Testing Suggested Rules of Thumb in Standing Second Growth Douglas Fir

by

Richard De Camp

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Foreword

This paper merely attempts to show by comparison the most simple and accurate rule of thumb that can be applied to a standing second growth Douglas Fir tree in order to determine its probable volume in cords. The rules of thumb were submitted by the forest mensuration class to Harry I. Nettleton, to whom acknowledgement is made for his kindness in helping with this study.

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Testing Suggested Rules of Thumb in Standing Second Growth Douglas Fir

Introduction

The primary purpose of this investigation is to determine the most simple and accurate rule of thumb for determining the probable number of stacked cords in a standing second growth Douglas Fir tree of a given DBH and height class. The studies for this problem were carried out in the Peavy Aboretum, six miles north of Corvallis.

In carrying out this study, the necessity for an easy and practical means of determining cordwood volume of standing trees was realized. There are numerous converting factors to determine the number of stacked cords in different tree species of different DBH and height classes, but in figuring the cords, one must always have a volume table to first determine the cubic foot or board foot volume of the tree. Many times a person may come upon a tree that he is desirous of knowing the stacked cord volume, but he has no volume table, so all he can do is to estimate the approximate volume. How much simpler it would be if he had a fairly accurate rule-of-thumb the he could apply to the DBH and height measurements of the tree. The stacked cord unit is used quite extensively in second growth Douglas Fir for fuel wood estimates on a given area, and also in payment for

woods operations.

Previous Investigations

To my knowledge no studies have been made along this line. A number of studies have been made to determine the amount of solid wood in a cord: the factors affecting the cubic foot volume of a cord; and to determine the correct converting factor to be used when changing cubic foot and foard foot to cords. However most of these investigations have been carried on in hardwood stands, and in softwood stands used for pulpwood.

The rules of thumb that were tested were developed by the students in forest mensuration. Approximately one hundred rules were submitted and from these, eleven were selected that checked out fairly close to a second growth Douglas Fir local cubic foot volume table. A merchantable height was taken to an eight inch top, which is the top limit used in cord wood cutting.

Method of Procedure

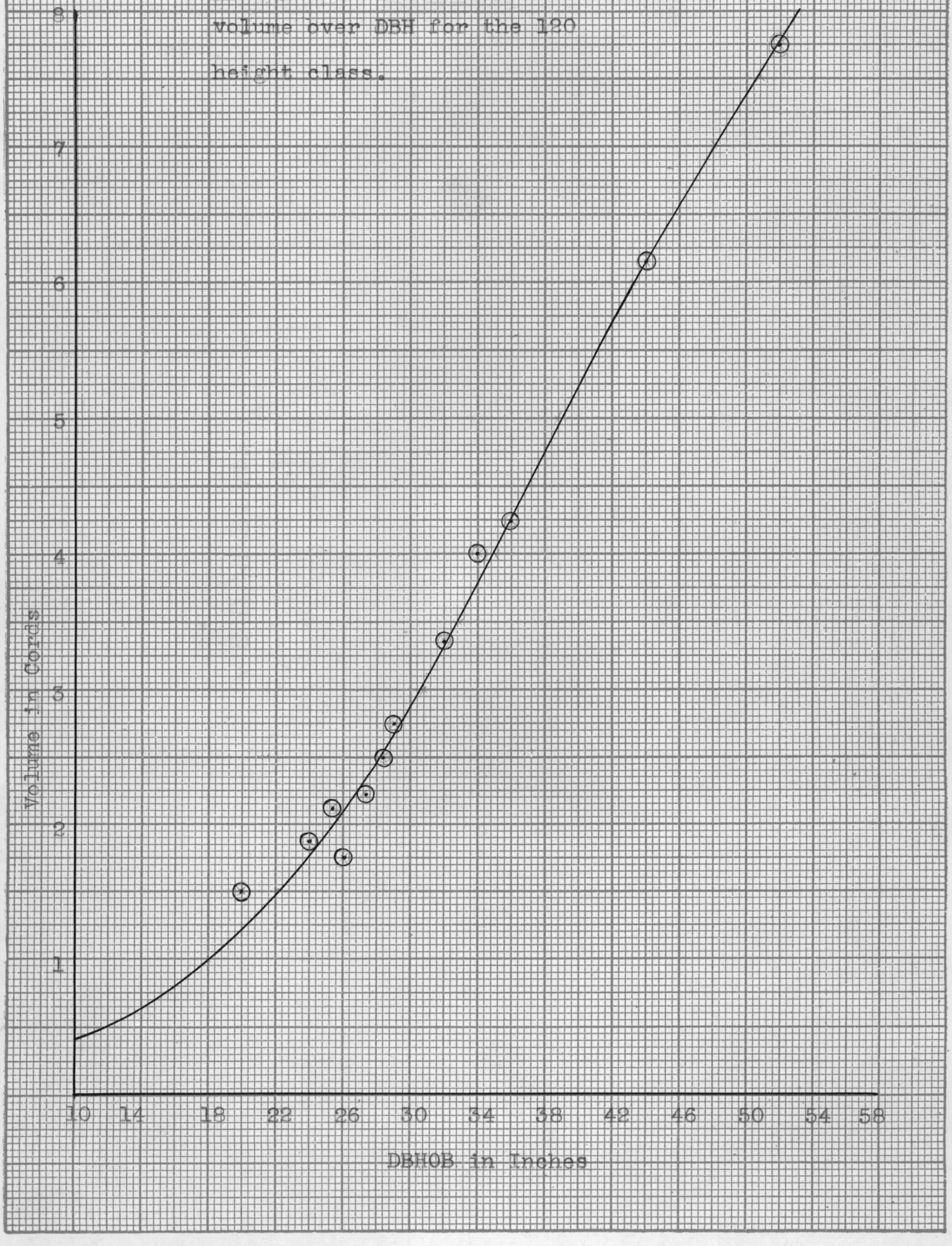
Field Work

The field work on this investigation required considerable time, for the reason that Saturdays were the only days that trees were being cut into cordwood at the Aboretum. The investigation required that the DBH and merchantable height to an eight inch top be taken on all trees that were felled. Diameter measurements were taken on all trees that were felled. Diameter measurements were taken with a diameter tape, and height measurements with a standard tape. After the tree had been bucked, split and stacked into piles, measurements were taken to get the number of cords in the tree. Trees that split badly upon felling or those with extensive decay were not used. If the trees were not bucked to an eight inch top by the wood cutters they were also disregarded. A total of twenty five trees, ranging in diameter from thirteen to forty inches and in height from seventy to one hundred and thirty two feet were measured and recorded. Trees above forty inches DBH were not considered second growth timber.

Office Computations

The twenty five trees were classified into twenty foot height classes, i.e., every tree that measured from seventy one to ninety feet in height was classified into the eighty foot height class, every tree that measured from ninety one to one hundred and ten feet in height was classified into the one hundred foot class, etc. The greatest

Fig. 1 Showing average curve of cord volume over DBH for the 120 height class.



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number of trees fell into the 120 foot height class.

The data was then placed on ordinary graph paper, by plotting cord volume over DBH, a separate curve for each height class. The plotted points for each height class were then connected with a straight line and a smooth curve drawn as the average curve.(Fig. 1)

After curves had been drawn for each height class, it was made clear that there was only enough samples for the one hundred and twenty foot height class to draw a good average curve that could be used. None of the other height classes contained enough samples to draw in an average curve. It was not possible to get any more samples, so it was assumed that the rules could be checked by the one hundred and twenty foot height class at the present time.. Had there been more samples available, more height classes could have been used and also the cord volume could have been placed in proper ratio to both the independent variables by harmonizing the curves.

A table(Fig.2) was then constructed by recording the cord volumes from the curve for each DBH class from twelve to forty inches.

A second table(Fig.3) was constructed which gave the cord volume of each rule of thumb for each DBH class. Volumes were tabulated for each DBH class at four inch intervals from twelve inches to forty inches. The volumes were then totalled for each rule of thumb, and also for the corresponding DBH classes in (Fig.2).

DBH	CORDS	DBH	CORDS
12	.49	27	2.25
13	.55	28	2.40
14	.65	29	2.62
15	.75	30	2.85
16	.85	31	3.05
17	.95	32	3.25
18	1.05	33	3.50
19	1.15	34	3.75
20	1.25	35	4.00
21	1.35	36	4.25
22	1.50	37	4.50
23	1.65	38	4.75
24	1.80	39	5.00
25	1.95	40	5.25
26	2.10	41	5.50

Fig. 2 Cord volume taken from graph for each DBH class in the 120 ft. height class

Rule of Thumb Numbers

DBH	S.C.	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
12	.49	.60	.40	.65	.33	.43	.32	.76	.42	.81	.45	.60
16	.85	.90	.80	.87	.58	.87	.57	.92	.75	1.08	.71	1.00
20	1.20	1.20	1.20	1.09	.93	1.31	.89	1.07	1.17	1.35	1.02	1.80
24	1.80	1.50	1.60	1.31	1.33	1.75	1.28	1.22	1.69	1.62	1.38	2.59
28	2.40	1.80	2.00	1.53	1.75	2.18	1.74	1.37	2.30	1.89	1.81	3.39
32	3.25	2.10	2.40	1.75	2.36	2.62	2.28	1.52	3.01	2.16	2.29	4.19
36	4.25	2.40	2.80	1.97	2.99	3.05	2.78	1.68	3.80	2.43	2.82	4.99
40	5.25	2.70	3.20	2.19	3.70	3.5	3.55	1.83	4.70	2.70	3.42	5.79
Total	19.54	13.20	14.40	12.36	13.97	15.71	13,39	10.37	17.84	14.04	13.90	24.35

Fig.3---Showing volumes for each rule of thumb in several DBH classes. Also totals for all DBH classes for each rule of thumb. (S.C. means stacked cords)

A third table (Fig.4) shows the total volume for each rule and the total volume for a stacked cord as taken from the field measurements. The difference was then determined between the total volumes and expressed as a percentage increase or decrease of the stacked cords. The table shows a good comparision of all the rules.

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Rule	Total Volume		Diff.	% Diff.
	S.C.	R.T.C.		
# 1	19.54	13.20	- 6.34	32.4%
2	"	14.40	- 5.14	26.3%
3	"	12.36	- 7.18	36.7%
4	"	13.97	- 5.57	28.5%
5.	"	15.71	- 3.83	19.6%
6	"	13.39	- 6.15	31.4%
7	"	10.37	- 9.17	46.3%
8	"	17.84	- 1.70	8.6%
9	"	14.04	- 5.50	28.1%
10	"	13.90	- 5.64	28.8%
11	"	24.35	+ 4.81	+24.6%

Fig. 4 --- Showing percentage differences between rules of thumb volumes and the stacked cord volumes as computed in Fig. 3.

Results of Comparison

Rule Number 1

$$\left(\frac{\text{DBH x No. 16' logs}}{100}\right)-.3$$

This rule gave large volumes on small trees and small volumes on larger trees. On trees in the 18 inch DBH class it checked out very close. The volume increased proportionally to the diameter, explaining the small volumeson the larger trees. The rule could never be applied to trees in the 120 foot class, unless a variable was introduced to increase the volume on larger trees.

Rule Number 2

$$\frac{(\text{DBH} - 8)\ H'}{1200}$$

where:

H = Merchantable height to 8" top

This rule gave low volumes for trees of all DBH classes, The rule could be applied to 12 and 14 inch classes if a variable number of .1 was added to the volumes of trees in those classes and it could be applied to 15 to 20 inch classes if a variable number of .05 was added to the volumes of trees in those classes. The rule however is impracticable.

Rule Number 3

$$\frac{\text{DBH x } H'}{2200}$$

where:

H'= Merchantable height to 8" top

In this rule the volume increased proportionally with the diameter. It gave a high volume for small trees and a very low volume for large trees. This rule could be very well applied in smaller height classes such as the sixty to eighty foot height classes. It is very impracticable for the 120 foot height class, and is second from the last in having the greatest percentage of difference from stacked cord volume.(Fig.4)

Rule Number 4

$$\frac{DBH^2 \times H'}{52,000}$$

This rule gave small volume for all size trees. Had this rule used a constant of 34,000 instead 52,000 it could very well be used for trees in the 120 foot Height class. The volume increases proportionally with the square of the diameter.

Rule Number 5

$$\frac{(DBH - 8)H'}{1100}$$

where:

H = Merchantable height to 8" top

This rule was similar to rule number 2, the only difference being, a constant of 1100 was used in comparison to 1200 used in the second rule. The rule gave low volume for trees of all DBH classes. If a constant of 1000 was applied to both rules they would check out fine for both rules, two and five.

Rule Number 6

$$\frac{DBH^2 \times H'}{54,000}$$

where:

H = Merchantable height to 8" top

This rule is similar to rule number 4, except it uses a constant of 54,000 where rule number 4 uses a constant of 52,000. Again if the constant of 34,000 was applied, the rule could be used for trees in the 120 foot height class.

Rule Number 7

$$\frac{D \times .0054 \times L}{85}$$

where:

D = Average diameter between DBH and top DIB of 8"

L = merchantable height to 8" top

This rule is very impracticable, giving very low volumes for all DBH classes(Fig.4).. It showed the greatest percentage of difference from the stacked cord volume. The volume being indirectly proportional to the average diameter of the tree, seems to be the reason for the slow increase in volume for each class.

Rule Number 8

$$\frac{R^2}{85}$$

where:

R^2= radius squared at breast height

85= cubic foot content of the cord

This rule was the most simple and accurate rule that was tested. The percent of difference was 8.6 (Fig.4) the least of any rule that was tested. This rule could be so used, that it would fit any method of stacking, by either increasing or decreasing the constant (85) and therefore making it variable. If the tree to which this rule is to be applied, appeared to be very limby and knotty, the constant could be decreased to compensate for a decrease in the volume of the stacked cord due to knots and limbs that prevent closer stacking. Likewise if the tree had a clear bole the constant could be increased to compensate for closer stacking. The simplicity of the rule makes it easy to use and easy to remember.

Rule Number 9

$$\frac{.9 \text{ DBH} \times \text{No. 16' logs}}{100}$$

This rule proved impracticable by giving large volumes for small trees and small volumes for large trees. This rule might be applicable in smaller height classes, however, its numerous factors which go to make it up, make it undesireable to use.

Rule Number 10

$$\frac{\left(\frac{\text{DBH} \not{-} 4}{2}\right) \times 5L'}{85{,}000}$$

where:

L = merchantable height to 8" top

This rule tends away from simplicity because of the numerous factors that go to make it up. It gives low

volumes for all DBH classes, and therefore the constant or 85,000 should be decreased to about 65,000 to be applicable to the 120 foot height class. At the present it could probably be used in 80 to 100 foot height classes.

Rule Number 11

(No. of 2" diameter deviations from 12" to and including diameter of tree in question) x (No. of 10' height deveiations from 50' height to and including height of tree in question) x (.057) ∕ .2

This was the only rule that gave a greater volume than those of stacked cords of corresponding DBH classes (Fig.3). If applied to 160' to 180' height classes the rule would probably check out very closely. However, it appears to be very impracticable because of its lenghty nature.

Conclusion

After a complete study of all eleven rules it appears that site would very greatly affect the rules of thumb. Different site classes require different constants in the rules as well as do different height classes. These rules were made up for all site classes, and when applied to one particular site, naturally their would be a great variation.

Methods of stacking will also influence the accuracy of these rules. On this particular site to which these rules were applied, the wood was stacked rather loosely some stacks containing probably as little as 75 cubic feet. That no doubt explains the reason for such a great percentage difference between the stacked cords and rule of thumb cords.

Rule number 8, $(\frac{R^2}{85})$, proved to be most accurate and simple rule that could be applied to the 120 foot height class. It is easy to remember and consists of only a few calculations, the characteristics of a good rule of thumb. The number of cubic feet in a cord or the denominator can be changed to meet any method of stacking that may result from the shape or form of the tree in question.

This study should be carried out further, so that several site classes are included and all height classes are used. In this way a more accurate check could be obtained for the rules.