/fir			
Peeler logs	17	24	Logs produce high-grade veneer or B and better lumber. No knots.
No. 1 sawmill	16	24	Logs produce B grade and better lumber. Log surface at least 65% free of knots or knot indicators.
No. 2 sawmill	12	12	Logs produce construction or better lumber. Sound, tight knots; diameters no greater than 2½ in. Minimum volume, 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 in. Minimum volume, 50 bd. ft net scale.
No. 4 sawmill	none	none	Logs do not meet No. 3 log requirements but produce at least 33⅓% of gross volume in merchantable lumber.

[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 is inferior to A- and B-grade veneer.

[c] Dimension lumber is yard lumber that measures 2 in or more but is less than 5 in 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 (in)	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 33⅓% in merchantable lumber.
No. 4 sawmill	none	none	Logs do not meet minimum gross diameter or net volume (which prevents grading them as No. 3), but do produce at least 33⅓% of gross volume in merchantable lumber. Minimum volume, 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, 8/in.
No. 1 sawmill	16	30	Logs produce D-grade select and better lumber. Log surface 90% clear of knots. Minimum annual ring count, 8/in.
No. 2 sawmill	12	24	Logs produce D-grade select and better lumber. Log surface 75% clear of knots. Minimum annual ring count, 8/in.
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, 8/in.
No. 4 sawmill	12	12	Logs produce No. 2-grade common and better lumber. Knots on log surface allowed up to 2½ inches in diameter. Larger knots are spaced like No. 3 logs.
No. 5 sawmill	12	6	Logs produce No. 3-grade common and better lumber.
No. 6 sawmill	none	none	Logs do not meet No. 5 requirements (neither diameter nor minimum volume), but produce at least 33⅓% of gross volume in merchantable lumber.
Special scales (all species)			
Utility (pulp) logs	12	6	Logs produce 100% of adjusted gross volume in firm-usable pulp chips. Maximum deductible defect, 50% of gross volume.
Special cull	8	16	Logs do not meet requirements for peeler or sawmill grade but are suitable for rotary cutting. Knot size usually cannot exceed 2½ inches in diameter. Maximum deductible defect, 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.

Scaling tickets

Scalers make out tickets at a log scaling facility, which is usually located at a mill. Each ticket has six copies that the scaler distributes to the log scaling organization, seller, buyer, logger, and trucker (with one copy left as an extra). You can obtain scaling tickets for 10¢ each from log scaling and grading bureaus. You can also buy a similar form from some stationery stores.

Figure 9 shows a log scaling ticket for western Oregon. Here is a rundown of the information it contains.

The numbers in the far left column are log numbers. Log length ("L") and diameter ("D") are listed under "Gross." Log number 1 measures 23 feet by 14 inches. This value is for the top section only of the log because logs measuring more than 40 feet are split into two sections. The slash mark under "Split" indicates the log was sectioned (see table 2, "Maximum length" section). Log number 2 makes up the rest of the original log.

Numbers under "L" of "Deducts" represent a deduction in length (2 is a 2-foot deduction, 20 is a 20-foot deduction). The "D" heading gives diameter deductions. The number "02" means that 2 inches are deducted from the diameter.

Codes for grade, species, and defect are listed on the back of each ticket. For the example in figure 9, the following codes apply:

Grade	*Code*
Special mill	20
No. 2 sawmill	29
No. 3 sawmill	32
Species	*Code*
Douglas-fir	02

Net volume

To determine the net volume of the logs listed on the log scaling ticket in figure 9, you need to obtain the Scribner board-foot volume for each log, add these volumes together, and subtract defect deductions.

Let's calculate the net volume for Douglas-fir (species 02, logs 1 through 5). You'll need to refer to figures 6 *and* 9 to do this.

Two logs, numbers 2 and 3, are special mill grade (20). Number 2 is 22 feet long with a 16-inch diameter. To convert this to Scribner board-foot volume, look at figure 6 and find the point where the length and diameter intersect—it's 220.

Find the Scribner volume for log 3, which measures 34 feet 18 inches. The point of intersection is 450. Add the two volumes together to obtain the gross volume of special mill grade:

220 + 450 = 670.

Logs number 1 and 4 are No. 2 sawmill grade (29). Find the volume for each log (1 is 160, 4 is 130). Add these figures for the total log volume:

160 + 130 = 290.

Follow the same procedure for No. 3 sawmill logs (grade 32). There is one log with a volume of 30.

Add the volumes of the three log grades to obtain the total gross volume of Douglas-fir, which is 990:

670 + 290 + 30 = 990.

Now go back and check the ticket for defect deductions. Log 1 has a 2-inch diameter reduction. It reduces from 23 feet 14 inches to 23 feet 12 inches. Its volume also reduces from 160 to 110, so you need to subtract 50 board feet from the total gross volume.

Log 4 has a 2-foot reduction in length, which reduces it from 26 to 24 feet. You previously determined that the log has a volume of 130. However, when length is reduced by 2 feet, the log volume becomes 120—a 10-board-foot reduction.

The total volume deduction for Douglas-fir is 60 (50 for log number 1; 10 for log number 4). Net volume is 930 board feet.

Here's a summary of the procedures you followed above:

Douglas-fir volume (bd ft)	
Special mill	670
No. 2 sawmill	290
No. 3 sawmill	+ 30
Total gross volume	990
Deductions	- 60
Net volume	930

Figure 9 (page 11).—*Log scaling ticket used in western Oregon:*

A *Log length is 23 feet.*
B *Diameter is 6 inches.*
C *Use "Butt diameter" to determine cubic volume.*
D *A grade of 29 makes this log a #2 sawmill.*
E *The slash marks in the "Split" column indicate this log was split into two segments for scaling purposes—one measuring 23 feet, the other 22 feet. Add these figures together for the total log length, 45 feet.*
F *The 02 in the "Species" column is the code for Douglas-fir.*
G *The 2 indicates a 2-foot length deduction.*
H *The 02 indicates a 2-inch diameter deduction.*

PRINT NUMBERS CAREFULLY.
USE THE FOLLOWING GUIDE.

0 1 2 3 4 5 6 7 8 9 X

TO:

FROM:

SCALED AT

TRUCKER	BRAND	TRUCKER	MONTH	DAY	YEAR
	PAINT CODES	OFFICE ONLY	9	SCALER	1594802

	BUTT DIA.	%	GROSS L	GROSS D	DEDUCTS L	DEDUCTS D	GRADE	SPECIES	SPLIT
1			23	14		02	29	02	1
2			22	16			20	02	1
3			34	18			20	02	
4			26	12	2		29	02	
5			22	06			32	02	
6									
7									

TRUCKER

	BUTT DIA.	%	GROSS L	GROSS D	DEDUCTS L	DEDUCTS D	GRADE	SPECIES	SPLIT
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									

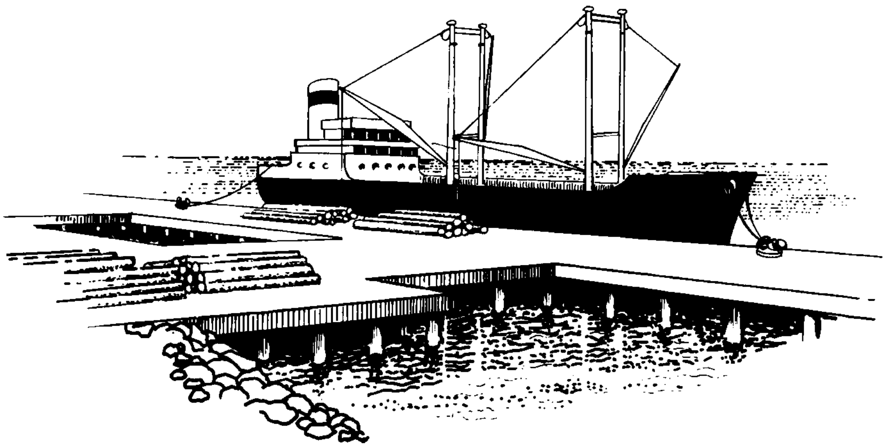


Figure 10.—*Although board-foot-volume measurement of export logs is similar to domestic methods, export log buyers use a modified grading system, influenced by the particular requirements of the importing country.*

Exporting logs

You might consider selling saw logs and peeler logs on the export market when the price is higher for export logs than domestic logs (see figure 10). 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, informal subgrades to meet each country's specific requirements for log diameters, lengths, and qualities.

While there are variations in the grades each country accepts, a general rule is that logs should be clean (few or no knots), straight, and free of rot, and have a ring count of more than 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.

For more information, see EC 1141, *Log Exports and the Private Woodland Owner* ("For further reading," page 17).

Measuring other products

Poles and piling

"Barkie" (unpeeled) poles and piling are products you can grow profitably on a small woodlot. Mill prices can be substantially higher than saw-log prices, especially when selling longer poles and piling.

Specifications for poles and piling are detailed, exacting—and often confusing (see appendix B). And 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.

Pole specifications. Poles should be straight, uniform, and sound (see figure 11). 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 can't be more than 8 inches.
- Trim knots flush. Decay in knots isn't allowed.
- Insect holes must measure 1/16 of an inch or less. Surface scarring is allowed, but all other insect damage is prohibited.

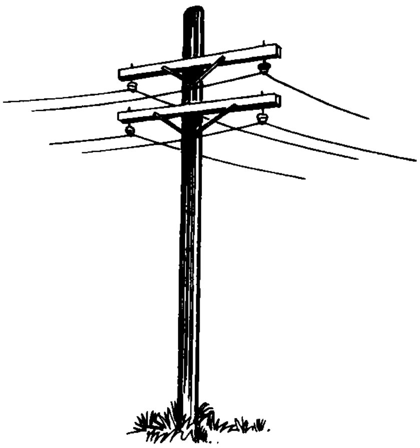


Figure 11.—*The value of poles, a high quality product, depends on species, length, top diameter, and either circumference 6 feet from the butt or butt diameter.*

- No side or top rot is allowed. Butt end decay is allowed in redcedar, but it mustn't exceed 10% of the butt area.
- Sap stain is allowed if there is no wood disintegration.

Piling specifications. These are similar to pole requirements. 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.) Here are two piling requirements:

- A straight line from the center of the butt end to the center of the top end should lie within the body of the pile.
- 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 its minimum top diameter and 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.

Knowledge of 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. For more information on pole management, see EC 1134, *Growing and Harvesting Douglas-fir Poles* ("For further reading," page 17).

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

Pole	Approximate Scribner bd. ft volume for top diameter (inside bark)						Pieces/	Linear
length	6″	7″	8″	9″	10″	11″	load	ft/load
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-in top as two 30-ft logs yielding 220 bd. ft or a 20-ft and 40-ft log yielding 230 bd. ft.

Piling 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, 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 \$/MBF (thousand board feet) saw-log price 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 and 9. Multiply this figure by 1,000 to calculate \$/MBF. Your equation looks like:

$$\frac{\$155 \times 1{,}000}{220 \text{ bd. ft}} = \$705/\text{MBF}.$$

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

$$\frac{\$155 \times 1{,}000}{290 \text{ bd. ft}} = \$534/\text{MBF}.$$

If the \$/MBF for the pole is greater than the value on the saw-log market, it is 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. Pole and piling companies can provide additional saw-log conversion information.

Posts

These range from 6 to 10 feet long with 2- to 8-inch diameters on the small end (see figure 12). They contain sound, straight wood with closely trimmed knots. Depending on your market, you can remove the bark or leave it intact.

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.

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.

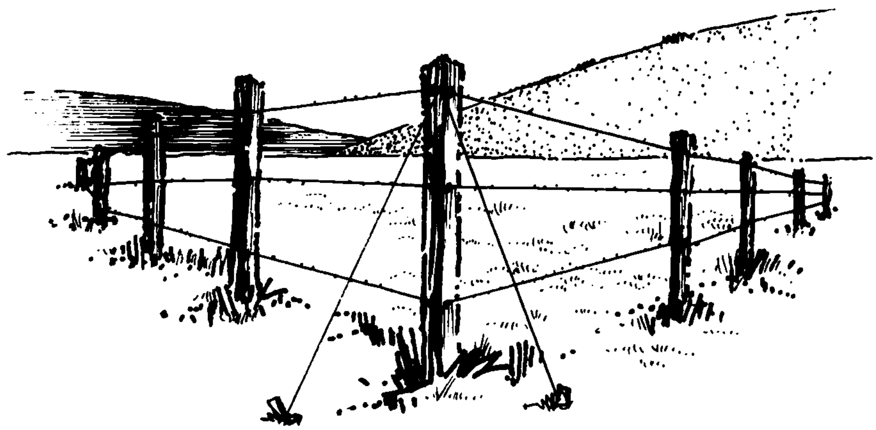


Figure 12.—*Sold by the piece, posts must be made from sound, straight wood and from a durable species.*

Pulp

You can sell small logs, both hardwood and conifer, and large, defective conifer logs as pulp or chip logs (see figure 13). They provide added income when market demand and distance to market are favorable.

Western hemlock, grand fir, spruce, lodgepole pine, red alder, cottonwood, and Douglas-fir 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).

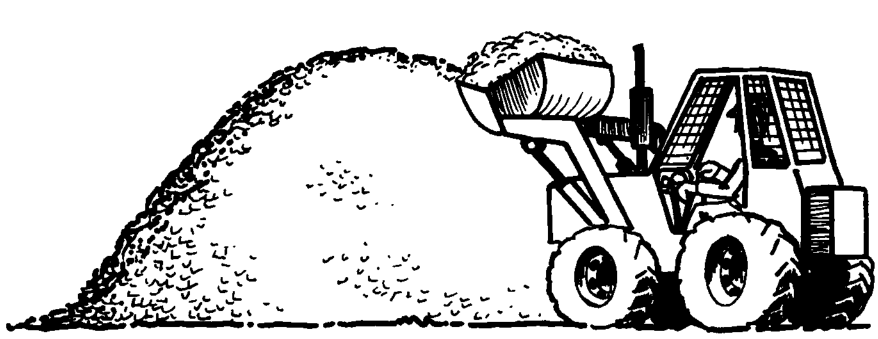


Figure 13.—*Pulp is usually measured by weight or cubic-foot volume.*

Measuring pulpwood usually involves using the standard cord, cubic foot, cunit, or weight method. Weight is used most often because it is easy and inexpensive. It is becoming increasingly more common, not only for pulp logs, but small conifer saw logs as well.

It is important to consider moisture content (the amount of water in wood) when estimating wood weight. Determining moisture levels is important because the price or value often reflects the amount of moisture in wood.

Mills calculate moisture content with two methods: percent ovendry (OD) weight, and percent total weight. Ovendry weight applies to wood that is exposed to high temperatures (100° C and above) until it stops losing moisture.

Percent ovendry weight is the percent of moisture in wood based on the ovendry weight of wood:

$$\frac{\text{wet wood wt. (lb)} - \text{OD wood wt. (lb)}}{\text{OD wood wt. (lb)}} \times 100 = \text{moisture \%}.$$

Percent total weight is the percent of moisture in a log based on the total weight of the log:

$$\left(1 - \frac{\text{OD wood wt. (lb)}}{\text{wet wood wt. (lb)}}\right) \times 100 = \text{moisture \%}.$$

Pulp and paper mills use both methods. The solid wood products industry usually uses percent ovendry weight.

Although both methods express the same thing—the amount of moisture in wood—they can give different moisture percentages for similar moisture contents.

For instance, a green alder log can have a 100% moisture content based on ovendry weight—and a 50% moisture content based on total weight.

It is important to know how a mill determines moisture content, to prevent any misunderstanding about wood weight between you and your buyer.

Appendix C lists the approximate weight of some common species at three moisture levels.

Here are some common measurement factors used in selling pulp and small logs.

- B.D.U. (Bone-dry unit) = 2,400 lb ovendry chips
- Chip unit = 200 cu ft gross chips = 2,400 lb B.D.U.
- Bone-dry ton = 2,000 lb ovendry chips

For red alder

- 1 cu ft bone-dry alder = 23 lb
- 1 cu ft green alder—about 46 lb
- 1 chip van = 10 to 12 units = 10 B.D.U. = 25 tons = 3,000 bd. ft
- 50,000 lb = average truckload = 25 tons = 25,000 lb B.D.U. material = 2,400 lb of chip unit weight = 10.4 units

For Douglas-fir

- 1 cu ft bone-dry Douglas-fir = 28 lb
- 1 cu ft green Douglas-fir = 38 to 60 lb
- 1 cunit (100 cu ft) of Douglas fir = 3,800 to 6,000 lb
- Self-loader maximum gross weight = 78,000 lb
- Self-loader net weight = 44,000 lb = 8 cunits of Douglas-fir at 55 lb/cu ft

Fuelwood

Firewood (see figure 14) is usually sold by the cord. Both hardwoods and conifers 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.

Figure 14.—*The standard cord or cubic-foot volume is used to measure fuel wood.*

You can determine the amount of cordwood in a stack by multiplying the height by the width by the length and dividing by 128 cubic feet. For example, the number of cords in a

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
Big leaf 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 Overholser, James, *Oregon Hardwood Timber Research Bulletin 16,* Oregon State University Forest Research Lab, 1977; and *Wood Handbook,* USDA Agriculture Handbook 72, 1974.

[b] At 20% moisture content. Adapted from *How to Estimate Recoverable Heat Energy in Wood and Bark Fuels,* USDA Forest Products Lab, General Technical Report FPL 29, 1979.

stack of firewood that is 8 feet wide by 6 feet high by 10 feet long is 3.8 cords:

$8 \times 6 \times 10 = 480$
$480 \div 128 = 3.75$ 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 (use the conversion factor from table 4):

90 cu ft $\times$ 3.41 bd. ft/cu ft = 307.

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.

Railroad ties

Although railroad ties are manufactured from many different North American species, only Douglas-fir, white oak, pine, western larch, grand-fir, and hemlock are acceptable in the Pacific Northwest because of their strength and ability to absorb wood preservatives.

Timber for ties must be sound, straight, and alive when cut. There can be no defects—decay, splits, shakes, large or numerous holes or knots, pitch seams, pitch rings—to impair the strength and durablility of a tie.

Contact railroad companies or local mills that manufacture ties for information on specifications and log requirements.

Hop poles

Used to support hop plants, hop poles are a product you can harvest where timber and markets are suitable. They are made primarily from lodgepole pine or Douglas-fir and, in Oregon, are usually treated with a wood preservative because of the damp climate.

Length and diameter requirements depend on a pole's function in the hop fields. *Anchor* poles require a 6- to 7-inch minimum top diameter and must be 22 feet long. *Center* poles have a minimum 4-inch top diameter and a length of 20 to 21 feet.

Trolling poles

Along the Oregon and Washington coast, there is some demand for wooden trolling poles for commercial salmon fishing boats. These poles are 25 to 55 feet long and have 3- to 7-inch butt diameters.

Spruce, Douglas-fir, and Port-Orford-cedar are preferred. Poles should be straight with a minimum taper. They are peeled and dried before being used.

Shakes and shingles

The heartwood of Western redcedar has high value for shakes and shingles. Mills purchase old growth, "buckskin" logs (downed logs), and freshly cut timber.

Normally, large diameter logs (20 inches plus) are in demand. Log lengths vary depending on the mill. Some mills prefer that you split and deliver shake material as cordwood.

Redcedar logs that grade as No. 2 sawmill and better are used for shakes. Log recovery may range from 10 to 12 squares per 1,000 board feet.

Tunnels from wood-boring insects can affect the grade and suitability of a log. Of course, the fewer knots and straighter the grain, the more desirable and greater the log value.

A buyer's guide listing names and addresses of shake and shingle mills is available from the Red Cedar Shingle and Handsplit Shakes Bureau, Suite 275, 515-116th Ave. NE, Bellevue, WA 98004; phone (206) 453-1324.

Boom and bumper logs

Where ocean vessels dock or log rafting occurs, there may be local demand for boom logs or bumper logs. These are usually high quality, long logs. Gather specifications from local port authorities or companies that handle waterborne logs.

Some final notes

This publication reviews the measurements of timber products commonly harvested from small woodlands in Oregon. There are other forest products that have market potential, including burls, floral greenery, cascara bark, arrow stock, mine props, and car stakes. Your county Extension agents 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 effectively market them depends not only on your knowledge of measurements and marketing but also on a flexible tree farm management plan tailored to *your* objectives.

For further reading

For OSU Extension Service publications, enclose the amounts indicated and send your order to Bulletin Mailing Office, Oregon State University, Corvallis 97331.

Bell, John, *Measuring Trees,* Pacific Northwest Extension publication PNW 31 (Oregon State University, Corvallis, revised 1982). 75¢ plus 25¢ postage.

Conversion Factors for the Pacific Northwest Forest Industry, Institute of Forest Products (University of Washington College of Forest Resources, Seattle, 1978).

Dilworth, J. R., *Log Scaling and Timber Cruising* (Corvallis: Oregon State University University Bookstores, Inc., 1981).

Forest Products Utilization Handbook, Colorado State Forest Service (Colorado State University, Fort Collins, 1979).

Husch, B., C. I. Miller, and T. W. Beers, *Forest Mensuration* (New York: Ronald Press Co., 1963).

Landgren, Chal, Mike Bondi, and William Emmingham, *Growing and Harvesting Douglas-fir Poles,* Oregon State University Extension Service Circular 1134 (Corvallis, 1983). 50¢ plus 25¢ postage.

Starkey, Scott J., and Norman E. Elwood, *Log Exports and the Private Woodland Owner,* Oregon State University Extension Service Circular 1141 (Corvallis, 1983). 75¢ plus 25¢ postage.

Woodard, Steve, *Tools for Measuring Your Forest,* Oregon State University Extension Service Circular 1129 (Corvallis, 1983). 50¢ plus 25¢ postage.

Appendixes

Appendix A.—*Log truck carrying capacities*

Truck	Log volume 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 reflect timber with a high degree of taper, or small logs. Midrange volumes depict older, second-growth timber. High volumes indicate old growth.

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″	8½″	8″	7″	6½″	6″	5″
Length of Pole—Feet	Minimum Circumference up 6 Feet Outside Bark (*)—Inches						
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					

*Allows for average bark. Heavy bark may reduce poles one class.

Unpeeled Douglas-fir Piling

Length	Class A		Class B	
	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″	9½″	45½″	8½″
50′-52′	52″	9½″	45½″	7½″
53′-72′	52″	8½″	48½″	7½″
73′-92′	52″	7½″	48½″	6½″
Over 92′	52″	6½″	48½″	5½″

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 Cooperative Extension Service publication EB 689 (Pullman, 1977). The "Diameter-Circumference Conversion" section is reproduced through the courtesy of Cascade Pole Co., Tacoma, Wash.

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, College of Forest Resources, University of Washington, Seattle (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]

dbh (inches)	Total height of tree in feet												
	30	40	50	60	70	80	90	100	110	120	130	140	150
	Cords per tree												
6..............	.02	.03	.04	.05	.06	.07							
8..............	.05	.07	.08	.10	.12	.14	.15						
10..............	.08	.11	.13	.16	.19	.21	.23	.26	.29	.31			
12..............	.12	.16	.19	.23	.26	.30	.33	.36	.41	.44			
14..............	.16	.20	.25	.30	.35	.40	.45	.49	.54	.59	.64	.70	
16..............		.26	.32	.38	.45	.51	.57	.62	.67	.74	.80	.88	.90
18..............			.40	.48	.55	.62	.70	.77	.83	.90	.98	1.07	1.17
20..............			.48	.57	.68	.75	.83	.92	.98	1.07	1.17	1.28	1.39
22..............			.57	.66	.76	.86	.96	1.05	1.13	1.24	1.35	1.46	1.60
24..............				.76	.87	.98	1.08	1.17	1.27	1.39	1.50	1.63	1.79

[a] Reproduced, with permission, from Sullivan, Michael D., ed., *Your Trees—A Crop* (Portland, Ore.: Industrial Forestry Association, no date); 75¢ a copy from the association, 225 SW Broadway, Room 400, Portland 97205. 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 .26 cord. You will cut 3.8 trees for each cord:

$$\frac{1 \text{ cord}}{.26 \text{ cord}} = 3.8$$

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