Anthracite Survey Paper No. 4 May 18, 1942

Mensuration Element

&

# VOLUME TABLES FOR COMMERCIAL TIMBER IN THE ANTHRACITE REGION OF PENNSYLVANIA

PROGRESS REPORT



FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

ALLEGHENY FOREST EXPERIMENT STATION

ECONOMIC SURVEY
ANTHRACITE FOREST REGION

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

ALLEGHENY FOREST EXPERIMENT STATION
(In cooperation with the University of Pennsylvania)
Bankers Securities Building, Philadelphia, Pa.

Hardy L. Shirley, Director

Anthracite Forest Region is a convenient name for 15 counties, shown on the map on the back of this publication, which contain or surround the hard-coal deposits of Pennsylvania. The forests of this region are now badly depleted. But preliminary estimate indicate that under good management they might, in time, furnish most of the forest products and services the region requires.

The Economic Survey of this region aims to determine:

(1) what measures, and how much labor, are needed to rebuild the forests;

(2) how much labor might be employed in permanent industries based on the restored forest.

Full answers to these questions will be of utmost value both now and in the period of readjustment following the War.

This paper was prepared by

DIVISION OF FOREST ECONOMICS

R. D. Forbes, Senior Forester

ECONOMIC SURVEY, ANTHRACITE FOREST REGION
Kingston Branch Post Office, Wilkes-Barre, Pa.

Clement Mesavage, Assistant Forester
Arthur S. Todd, Junior Forester
Earl J. Rogers, Assistant Forester

Note: Assistance in the preparation of this paper was received from the Work Projects Administration, under official project 165-2-23-834.

# VOLUME TABLES FOR COMMERCIAL TIMBER IN THE ANTHRACITE REGION OF PENNSYLVANIA

By Clement Mesavage*

Tree volume tables are almost indispensable in obtaining reliable estimates of the amount of standing timber on a tract prior to its sale, purchase, or management. A number of such tables previously published will give accurate results if used properly, but their use in the Anthracite Region of Pennsylvania has been limited, largely because they are difficult to apply. These difficulties arise partly from the fact that the tables are based on total height or height to a fixed top diameter, and give volume of that portion of the tree trunk below a fixed top diameter. All of this portion may not be merchantable because of large branches in the top, especially in hardwoods, and serious errors in estimating merchantable volume may result from the use of these tables. The tables also assume that trees within a species or group of species have similar taper. Their authors recognize that this may not be the case, and expect adjustments to be made by comparing the tabular volumes with those of trees which have been felled or climbed on the area being cruised. Such adjustments are always expensive and time-consuming, and require a considerable amount of office work before the tables are ready for use.



The tables presented in this paper were designed to overcome these difficulties. There are only six for board feet, in three common log rules, and three for cubic feet. They give the volumes for any commercial species in this region.

Height measurements are restricted to the merchantable portion of the tree. The adjustments necessary to use the tables anywhere in this region can be made by simple ocular estimates of tree taper, instead of precise tree measurements. Although the board foot volume tables were made specifically for use in the Anthracite Forest Region, limited checks on timber elsewhere, and comparisons with volume tables acceptable for many species throughout the eastern United States, indicate that these tables may be suitable for a much wider range of species and regions.

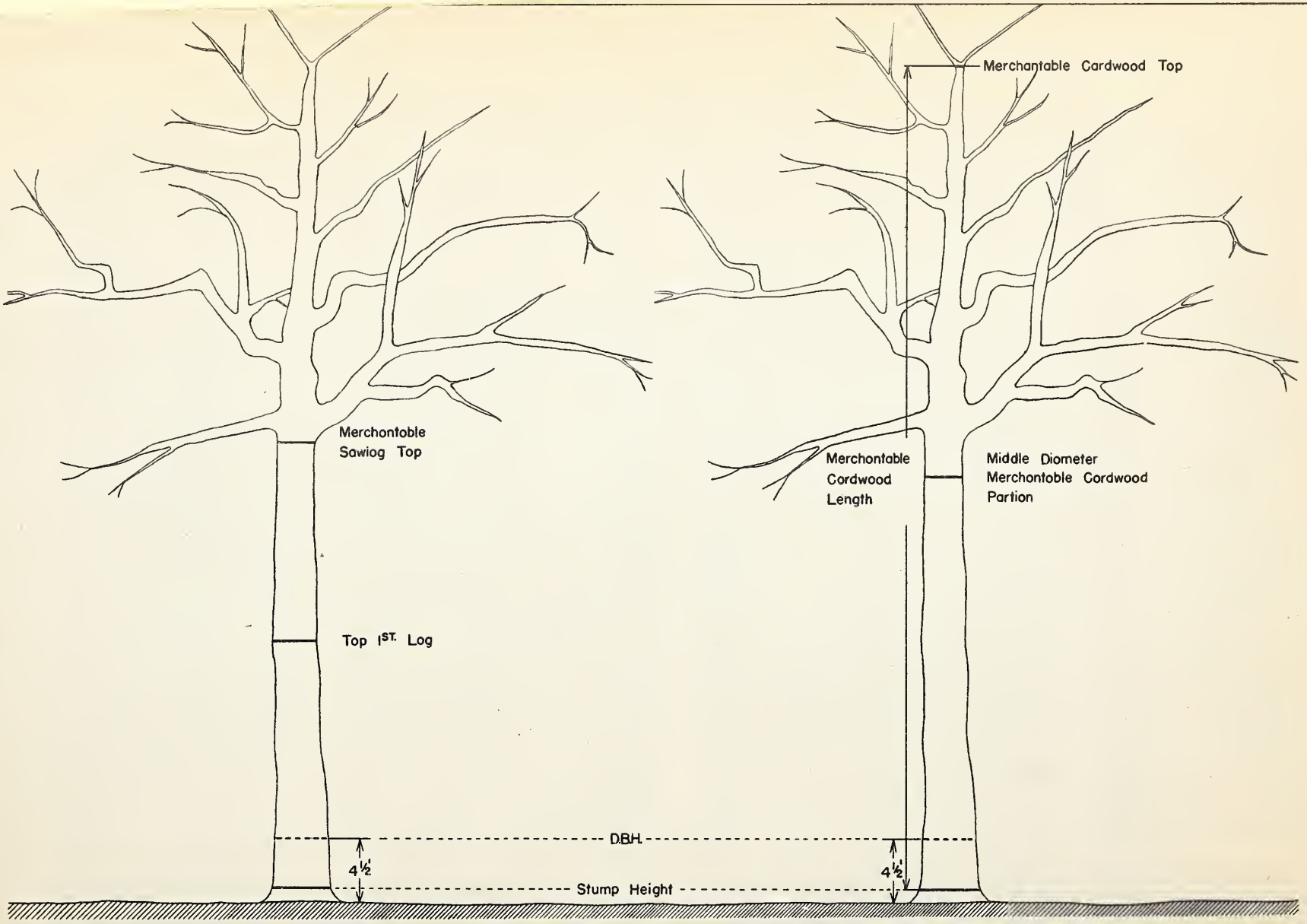
## BOARD FOOT VOLUME TABLES

The board foot volume tables are based on diameter breast high, merchantable height in 16 foot logs, and an index of tree taper known as the Girard Form Class.1/ The Girard Form Class is the ratio of the

---

* Grateful acknowledgements are due to James W. Girard, Assistant Director, United States Forest Survey, for nearly all of the basic data used in these tables, and for his practical suggestions in their construction.

1/ Developed by James W. Girard, Assistant Director, United States Forest Survey.




$$\text{Girard Form Class} = \frac{\text{Dia. I. B. Top 1}^{\text{st}}\text{ Log}}{\text{D.B.H.}} \times 100$$

$$\text{Girard Form Point} = \frac{\text{Mid. Dia. O. B. Merch. Cordwood}}{\text{D.B.H.}} \times 100$$

diameter inside bark at the top of the first log to the diameter breast high, outside bark, expressed as a percentage. For example, a tree having a d.b.h. of 20.0 inches. and measuring 16.0 inches inside the bark at the top of the first log, has a form class of 80. The relationship is illustrated on the opposite page. It should not be confused with the classic "form class" or "form quotient", which is the percentage relationship between d.b.h. and the diameter outside bark at a point half way between breast height and the tip of the tree. Since it defines the scaling diameter of the first log in a tree, the Girard Form Class is a true index of the volume of one-log trees. In trees containing more than one log, the only variable unaccounted for is the rate of taper in the upper log or logs. The Economic Survey determined, from measurements on many trees in the Anthracite Region, that upper log taper could be divided for all practical purposes into three groupings:

1. Low. Includes all hardwoods regardless of species
2. Medium. Includes old-growth hemlock and white pine
3. High. Includes second-growth white pine, hemlock, pitch pine, and possibly spruce

These tapers, shown for the low and medium groupings on page 11, control the scaling diameters of upper logs entering into board foot volume in the tables. Tapers in individual trees will seldom correspond exactly to the average values given, but the deviation of average tree volumes based on these tapers is usually not excessive even in a small number of trees. Diameter inside bark at top of first log in trees of various diameters and form classes are given on page 10.

Application of Board Foot Volume Tables

If considered over a wide geographical range, Girard Form Class tends to be relatively constant for a species. However, because it is sensitive to all factors which influence butt-swell, local differences in form class may be very appreciable. In using these tables, therefore, it is first necessary to determine the average form class of each species, by d.b.h. classes, in the woods being cruised. The number of trees which need to be measured for form class depends upon the variation among trees. Ordinarily, about 100 trees of each species, well distributed as to d.b.h. class and location in the woods, are sufficient. Smoothing the form class values by plotting them over D.B.H. may be necessary.

Once form class is determined, the volume in average trees of any diameter and merchantable height can be obtained from the form class tables on pages 16 to 21. Although these tables are furnished only for Form Classes 78 and 85, values for trees of any form class between 74 and 89 can be obtained by means of the chart appearing with each set of board foot volume tables. The simple instructions needed to use this chart are given on page 15.

Volume tables so constructed are "custom made", and should be discarded after the trees are cut, because there is no assurance that the remaining trees, or the trees which will grow up later, will have the same form class averages as the trees in the original stand.

If merchantable height is estimated at the same time as form class, it is easy, by plotting tree volumes as calculated from the tables over d.b.h. and smoothing with a curve, to make up a table based on diameter alone.

Ocular Estimates of Girard Form Class

Average form class may be obtained from measurements on felled or climbed trees. However, it is more practicable to obtain it ocularly from standing trees, because:

(a) The choice of sample trees is not restricted to those which can be climbed or cut, and a very representative selection can therefore be obtained without difficulty.

(b) Sample tree data can be collected very rapidly. With practice, form class can be estimated as easily as diameter. A cruiser with a "good eye" for form class, diameter, and merchantable height, can by this method prepare volume tables for sawtimber tracts in a few hours, including office work.

The ability to estimate form class can be acquired very easily. Although first attempts may be disappointing, a very good start can be made with only a few hours practice. The following training procedure is suggested:

1. Stand well away from the tree in such a position that the trunk is clearly visible from d.b.h. to the top of the first 16-foot log.

2. Study the relationship between the top d.i.b. of the first log and the d.b.h. Do not try to derive form class from ocular estimates of the actual diameters at these points.

3. Estimate the percentage relationship (form class) and record it.

4. Check the estimate by measuring the form class percentage as follows:

   (a) Using a caliper, measure and record to the nearest tenth of an inch the d.b.h. visible from the point where the ocular estimate of form class was made.

   (b) Similarly, measure and record the diameter outside bark at the top of the first log. A light ladder or tree climbers can be used to get up the tree.

(c) Obtain double bark thickness to the nearest 0.05 inches at the top of the first log, using a Swedish bark gauge, or chipping the bark with a hand axe and measuring with a scale. Subtract the double bark thickness from d.o.b.

(d) Divide the d.i.b. at the top of the first log by d.b.h. The quotient is the Girard Form Class of the tree as it appeared from the point where the ocular estimate was made.

5. Record the measured form class and compare it with the estimated form class.

6. Repeat the experiment on a number of trees. Because errors made on individual trees will soon be found to compensate, it is unnecessary to estimate form class of individual trees exactly.

Trees with elliptical cross-sections may of course have a different form class depending on which side of the tree one looks at. In actual practice, it is unnecessary to average the form class from two points of view because single measurements on a number of trees will be compensating.

A knowledge of bark thickness is of course indispensable in ocular form class determinations. Although this is best obtained through experience, the average values on page 9 will be found helpful. These measurements indicate the average double bark thickness of logs of various diameters without regard to the position of the log in the tree; they should not be used for bark thickness at breast high.

Species Form Class Averages

As previously mentioned, form class tends to be relatively constant within a species for large areas. When a high degree of accuracy is not essential, tables for the more important commercial species can be derived from the basic tables in this report by using these regional averages:

| Form Class | Upper Log Taper Grouping | Species |
|---|---|---|
| 84 | Low | Beech |
| 82 | Low | Black Cherry |
| 81 | Low | Basswood, Ash, Old-growth Oaks and Yellowpoplar |
| 81 | Medium | Old-growth White Pine and Hemlock |
| 79 | Low | Second-growth Yellowpoplar |
| 79 | High | Second-growth White Pine |
| 78 | Low | Second-growth Oaks, Maple, and Birch |
| 78 | High | Spruce |
| 76 | High | Second-growth Hemlock |

## Merchantable Height Estimates

Estimates of merchantable height should be made carefully. In the board foot tables, the upper diameter is in no case less than 8 inches for hardwoods, or less than 6 inches in conifers, irrespective of local utilization practices, and go to a variable top diameter depending upon the upper limit of actual merchantability, which generally is the point at which the tree divides into large branches. This must be understood thoroughly or the volume tables will not be accurate. Especially with small conifers there is a tendency to consider merchantable height as extending to a point too high in the tree, because of the relatively small branches. When this is done there is extreme danger that the volume table will over-scale the tree. For example, an average 20-inch old growth White Pine with a form class of 78, and $3\frac{1}{2}$ sixteen foot logs, has a top diameter of about 10.0 inches, and a Scribner gross scale of 370 board feet. Above this point the stem tapers sharply because of branches, but by lopping the branches, 4 sixteen foot logs to a top diameter of about 7.8 inches may be cut. If the tree is scaled in sixteen foot logs (as are all trees in these tables), the sum of the scale for $3\frac{1}{2}$ sixteen foot logs is as great as for 4 logs, because a 10.0-inch top log 8 feet long scales the same as a 7.8-inch log 16 feet long. The volume table, however, shows that 4-log trees of this diameter and form class have 395 board feet, Scribner. The volume table would, therefore, overscale this tree by 25 board feet if it were estimated as 4 logs.

If a tree is scaled properly, the volume of the top log is by no means negligible. Percentage of tree volume in top 16-foot logs of trees of Form Class 78, scaled by the Scribner Decimal C Rule (curved from formula), are as follows:

| | 2 Log Trees | | 3 Log Trees | | 4 Log Trees | |
|---|---|---|---|---|---|---|
| D.B.H. | Low Upper Taper | Medium Upper Taper | Low Upper Taper | Medium Upper Taper | Low Upper Taper | Medium Upper Taper |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| 10 | -- | 35 | -- | -- | -- | -- |
| 12 | 37 | 35 | -- | 13 | -- | -- |
| 14 | 39 | 38 | 18 | 17 | -- | -- |
| 16 | 40 | 39 | 20 | 18 | 9 | 7 |
| 18 | 42 | 40 | 21 | 19 | 10 | 8 |
| 20 | 42 | 40 | 22 | 20 | 11 | 9 |
| 22 | 43 | 40 | 23 | 21 | 12 | 10 |
| 24 | 43 | 41 | 23 | 21 | 13 | 11 |
| 26 | 43 | 41 | 23 | 21 | 13 | 11 |
| 28 | 43 | 41 | 24 | 22 | 14 | 11 |
| 30 | 44 | 41 | 24 | 22 | 14 | 12 |

## Field Check of Board Foot Volume Tables

The board foot volume tables were tested on logging jobs scattered over the Anthracite Region. The following table shows how the total measured scale, by species but without regard to size of tree, compared with the volume table estimate:

ALL TREE SIZES

| Species | Trees Measured | Gross Volume, Int. 1/4 Rule | | Deviation from measured scale |
|---|---|---|---|---|
| | | Measured | Volume Table | |
| | Number | Bd. Ft. | Bd. Ft. | Percent |
| White pine | 77 | 16,820 | 15,774 | -6.2 |
| Hemlock, Pitch pine | 249 | 42,636 | 44,768 | 5.0 |
| Oaks | 61 | 10,467 | 10,618 | 1.4 |
| Maples | 118 | 45,070 | 44,846 | -0.5 |
| Beech | 97 | 23,873 | 23,908 | 0.1 |
| Birches | 59 | 17,251 | 17,503 | 1.5 |
| Ash, Cherry, Gum, yellowpoplar, basswood | 84 | 14,587 | 14,954 | 2.5 |
| Totals | 745 | 170,704 | 172.371 | 1.0 |

By size of tree, the comparison is as shown on page 8.

ALL SPECIES

| D.B.H. | Merchantable Height: 16 ft. to 28 ft. Trees Number | Gross Volume, Int. 1/4 Rule Measured Bd.Ft. | Volume Table Bd.Ft. | 30 ft. to 44 ft. Trees Number | Gross Volume, Int. 1/4 Rule Measured Bd.Ft. | Volume Table Bd.Ft. | 46 ft. to 64 ft. Trees Number | Gross Volume, Int. 1/4 Rule Measured Bd.Ft. | Volume Table Bd.Ft. | All heights Trees Number | Gross Volume, Int. 1/4 Rule Measured Bd.Ft. | Volume Table Bd.Ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.0 to 12.9 | 132 | 6,300 | 6,539 | 89 | 9,166 | 8,871 | 8 | 1.093 | 979 | 229 | 16,559 | 16,389 |
| 13.0 to 16.9 | 39 | 4,396 | 4,399 | 154 | 24,504 | 25,406 | 57 | 13,289 | 13,221 | 250 | 42,189 | 43,026 |
| 17.0 to 20.9 | 10 | 2,662 | 2,380 | 50 | 16,447 | 16,732 | 84 | 32,204 | 32,894 | 144 | 51,313 | 52,006 |
| 21.0 to 24.9 | 3 | 419 | 360 | 44 | 18,635 | 18,395 | 44 | 17,936 | 18,850 | 91 | 36,990 | 37,605 |
| 25.0 to 28.9 | | | | 11 | 8,184 | 8,140 | 12 | 9,770 | 9,510 | 23 | 17,954 | 17,650 |
| 29.0 to 32.9 | | | | 4 | 2,182 | 2,110 | 3 | 2,433 | 2,550 | 7 | 4,615 | 4,660 |
| 33.0 to 34.9 | | | | | | | 1 | 1,084 | 1,035 | 1 | 1,084 | 1,035 |
| Totals | 184 | 13,777 | 13,678 | 352 | 79,118 | 79,654 | 209 | 77,809 | 79,039 | 745 | 170,704 | 172,371 |

AVERAGE DOUBLE BARK THICKNESS OF LOGS
PENNSYLVANIA ANTHRACITE REGION

| D.I.B. | White Pine | Hemlock | Hickory, Red, Black & White Oaks | Chest-nut Oak | Maple and Birch | Ash, Basswood, Yellowpoplar, Black Cherry | Beech |
|---|---|---|---|---|---|---|---|
| 5 | 0.4 | 0.5 | 0.6 | 1.2 | 0.4 | 0.4 | 0.2 |
| 6 | 0.4 | 0.5 | 0.6 | 1.3 | 0.4 | 0.5 | 0.2 |
| 7 | 0.5 | 0.6 | 0.6 | 1.3 | 0.5 | 0.5 | 0.2 |
| 8 | 0.5 | 0.7 | 0.7 | 1.4 | 0.5 | 0.6 | 0.3 |
| 9 | 0.6 | 0.7 | 0.8 | 1.4 | 0.6 | 0.6 | 0.3 |
| 10 | 0.6 | 0.8 | 0.8 | 1.4 | 0.7 | 0.6 | 0.4 |
| 11 | 0.7 | 0.8 | 0.9 | 1.5 | 0.7 | 0.8 | 0.4 |
| 12 | 0.7 | 0.9 | 0.9 | 1.5 | 0.7 | 0.8 | 0.4 |
| 13 | 0.8 | 1.0 | 0.9 | 1.5 | 0.7 | 0.9 | 0.4 |
| 14 | 0.8 | 1.0 | 1.0 | 1.6 | 0.8 | 0.9 | 0.5 |
| 15 | 0.9 | 1.1 | 1.0 | 1.6 | 0.8 | 1.0 | 0.5 |
| 16 | 0.9 | 1.1 | 1.0 | 1.7 | 0.8 | 1.0 | 0.5 |
| 17 | 1.0 | 1.2 | 1.1 | 1.7 | 0.9 | 1.0 | 0.6 |
| 18 | 1.0 | 1.3 | 1.1 | 1.8 | 0.9 | 1.1 | 0.6 |
| 19 | 1.1 | 1.3 | 1.1 | 1.8 | 1.0 | 1.1 | 0.6 |
| 20 | 1.2 | 1.3 | 1.2 | 1.8 | 1.0 | 1.2 | 0.7 |

TOP DIAMETER OF FIRST LOG,*
BY TREE DIAMETER AND FORM CLASS

| D.B.H. | Form Class | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 |
| In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| 12 | 8.0 | 8.2 | 8.3 | 8.4 | 8.5 | 8.6 | 8.8 | 8.9 | 9.0 | 9.1 | 9.2 | 9.4 |
| 14 | 9.4 | 9.5 | 9.7 | 9.8 | 9.9 | 10.1 | 10.2 | 10.4 | 10.5 | 10.6 | 10.8 | 10.9 |
| 16 | 10.7 | 10.9 | 11.0 | 11.2 | 11.4 | 11.5 | 11.7 | 11.8 | 12.0 | 12.2 | 12.3 | 12.5 |
| 18 | 12.1 | 12.2 | 12.4 | 12.6 | 12.8 | 13.0 | 13.1 | 13.3 | 13.5 | 13.7 | 13.9 | 14.0 |
| 20 | 13.4 | 13.6 | 13.8 | 14.0 | 14.2 | 14.4 | 14.6 | 14.8 | 15.0 | 15.2 | 15.4 | 15.6 |
| 22 | 14.7 | 15.0 | 15.2 | 15.4 | 15.6 | 15.8 | 16.1 | 16.3 | 16.5 | 16.7 | 16.9 | 17.2 |
| 24 | 16.1 | 16.3 | 16.6 | 16.8 | 17.0 | 17.3 | 17.5 | 17.8 | 18.0 | 18.2 | 18.5 | 18.7 |
| 26 | 17.4 | 17.7 | 17.9 | 18.2 | 18.5 | 18.7 | 19.0 | 19.2 | 19.5 | 19.8 | 20.0 | 20.3 |
| 28 | 18.8 | 19.0 | 19.3 | 19.6 | 19.9 | 20.2 | 20.4 | 20.7 | 21.0 | 21.3 | 21.6 | 21.8 |
| 30 | 20.1 | 20.4 | 20.7 | 21.0 | 21.3 | 21.6 | 21.9 | 22.2 | 22.5 | 22.8 | 23.1 | 23.4 |

| D.B.H. | Form Class (Continued) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| 12 | 9.5 | 9.6 | 9.7 | 9.8 | 10.0 | 10.1 | 10.2 | 10.3 | 10.4 | 10.6 | 10.7 | 10.8 |
| 14 | 11.1 | 11.2 | 11.3 | 11.5 | 11.6 | 11.8 | 11.9 | 12.0 | 12.2 | 12.3 | 12.5 | 12.6 |
| 16 | 12.6 | 12.8 | 13.0 | 13.1 | 13.3 | 13.4 | 13.6 | 13.8 | 13.9 | 14.1 | 14.2 | 14.4 |
| 18 | 14.2 | 14.4 | 14.6 | 14.8 | 14.9 | 15.1 | 15.3 | 15.5 | 15.7 | 15.8 | 16.0 | 16.2 |
| 20 | 15.8 | 16.0 | 16.2 | 16.4 | 16.6 | 16.8 | 17.0 | 17.2 | 17.4 | 17.6 | 17.8 | 18.0 |
| 22 | 17.4 | 17.6 | 17.8 | 18.0 | 18.3 | 18.5 | 18.7 | 18.9 | 19.1 | 19.4 | 19.6 | 19.8 |
| 24 | 19.0 | 19.2 | 19.4 | 19.7 | 19.9 | 20.2 | 20.4 | 20.6 | 20.9 | 21.1 | 21.4 | 21.6 |
| 26 | 20.5 | 20.8 | 21.1 | 21.3 | 21.6 | 21.8 | 22.1 | 22.4 | 22.6 | 22.9 | 23.1 | 23.4 |
| 28 | 22.1 | 22.4 | 22.7 | 23.0 | 23.2 | 23.5 | 23.8 | 24.1 | 24.4 | 24.6 | 24.9 | 25.2 |
| 30 | 23.7 | 24.0 | 24.3 | 24.6 | 24.9 | 25.2 | 25.5 | 25.8 | 26.1 | 26.4 | 26.7 | 27.0 |

* All logs are 16.3 feet long

UPPER-LOG* TAPERS
TO LIMIT OF AVERAGE SAWTIMBER MERCHANTABILITY

Low and Medium Tapers

| D.B.H. | 2-Log Trees: Second log | 3-Log Trees: Second log | 3-Log Trees: Third log | 4-Log Trees: Second log | 4-Log Trees: Third log | 4-Log Trees: Fourth log |
|---|---|---|---|---|---|---|
| In. | In. | In. | In. | In. | In. | In. |
| | | Low Upper-Log Taper (Hardwoods) | | | | |
| 12 | 1.6 | --- | --- | --- | --- | --- |
| 14 | 1.7 | 1.4 | 1.9 | --- | --- | --- |
| 16 | 1.9 | 1.5 | 2.1 | 1.2 | 1.9 | 2.3 |
| 18 | 2.0 | 1.6 | 2.2 | 1.3 | 2.0 | 2.5 |
| 20 | 2.1 | 1.7 | 2.3 | 1.4 | 2.2 | 2.6 |
| 22 | 2.2 | 1.8 | 2.5 | 1.5 | 2.4 | 2.7 |
| 24 | 2.3 | 1.8 | 2.7 | 1.5 | 2.6 | 2.8 |
| 26 | 2.4 | 1.9 | 2.9 | 1.6 | 2.8 | 3.0 |
| 28 | 2.5 | 1.9 | 3.1 | 1.7 | 2.8 | 3.2 |
| 30 | 2.6 | 2.0 | 3.3 | 1.8 | 3.0 | 3.4 |
| | | Medium Upper-Log Taper (Old-growth White Pine and Hemlock) | | | | |
| In. | In. | In. | In. | In. | In. | In. |
| 10 | 1.5 | --- | --- | --- | --- | --- |
| 12 | 1.7 | 1.4 | 2.0 | --- | --- | --- |
| 14 | 1.9 | 1.6 | 2.1 | --- | --- | --- |
| 16 | 2.1 | 1.7 | 2.3 | 1.4 | 1.9 | 2.7 |
| 18 | 2.3 | 1.9 | 2.4 | 1.5 | 2.1 | 2.9 |
| 20 | 2.5 | 2.0 | 2.7 | 1.7 | 2.3 | 3.0 |
| 22 | 2.7 | 2.2 | 2.9 | 1.8 | 2.6 | 3.2 |
| 24 | 2.9 | 2.4 | 3.0 | 1.9 | 2.8 | 3.4 |
| 26 | 3.1 | 2.6 | 3.2 | 2.0 | 3.0 | 3.7 |
| 28 | 3.3 | 2.7 | 3.3 | 2.1 | 3.2 | 3.8 |
| 30 | 3.5 | 2.9 | 3.5 | 2.2 | 3.5 | 4.0 |

* All logs are 16.3 feet long

Basic data from James W. Girard, 1940.
Mesavage, 1942.

SCALE IN BOARD FEET OF 16-FOOT LOGS 1/

International $\frac{1}{4}$-inch Rule

Computed from Formula $V = 0.796D^2 - 1.375D - 1.230$

Top diameter of log, inside both barks

| | Tenths of Inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Inches | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| 6 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 |
| 7 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 38 |
| 8 | 39 | 40 | 41 | 42 | 43 | 45 | 46 | 47 | 48 | 50 |
| 9 | 51 | 52 | 53 | 55 | 56 | 58 | 59 | 60 | 62 | 63 |
| 10 | 65 | 66 | 68 | 69 | 71 | 72 | 74 | 75 | 77 | 78 |
| 11 | 80 | 82 | 83 | 85 | 87 | 88 | 90 | 92 | 93 | 95 |
| 12 | 97 | 99 | 100 | 102 | 104 | 106 | 108 | 110 | 112 | 113 |
| 13 | 115 | 117 | 119 | 121 | 123 | 125 | 127 | 129 | 131 | 133 |
| 14 | 136 | 138 | 140 | 142 | 144 | 146 | 148 | 151 | 153 | 155 |
| 15 | 157 | 160 | 162 | 164 | 166 | 169 | 171 | 173 | 176 | 178 |
| 16 | 181 | 183 | 185 | 188 | 190 | 193 | 195 | 198 | 200 | 203 |
| 17 | 205 | 208 | 211 | 213 | 216 | 218 | 221 | 224 | 226 | 229 |
| 18 | 232 | 235 | 237 | 240 | 243 | 246 | 249 | 251 | 254 | 257 |
| 19 | 260 | 263 | 266 | 269 | 272 | 275 | 278 | 281 | 284 | 287 |
| 20 | 290 | 293 | 296 | 299 | 302 | 305 | 308 | 311 | 315 | 318 |
| 21 | 321 | 324 | 327 | 331 | 334 | 337 | 340 | 344 | 347 | 350 |
| 22 | 354 | 357 | 361 | 364 | 367 | 371 | 374 | 378 | 381 | 385 |
| 23 | 388 | 392 | 395 | 399 | 402 | 406 | 410 | 413 | 417 | 421 |
| 24 | 424 | 428 | 432 | 435 | 439 | 443 | 447 | 450 | 454 | 458 |
| 25 | 462 | 466 | 470 | 473 | 477 | 481 | 485 | 489 | 493 | 497 |
| 26 | 501 | 505 | 509 | 513 | 517 | 521 | 525 | 530 | 534 | 538 |
| 27 | 542 | 546 | 550 | 554 | 559 | 563 | 567 | 571 | 576 | 580 |
| 28 | 584 | 589 | 593 | 597 | 602 | 606 | 611 | 615 | 619 | 624 |
| 29 | 628 | 633 | 637 | 642 | 646 | 651 | 655 | 660 | 665 | 669 |
| 30 | 674 | 679 | 683 | 688 | 693 | 697 | 702 | 707 | 712 | 716 |

1/ Compiled by E. T. Hawes, Region 8, U. S. Forest Service

This table to be used for purposes of volume table construction only.

V = volume in board feet
D = diameter of log at small end, inside bark, in inches

## SCALE IN BOARD FEET OF 16-FOOT LOGS 1/

Scribner Decimal C Rule
Computed from Formula, curved and read to nearest board foot

Formula $V = 0.79D^2 - (2D + 4)$

| | Top diameter of log, inside both barks | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tenths of Inches | | | | | | | | | |
| Inches | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. |
| 6 | 12 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 20 |
| 7 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 28 | 30 |
| 8 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 40 | 41 |
| 9 | 42 | 43 | 44 | 46 | 47 | 48 | 50 | 51 | 52 | 54 |
| 10 | 55 | 56 | 58 | 59 | 61 | 62 | 64 | 65 | 67 | 68 |
| 11 | 70 | 71 | 73 | 74 | 76 | 77 | 79 | 81 | 82 | 84 |
| 12 | 86 | 87 | 89 | 91 | 93 | 94 | 96 | 98 | 100 | 102 |
| 13 | 104 | 105 | 107 | 109 | 111 | 113 | 115 | 117 | 119 | 121 |
| 14 | 123 | 125 | 127 | 129 | 131 | 133 | 135 | 137 | 139 | 142 |
| 15 | 144 | 146 | 148 | 150 | 153 | 155 | 157 | 159 | 162 | 164 |
| 16 | 166 | 169 | 171 | 173 | 176 | 178 | 180 | 183 | 185 | 188 |
| 17 | 190 | 193 | 195 | 198 | 200 | 203 | 206 | 208 | 211 | 213 |
| 18 | 216 | 219 | 221 | 224 | 227 | 229 | 232 | 235 | 238 | 240 |
| 19 | 243 | 246 | 249 | 252 | 255 | 257 | 260 | 263 | 266 | 269 |
| 20 | 272 | 275 | 278 | 281 | 284 | 287 | 290 | 293 | 296 | 299 |
| 21 | 302 | 306 | 309 | 312 | 315 | 318 | 321 | 325 | 328 | 331 |
| 22 | 334 | 338 | 341 | 344 | 348 | 351 | 354 | 358 | 361 | 364 |
| 23 | 368 | 371 | 375 | 378 | 382 | 385 | 389 | 392 | 396 | 399 |
| 24 | 403 | 407 | 410 | 414 | 418 | 421 | 425 | 429 | 432 | 436 |
| 25 | 440 | 444 | 447 | 451 | 455 | 459 | 463 | 466 | 470 | 474 |
| 26 | 478 | 482 | 486 | 490 | 494 | 498 | 502 | 506 | 510 | 514 |
| 27 | 518 | 522 | 526 | 530 | 534 | 538 | 543 | 547 | 551 | 555 |
| 28 | 559 | 564 | 568 | 572 | 576 | 581 | 585 | 589 | 594 | 598 |
| 29 | 602 | 607 | 611 | 616 | 620 | 624 | 629 | 633 | 638 | 642 |
| 30 | 647 | 652 | 656 | 661 | 665 | 670 | 675 | 679 | 684 | 688 |

1/ From "Timber Cruising" - James W. Girard and Suren R. Gevorkiantz

This table to be used for purposes of volume table construction only.

V = volume in board feet
D = diameter of log at small end, inside bark, in inches

SCALE IN BOARD FEET OF 16-FOOT LOGS 1/

Doyle Rule

Computed from Formula $V = \frac{(D-4)^2 \times L}{16}$

| | Top diameter of log, inside both barks | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tenths of Inches | | | | | | | | | |
| Inches | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd.ft. | Bd ft | Bd.ft. |
| 6 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 |
| 7 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 14 | 15 |
| 8 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 9 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 34 | 35 |
| 10 | 36 | 37 | 38 | 40 | 41 | 42 | 44 | 45 | 46 | 48 |
| 11 | 49 | 50 | 52 | 53 | 55 | 56 | 58 | 59 | 61 | 62 |
| 12 | 64 | 66 | 67 | 69 | 71 | 72 | 74 | 76 | 77 | 79 |
| 13 | 81 | 83 | 85 | 86 | 88 | 90 | 92 | 94 | 96 | 98 |
| 14 | 100 | 102 | 104 | 106 | 108 | 110 | 112 | 114 | 117 | 119 |
| 15 | 121 | 123 | 125 | 128 | 130 | 132 | 135 | 137 | 139 | 142 |
| 16 | 144 | 146 | 149 | 151 | 154 | 156 | 159 | 161 | 164 | 166 |
| 17 | 169 | 172 | 174 | 177 | 180 | 182 | 185 | 188 | 190 | 193 |
| 18 | 196 | 199 | 202 | 204 | 207 | 210 | 213 | 216 | 219 | 222 |
| 19 | 225 | 228 | 231 | 234 | 237 | 240 | 243 | 246 | 250 | 253 |
| 20 | 256 | 259 | 262 | 266 | 269 | 272 | 275 | 279 | 282 | 286 |
| 21 | 289 | 292 | 296 | 299 | 303 | 306 | 310 | 313 | 317 | 320 |
| 22 | 324 | 328 | 331 | 335 | 339 | 342 | 346 | 350 | 353 | 357 |
| 23 | 361 | 365 | 369 | 372 | 376 | 380 | 384 | 388 | 392 | 396 |
| 24 | 400 | 404 | 408 | 412 | 416 | 420 | 424 | 428 | 433 | 437 |
| 25 | 441 | 445 | 449 | 454 | 458 | 462 | 467 | 471 | 475 | 480 |
| 26 | 484 | 488 | 493 | 497 | 502 | 506 | 511 | 515 | 520 | 524 |
| 27 | 529 | 534 | 538 | 543 | 548 | 552 | 557 | 562 | 566 | 571 |
| 28 | 576 | 581 | 586 | 590 | 595 | 600 | 605 | 610 | 615 | 620 |
| 29 | 625 | 630 | 635 | 640 | 645 | 650 | 655 | 660 | 666 | 671 |
| 30 | 676 | 681 | 686 | 692 | 697 | 702 | 708 | 713 | 718 | 724 |

1/ Compiled by Southern Forest Experiment Station, 1934.

This table to be used for purposes of volume table construction only.

V = volume in board feet
D = diameter of log at small end, inside bark, in inches
L = length of log in feet

## INSTRUCTIONS FOR USING FORM CLASS CHART

The chart appearing on this page was designed to eliminate separate board foot volume tables for each form class. With its use, tree volumes can be obtained for trees having a form class higher or lower than those for which basic tables are presented. Within limits, an increase or decrease in Girard Form Class represents a uniform increase or decrease in the volume of the trees. Average changes in volume due to changes in form class are:

| Form Class Increase | Change in Volume | Form Class Decrease | Change in Volume |
|---|---|---|---|
| 1% | 3.0% | 1% | -2.8% |
| 2% | 6.1% | 2% | -5.8% |
| 3% | 9.4% | 3% | -8.7% |
| 4% | 12.8% | 4% | -11.7% |

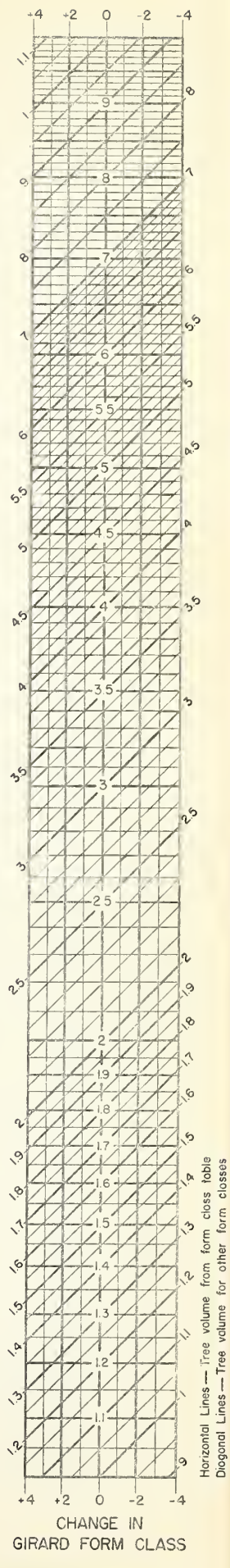
Thus a tree which has a Form Class 81 will have a volume 9.4% higher than a Form Class 78 tree of the same species or species group, diameter, and merchantable height. Assuming the volume of a Form Class 78 tree to be 500 board feet. the Form Class 81 volume can be determined directly from the chart as follows:

1. Locate the vertical line representing +3% change in form class.

2. Follow this line to its intersection with the horizontal line labelled "5", which in this case represents "500".

3. The diagonal line passing through this intersection is "548", which rounded out to nearest 5 feet is "550", the board foot volume desired.

Similarly, in determining the volume of a Form Class 82 tree, its volume would first be determined from the pertinent Form Class 85 volume table and reduced to Form Class 82 on the chart. If the Form Class 85 volume were 500 board feet, the Form Class 82 would be obtained by following the vertical line representing -3% change in form class. The diagonal passing through the intersection of this vertical line and the horizontal line representing 500 board feet is about 460 board feet.



TREE VOLUMES IN BOARD FEET, HARDWOODS

by D.B.H. and Number of Logs

Girard Form Class 78

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 12 | 56 | 74 | 92 | --- | --- | --- | --- |
| 14 | 78 | 105 | 130 | 150 | 170 | --- | --- |
| 16 | 106 | 145 | 180 | 210 | 235 | 255 | 275 |
| 18 | 136 | 185 | 235 | 270 | 310 | 335 | 360 |
| 20 | 171 | 235 | 295 | 345 | 395 | 430 | 465 |
| 22 | 211 | 295 | 370 | 430 | 490 | 540 | 580 |
| 24 | 251 | 350 | 440 | 520 | 595 | 655 | 705 |
| 26 | 299 | 420 | 530 | 625 | 710 | 780 | 840 |
| 28 | 347 | 490 | 615 | 735 | 835 | 920 | 990 |
| 30 | 402 | 570 | 715 | 850 | 970 | 1065 | 1155 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 12 | 47 | 61 | 75 | --- | --- | --- | --- |
| 14 | 68 | 90 | 110 | 130 | 145 | --- | --- |
| 16 | 94 | 130 | 160 | 185 | 205 | 225 | 240 |
| 18 | 123 | 170 | 210 | 245 | 275 | 300 | 320 |
| 20 | 157 | 215 | 270 | 315 | 360 | 395 | 415 |
| 22 | 195 | 270 | 340 | 400 | 450 | 495 | 525 |
| 24 | 235 | 330 | 410 | 485 | 550 | 605 | 645 |
| 26 | 281 | 395 | 495 | 585 | 665 | 730 | 780 |
| 28 | 328 | 460 | 580 | 685 | 780 | 860 | 925 |
| 30 | 382 | 535 | 680 | 805 | 915 | 1005 | 1080 |
| | | | Doyle Log Rule* | | | | |
| 12 | 29 | 36 | 43 | --- | --- | --- | --- |
| 14 | 48 | 60 | 75 | 85 | 90 | --- | --- |
| 16 | 72 | 95 | 115 | 130 | 145 | 155 | 165 |
| 18 | 100 | 135 | 165 | 190 | 210 | 225 | 240 |
| 20 | 135 | 185 | 225 | 260 | 290 | 315 | 330 |
| 22 | 174 | 240 | 295 | 340 | 385 | 415 | 440 |
| 24 | 216 | 295 | 370 | 430 | 485 | 530 | 565 |
| 26 | 266 | 370 | 460 | 540 | 605 | 660 | 705 |
| 28 | 317 | 440 | 550 | 650 | 735 | 805 | 855 |
| 30 | 376 | 525 | 660 | 775 | 880 | 960 | 1025 |

Gross board foot volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 8 inches inside bark. Compiled from taper tables. Mesavage, 1942.

* Note log rules pages 12, 13, 14.

TREE VOLUMES IN BOARD FEET, HARDWOODS

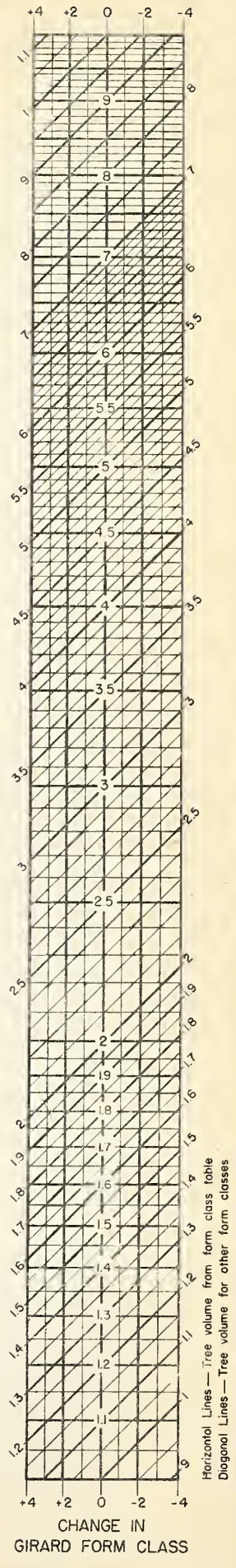
by D.B.H. and Number of Logs

Girard Form Class 85

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 12 | 68 | 91 | 115 | --- | --- | --- | --- |
| 14 | 95 | 130 | 165 | 195 | 215 | --- | --- |
| 16 | 127 | 175 | 220 | 260 | 290 | 320 | 345 |
| 18 | 164 | 225 | 285 | 340 | 380 | 425 | 455 |
| 20 | 205 | 285 | 360 | 425 | 485 | 535 | 575 |
| 22 | 251 | 355 | 445 | 525 | 600 | 665 | 715 |
| 24 | 302 | 425 | 535 | 640 | 730 | 805 | 870 |
| 26 | 357 | 500 | 640 | 760 | 865 | 960 | 1035 |
| 28 | 417 | 585 | 750 | 895 | 1020 | 1135 | 1225 |
| 30 | 481 | 680 | 865 | 1035 | 1185 | 1310 | 1420 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 12 | 58 | 77 | 95 | --- | --- | --- | --- |
| 14 | 84 | 110 | 140 | 165 | 185 | --- | --- |
| 16 | 115 | 155 | 195 | 225 | 255 | 285 | 305 |
| 18 | 150 | 205 | 260 | 305 | 345 | 380 | 405 |
| 20 | 190 | 265 | 330 | 395 | 445 | 490 | 525 |
| 22 | 235 | 335 | 415 | 490 | 555 | 610 | 655 |
| 24 | 284 | 400 | 505 | 600 | 680 | 755 | 810 |
| 26 | 338 | 475 | 600 | 715 | 815 | 900 | 970 |
| 28 | 396 | 560 | 710 | 850 | 965 | 1070 | 1155 |
| 30 | 459 | 650 | 825 | 985 | 1120 | 1240 | 1340 |
| | | | Doyle Log Rule* | | | | |
| 12 | 38 | 49 | 59 | --- | --- | --- | --- |
| 14 | 62 | 85 | 100 | 115 | 125 | --- | --- |
| 16 | 92 | 125 | 150 | 175 | 195 | 210 | 225 |
| 18 | 128 | 175 | 215 | 250 | 280 | 305 | 320 |
| 20 | 169 | 230 | 290 | 335 | 380 | 415 | 440 |
| 22 | 216 | 300 | 370 | 435 | 490 | 535 | 575 |
| 24 | 269 | 375 | 470 | 555 | 625 | 685 | 730 |
| 26 | 328 | 455 | 575 | 675 | 765 | 840 | 900 |
| 28 | 392 | 545 | 690 | 820 | 930 | 1025 | 1100 |
| 30 | 462 | 650 | 820 | 975 | 1105 | 1220 | 1305 |

Gross board foot volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 8 inches inside bark. Compiled from taper tables. Mesavage, 1942.

* Note log rules pages 12, 13, 14.



TREE VOLUMES IN BOARD FEET,
OLD-GROWTH WHITE PINE AND HEMLOCK

Girard Form Class 78

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 10 | 36 | 47 | 58 | --- | --- | --- | --- |
| 12 | 56 | 75 | 91 | 105 | 115 | --- | --- |
| 14 | 78 | 105 | 130 | 150 | 165 | --- | --- |
| 16 | 106 | 145 | 175 | 205 | 230 | 250 | 265 |
| 18 | 136 | 185 | 230 | 265 | 295 | 325 | 345 |
| 20 | 171 | 230 | 290 | 335 | 375 | 410 | 440 |
| 22 | 211 | 285 | 355 | 415 | 465 | 510 | 550 |
| 24 | 251 | 340 | 425 | 495 | 560 | 615 | 660 |
| 26 | 299 | 405 | 510 | 595 | 670 | 740 | 795 |
| 28 | 347 | 475 | 595 | 695 | 785 | 865 | 930 |
| 30 | 402 | 555 | 690 | 805 | 910 | 1000 | 1080 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 10 | 28 | 36 | 43 | 50 | --- | --- | --- |
| 12 | 47 | 62 | 74 | 85 | 90 | --- | --- |
| 14 | 68 | 91 | 110 | 125 | 135 | --- | --- |
| 16 | 94 | 125 | 155 | 175 | 195 | 215 | 225 |
| 18 | 123 | 165 | 205 | 235 | 260 | 290 | 305 |
| 20 | 157 | 210 | 260 | 305 | 340 | 370 | 395 |
| 22 | 195 | 265 | 330 | 380 | 425 | 465 | 500 |
| 24 | 235 | 320 | 395 | 460 | 515 | 565 | 605 |
| 26 | 281 | 385 | 475 | 555 | 620 | 685 | 735 |
| 28 | 328 | 450 | 555 | 655 | 735 | 810 | 865 |
| 30 | 382 | 525 | 650 | 765 | 860 | 940 | 1015 |
| | | | Doyle Log Rule* | | | | |
| 10 | 14 | 17 | 19 | --- | --- | --- | --- |
| 12 | 29 | 36 | 43 | 48 | 49 | --- | --- |
| 14 | 48 | 61 | 73 | 80 | 86 | --- | --- |
| 16 | 72 | 77 | 115 | 130 | 140 | 150 | 155 |
| 18 | 100 | 135 | 160 | 180 | 200 | 215 | 225 |
| 20 | 135 | 180 | 220 | 250 | 275 | 295 | 310 |
| 22 | 174 | 230 | 285 | 325 | 360 | 385 | 410 |
| 24 | 216 | 290 | 355 | 410 | 455 | 495 | 525 |
| 26 | 266 | 360 | 440 | 505 | 565 | 610 | 655 |
| 28 | 317 | 425 | 525 | 610 | 685 | 745 | 795 |
| 30 | 376 | 515 | 630 | 730 | 815 | 890 | 955 |

Gross board foot volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 6 inches inside bark. Compiled from taper tables. Mesavage, 1942.

* Note log rules pages 12, 13, 14.

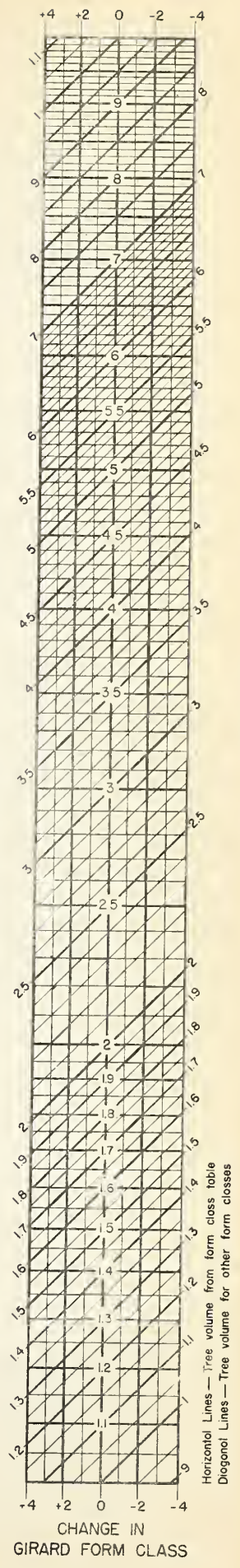
# TREE VOLUMES IN BOARD FEET, OLD-GROWTH WHITE PINE AND HEMLOCK

Girard Form Class 85

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 10 | 45 | 59 | 73 | --- | --- | --- | --- |
| 12 | 68 | 95 | 115 | 130 | 140 | --- | --- |
| 14 | 95 | 130 | 160 | 185 | 205 | --- | --- |
| 16 | 127 | 175 | 215 | 250 | 280 | 305 | 330 |
| 18 | 164 | 225 | 280 | 325 | 365 | 405 | 435 |
| 20 | 205 | 280 | 350 | 410 | 465 | 510 | 550 |
| 22 | 251 | 345 | 430 | 505 | 570 | 630 | 680 |
| 24 | 302 | 415 | 520 | 610 | 690 | 765 | 825 |
| 26 | 357 | 490 | 615 | 725 | 820 | 910 | 980 |
| 28 | 417 | 575 | 720 | 850 | 965 | 1070 | 1160 |
| 30 | 481 | 665 | 835 | 990 | 1120 | 1240 | 1340 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 10 | 36 | 47 | 57 | --- | --- | --- | --- |
| 12 | 58 | 76 | 94 | 105 | 115 | --- | --- |
| 14 | 84 | 110 | 140 | 160 | 175 | --- | --- |
| 16 | 115 | 155 | 190 | 220 | 250 | 270 | 290 |
| 18 | 150 | 200 | 255 | 295 | 330 | 360 | 390 |
| 20 | 190 | 255 | 325 | 375 | 425 | 460 | 500 |
| 22 | 235 | 320 | 400 | 465 | 530 | 575 | 625 |
| 24 | 284 | 385 | 485 | 565 | 645 | 705 | 765 |
| 26 | 338 | 460 | 580 | 675 | 770 | 840 | 915 |
| 28 | 396 | 540 | 685 | 800 | 915 | 1000 | 1085 |
| 30 | 459 | 625 | 795 | 925 | 1060 | 1160 | 1265 |
| | | | Doyle Log Rule* | | | | |
| 10 | 20 | 25 | 29 | --- | --- | --- | --- |
| 12 | 38 | 48 | 58 | 65 | 69 | --- | --- |
| 14 | 62 | 84 | 100 | 110 | 120 | --- | --- |
| 16 | 92 | 125 | 150 | 170 | 185 | 200 | 210 |
| 18 | 128 | 170 | 210 | 240 | 265 | 285 | 305 |
| 20 | 169 | 225 | 280 | 325 | 360 | 390 | 415 |
| 22 | 216 | 290 | 360 | 420 | 465 | 505 | 540 |
| 24 | 269 | 360 | 450 | 525 | 585 | 640 | 685 |
| 26 | 328 | 450 | 555 | 645 | 720 | 785 | 845 |
| 28 | 392 | 540 | 665 | 775 | 875 | 955 | 1030 |
| 30 | 462 | 635 | 785 | 920 | 1035 | 1135 | 1225 |

Gross board foot volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 6 inches inside bark. Compiled from taper tables. Mesavage, 1942.

* Note log rules pages 12, 13, 14.



TREE VOLUMES IN BOARD FEET,
SECOND-GROWTH WHITE PINE AND HEMLOCK

Girard Form Class 78

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 10 | 36 | 48 | 57 | --- | --- | --- | --- |
| 12 | 56 | 75 | 90 | 100 | 110 | --- | --- |
| 14 | 78 | 105 | 130 | 145 | 160 | --- | --- |
| 16 | 106 | 140 | 170 | 200 | 225 | 240 | 255 |
| 18 | 136 | 180 | 225 | 255 | 280 | 305 | 330 |
| 20 | 171 | 225 | 285 | 320 | 355 | 390 | 415 |
| 22 | 211 | 280 | 340 | 395 | 440 | 485 | 520 |
| 24 | 251 | 335 | 410 | 470 | 525 | 580 | 620 |
| 26 | 299 | 400 | 490 | 565 | 630 | 695 | 750 |
| 28 | 347 | 470 | 575 | 665 | 740 | 815 | 875 |
| 30 | 402 | 550 | 670 | 770 | 855 | 940 | 1010 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 10 | 28 | 35 | 42 | --- | --- | --- | --- |
| 12 | 47 | 59 | 74 | 80 | 86 | --- | --- |
| 14 | 68 | 90 | 110 | 120 | 125 | --- | --- |
| 16 | 94 | 125 | 150 | 170 | 185 | 200 | 210 |
| 18 | 123 | 165 | 200 | 225 | 245 | 275 | 290 |
| 20 | 157 | 205 | 250 | 290 | 320 | 350 | 375 |
| 22 | 195 | 260 | 315 | 365 | 405 | 445 | 475 |
| 24 | 235 | 310 | 380 | 435 | 480 | 530 | 565 |
| 26 | 281 | 370 | 450 | 520 | 580 | 635 | 690 |
| 28 | 328 | 435 | 530 | 615 | 690 | 755 | 810 |
| 30 | 382 | 510 | 620 | 720 | 810 | 885 | 955 |
| | | | Doyle Log Rule* | | | | |
| 10 | 14 | 16 | 18 | --- | --- | --- | --- |
| 12 | 29 | 36 | 42 | --- | --- | --- | --- |
| 14 | 48 | 60 | 71 | 78 | 82 | --- | --- |
| 16 | 72 | 95 | 115 | 125 | 135 | 140 | 145 |
| 18 | 100 | 130 | 155 | 175 | 190 | 205 | 210 |
| 20 | 135 | 175 | 210 | 240 | 260 | 280 | 290 |
| 22 | 174 | 225 | 270 | 310 | 335 | 365 | 380 |
| 24 | 216 | 285 | 340 | 390 | 425 | 465 | 490 |
| 26 | 266 | 350 | 420 | 475 | 530 | 575 | 610 |
| 28 | 317 | 415 | 500 | 575 | 640 | 695 | 740 |
| 30 | 376 | 495 | 600 | 690 | 760 | 830 | 890 |

Gross board foot preliminary table volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 6 inches inside bark. Mesavage, 1942.

* Note log rules pages 12, 13, 14.

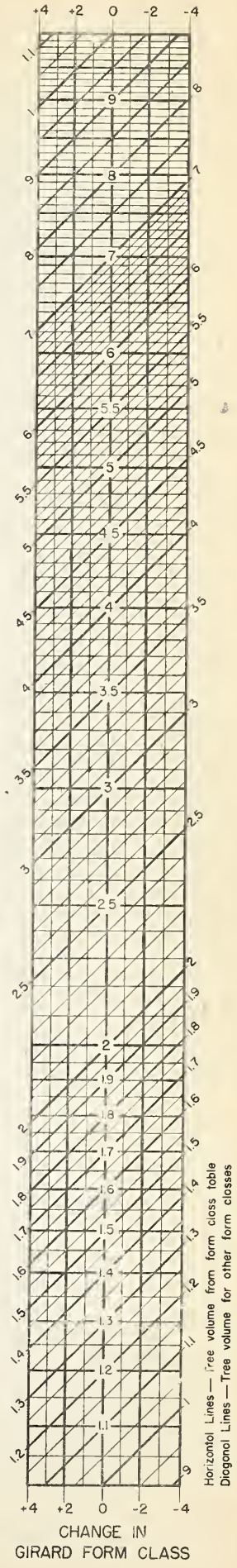
# TREE VOLUMES IN BOARD FEET, SECOND-GROWTH WHITE PINE AND HEMLOCK

## Girard Form Class 85

| D.B.H. | Number of 16-foot logs | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1½ | 2 | 2½ | 3 | 3½ | 4 |
| Inches | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. | Bd.Ft. |
| | | | International ¼ Log Rule* | | | | |
| 10 | 45 | 60 | 71 | --- | --- | --- | --- |
| 12 | 68 | 93 | 115 | --- | --- | --- | --- |
| 14 | 95 | 125 | 155 | 180 | 195 | --- | --- |
| 16 | 127 | 170 | 210 | 240 | 270 | 295 | 315 |
| 18 | 164 | 220 | 275 | 315 | 350 | 390 | 415 |
| 20 | 205 | 275 | 340 | 395 | 445 | 490 | 525 |
| 22 | 251 | 335 | 415 | 480 | 540 | 595 | 645 |
| 24 | 302 | 405 | 505 | 580 | 650 | 720 | 780 |
| 26 | 357 | 480 | 590 | 690 | 780 | 860 | 930 |
| 28 | 417 | 560 | 690 | 810 | 915 | 1015 | 1100 |
| 30 | 481 | 655 | 805 | 945 | 1060 | 1170 | 1265 |
| | | | Scribner Decimal C Log Rule* | | | | |
| 10 | 36 | 46 | 52 | --- | --- | --- | --- |
| 12 | 58 | 78 | 92 | 105 | 110 | --- | --- |
| 14 | 84 | 110 | 140 | 155 | 165 | --- | --- |
| 16 | 115 | 155 | 185 | 220 | 245 | 265 | 275 |
| 18 | 150 | 200 | 250 | 285 | 315 | 350 | 375 |
| 20 | 190 | 255 | 315 | 360 | 405 | 445 | 475 |
| 22 | 235 | 315 | 385 | 450 | 505 | 555 | 595 |
| 24 | 284 | 380 | 465 | 540 | 610 | 665 | 720 |
| 26 | 338 | 455 | 560 | 650 | 730 | 805 | 865 |
| 28 | 396 | 540 | 660 | 770 | 865 | 950 | 1020 |
| 30 | 459 | 625 | 765 | 895 | 1005 | 1105 | 1195 |
| | | | Doyle Log Rule* | | | | |
| 10 | 20 | --- | --- | --- | --- | --- | --- |
| 12 | 38 | 49 | 57 | --- | --- | --- | --- |
| 14 | 62 | 83 | 100 | 110 | 115 | --- | --- |
| 16 | 92 | 120 | 150 | 165 | 175 | 190 | 195 |
| 18 | 128 | 165 | 205 | 235 | 250 | 275 | 290 |
| 20 | 169 | 220 | 270 | 305 | 340 | 370 | 390 |
| 22 | 216 | 285 | 350 | 400 | 440 | 475 | 505 |
| 24 | 269 | 355 | 430 | 495 | 550 | 600 | 645 |
| 26 | 328 | 435 | 535 | 615 | 680 | 745 | 795 |
| 28 | 392 | 525 | 640 | 735 | 825 | 900 | 965 |
| 30 | 462 | 615 | 750 | 865 | 970 | 1065 | 1150 |

Gross board foot preliminary table volume in 16-foot logs above stump to point where the stem divides into large branches. Top diameter variable, not less than 6 inches inside bark. Mesavage, 1942.

*Note log rules pages 12, 13, 14.



## CUBIC FOOT VOLUME TABLES

Cubic foot volume tables are generally useful in determining the amount of wood in a tree which is suitable for mine props or other round material. The original volume determinations are made in terms of cubic feet, and are then converted to weight, or cords, by the use of converting factors.1/ Such products need not have the size or quality necessary in saw timber, and for this reason, tree utilization can be more complete. If the taper of the merchantable portion of such trees can be considered to approach that of a frustum of a cone, (it more nearly approaches that of a frustum of a paraboloid), a simple means of determining the cubic foot contents of a tree is to multiply the length of the merchantable portion of the tree by the cross-sectional area at a point half way between the stump and the merchantable top. This is known as Huber's Formula ($V = L \times A_{\frac{1}{2}}$).

By the use of this formula, an approximate cubic foot volume table can be prepared by determining the average merchantable height and average middle diameter of trees for each d.b.h. class of a species. Variation in taper is reflected in the middle diameter of the merchantable portion of the tree. The percentage relationship of this diameter, when measured outside bark, to the diameter at breast high is known as the Girard Form Point, which should not be confused with the Girard Form Class. See illustration, page 2.

The form point of individual trees will vary widely with the diameter breast high and the top diameter of the merchantable portion of the tree. On the average, however, the form point is smaller among the larger trees. According to James W. Girard, the form points of trees in the Anthracite Region are for all practical purposes similar to those of Southern pines, which he found to vary about as follows:

| | High Form | | Average Form | | Low Form | |
|---|---|---|---|---|---|---|
| D.B.H. | Form Point | Middle Diameter | Form Point | Middle Diameter | Form Point | Middle Diameter |
| 6 | 85 | 5.1 | 83 | 5.0 | 81 | 4.95 |
| 8 | 83 | 6.7 | 81 | 6.5 | 79 | 6.3 |
| 10 | 81 | 8.1 | 79 | 7.9 | 77 | 7.7 |
| 12 | 79 | 9.5 | 77 | 9.2 | 75 | 9.0 |
| 14 | 77 | 10.8 | 75 | 10.5 | 73 | 10.2 |
| 16 | 75 | 12.0 | 73 | 11.7 | 71 | 11.4 |
| 18 | 73 | 13.1 | 71 | 12.8 | 69 | 12.4 |

1/ A number of converting factors useful for the measurement of wood products in the Anthracite Region have been prepared by the Experiment Station and will be published later, but are now available on request.

These relationships are based on a variable merchantable cordwood top diameter which in no case is less than 4 inches, outside bark. The cubic tables on pages 24 to 26 have been compiled with these form point percentages as a base. In applying them, it is necessary only to determine which of the three tables will most nearly fit each species in the area being cruised. Actual measurements of form point can be made either on felled trees or on windfalls, but, like form class, the form point of a tree can be estimated ocularly after some practice. The ocular method is preferable because of its speed and flexibility in the choice of sample trees.

When a high degree of accuracy is not essential, use of the tables based on "average" form point will be found to give reasonable approximation for all species in this region.

TREE VOLUMES IN CUBIC FEET, INCLUDING BARK, ALL SPECIES

by D.B.H. and Merchantable Length

TREES OF ABOVE-AVERAGE FORM

| Form Point | D.B.H. | Merchantable length of stem in feet | | | | | | | | | | | | | | Middle Diameter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | Inches |
| | | Cubic Feet | | | | | | | | | | | | | | |
| 85 | 6 | 1.7 | 2.3 | 2.8 | 3.4 | 4.0 | 4.5 | 5.1 | | | | | | | | 5.1 |
| 83 | 8 | | 3.9 | 4.9 | 5.9 | 6.9 | 7.8 | 8.8 | 9.8 | 10.8 | 11.8 | | | | | 6.7 |
| 81 | 10 | | | 7.2 | 8.6 | 10.0 | 11.5 | 12.9 | 14.3 | 15.8 | 17.2 | 18.6 | 20.0 | 21.5 | | 8.1 |
| 79 | 12 | | | | 11.8 | 13.8 | 15.7 | 17.7 | 19.7 | 21.7 | 23.6 | 25.6 | 27.6 | 29.5 | 31.5 | 9.5 |
| 77 | 14 | | | | | 17.8 | 20.4 | 22.9 | 25.4 | 28.0 | 30.5 | 33.1 | 35.6 | 38.2 | 40.7 | 10.8 |
| 75 | 16 | | | | | | 25.1 | 28.3 | 31.4 | 34.5 | 37.7 | 40.8 | 44.0 | 47.1 | 50.2 | 12.0 |

Top utilization assumed to average approximately 5 inches outside bark, varying from 3.8 inches to 6 inches.

James W. Girard

Compiled by Southern Forest Experiment Station

TREE VOLUMES IN CUBIC FEET, INCLUDING BARK, ALL SPECIES

by D.B.H. and Merchantable Length

TREES OF AVERAGE FORM

| Form Point | D.B.H. | Merchantable length of stem in feet | | | | | | | | | | | | | | Middle Diameter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | Inches |
| | | Cubic Feet | | | | | | | | | | | | | | |
| 83 | 6 | 1.6 | 2.1 | 2.7 | 3.2 | 3.8 | 4.3 | 4.8 | | | | | | | | 4.95 |
| 81 | 8 | | 3.7 | 4.6 | 5.5 | 6.4 | 7.4 | 8.3 | 9.2 | 10.1 | 11.0 | | | | | 6.50 |
| 79 | 10 | | | 6.8 | 8.2 | 9.6 | 10.9 | 12.3 | 13.7 | 15.0 | 16.4 | 17.8 | 19.2 | 20.5 | | 7.92 |
| 77 | 12 | | | | 11.2 | 13.0 | 14.9 | 16.7 | 18.6 | 20.5 | 22.3 | 24.2 | 26.0 | 27.9 | 29.8 | 9.23 |
| 75 | 14 | | | | | 16.9 | 19.3 | 21.7 | 24.1 | 26.5 | 28.9 | 31.3 | 33.7 | 36.1 | 38.5 | 10.51 |
| 73 | 16 | | | | | | 23.9 | 26.9 | 29.9 | 32.9 | 35.9 | 38.9 | 41.9 | 44.9 | 47.9 | 11.71 |

Top utilization assumed to average approximately 5 inches outside bark, varying from 3.8 inches to 6 inches.

James W. Girard

Compiled by Southern Forest Experiment Station

TREE VOLUMES IN CUBIC FEET, INCLUDING BARK, ALL SPECIES

by D.B.H. and Merchantable Length

TREES OF BELOW-AVERAGE FORM

| Form Point | D.B.H. | Merchantable length of stem in feet | | | | | | | | | | | | | | Middle Diameter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | Inches |
| | | Cubic Feet | | | | | | | | | | | | | | |
| 81 | 6 | 1.6 | 2.1 | 2.6 | 3.1 | 3.7 | 4.2 | 4.7 | | | | | | | | 4.9 |
| 79 | 8 | | 3.5 | 4.3 | 5.2 | 6.0 | 6.9 | 7.8 | 8.6 | 9.5 | 10.4 | | | | | 6.3 |
| 77 | 10 | | | 6.5 | 7.8 | 9.0 | 10.3 | 11.6 | 12.9 | 14.2 | 15.5 | 16.8 | 18.1 | 19.4 | | 7.7 |
| 75 | 12 | | | | 10.6 | 12.4 | 14.1 | 15.9 | 17.7 | 19.4 | 21.2 | 23.0 | 24.8 | 26.5 | 28.3 | 9.0 |
| 73 | 14 | | | | | 15.9 | 18.1 | 20.4 | 22.7 | 24.9 | 27.2 | 29.5 | 31.8 | 34.0 | 36.3 | 10.2 |
| 71 | 16 | | | | | | 22.7 | 25.5 | 28.4 | 31.2 | 34.0 | 36.9 | 39.7 | 42.5 | 45.4 | 11.4 |

Top utilization assumed to average approximately 5 inches outside bark, varying from 3.8 inches to 6 inches.

James W. Girard

Compiled by Southern Forest Experiment Station

## AREA OF CIRCLES IN SQUARE FEET (BASAL AREA TABLE) 1/

| Diameter | Diameter - tenths of inches | | | | | | | | | | Diameter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | |
| | Area - square feet | | | | | | | | | | |
| Inches | | | | | | | | | | | Inches |
| | | | | | | 0.001 | 0.002 | 0.003 | 0.003 | 0.004 | |
| 1 | 0.005 | 0.007 | 0.008 | 0.009 | 0.011 | 0.012 | 0.014 | 0.016 | 0.018 | 0.020 | 1 |
| 2 | .022 | .024 | .026 | .029 | .031 | .034 | .037 | .040 | .043 | .046 | 2 |
| 3 | .049 | .052 | .056 | .059 | .063 | .067 | .071 | .075 | .079 | .083 | 3 |
| 4 | .087 | .092 | .096 | .101 | .106 | .110 | .115 | .120 | .126 | .131 | 4 |
| 5 | .136 | .142 | .147 | .153 | .159 | .165 | .171 | .177 | .183 | .190 | 5 |
| 6 | .196 | .203 | .210 | .216 | .223 | .230 | .238 | .245 | .252 | .260 | 6 |
| 7 | .267 | .275 | .283 | .291 | .299 | .307 | .315 | .323 | .332 | .340 | 7 |
| 8 | .349 | .358 | .367 | .376 | .385 | .394 | .403 | .413 | .422 | .432 | 8 |
| 9 | .442 | .452 | .462 | .472 | .482 | .492 | .503 | .513 | .524 | .535 | 9 |
| 10 | .545 | .556 | .567 | .579 | .590 | .601 | .613 | .624 | .636 | .648 | 10 |
| 11 | .660 | .672 | .684 | .696 | .709 | .721 | .734 | .747 | .759 | .772 | 11 |
| 12 | .785 | .799 | .812 | .825 | .839 | .852 | .866 | .880 | .894 | .908 | 12 |
| 13 | .922 | .936 | .950 | .965 | .979 | .994 | 1.009 | 1.024 | 1.039 | 1.054 | 13 |
| 14 | 1.069 | 1.084 | 1.100 | 1.115 | 1.131 | 1.147 | 1.163 | 1.179 | 1.195 | 1.211 | 14 |
| 15 | 1.227 | 1.244 | 1.260 | 1.277 | 1.294 | 1.310 | 1.327 | 1.344 | 1.362 | 1.379 | 15 |
| 16 | 1.396 | 1.414 | 1.431 | 1.449 | 1.467 | 1.485 | 1.503 | 1.521 | 1.539 | 1.558 | 16 |
| 17 | 1.576 | 1.595 | 1.614 | 1.632 | 1.651 | 1.670 | 1.689 | 1.709 | 1.728 | 1.748 | 17 |
| 18 | 1.767 | 1.787 | 1.807 | 1.827 | 1.847 | 1.867 | 1.887 | 1.907 | 1.928 | 1.948 | 18 |
| 19 | 1.969 | 1.990 | 2.011 | 2.032 | 2.053 | 2.074 | 2.095 | 2.117 | 2.138 | 2.160 | 19 |
| 20 | 2.182 | 2.204 | 2.226 | 2.248 | 2.270 | 2.292 | 2.315 | 2.337 | 2.360 | 2.382 | 20 |
| 21 | 2.405 | 2.428 | 2.451 | 2.474 | 2.498 | 2.521 | 2.545 | 2.568 | 2.592 | 2.616 | 21 |
| 22 | 2.640 | 2.664 | 2.688 | 2.712 | 2.737 | 2.761 | 2.786 | 2.810 | 2.835 | 2.860 | 22 |
| 23 | 2.885 | 2.910 | 2.936 | 2.961 | 2.986 | 3.012 | 3.038 | 3.064 | 3.089 | 3.115 | 23 |
| 24 | 3.142 | 3.168 | 3.194 | 3.221 | 3.247 | 3.274 | 3.301 | 3.328 | 3.355 | 3.382 | 24 |

| Diameter | Area | Diameter | Area | Diameter | Area | Diameter | Area | Diameter | Area |
|---|---|---|---|---|---|---|---|---|---|
| Inches | Sq.Ft. | Inches | Sq.Ft. | Inches | Sq.Ft. | Inches | Sq.Ft. | Inches | Sq.Ft. |
| 25 | 3.409 | 32 | 5.585 | 39 | 8.296 | 46 | 11.541 | 53 | 15.321 |
| 26 | 3.687 | 33 | 5.940 | 40 | 8.727 | 47 | 12.048 | 54 | 15.904 |
| 27 | 3.976 | 34 | 6.305 | 41 | 9.168 | 48 | 12.566 | 55 | 16.499 |
| 28 | 4.276 | 35 | 6.681 | 42 | 9.621 | 49 | 13.095 | 56 | 17.104 |
| 29 | 4.587 | 36 | 7.069 | 43 | 10.085 | 50 | 13.635 | 57 | 17.721 |
| 30 | 4.909 | 37 | 7.467 | 44 | 10.559 | 51 | 14.186 | 58 | 18.348 |
| 31 | 5.241 | 38 | 7.876 | 45 | 11.045 | 52 | 14.748 | 59 | 18.986 |

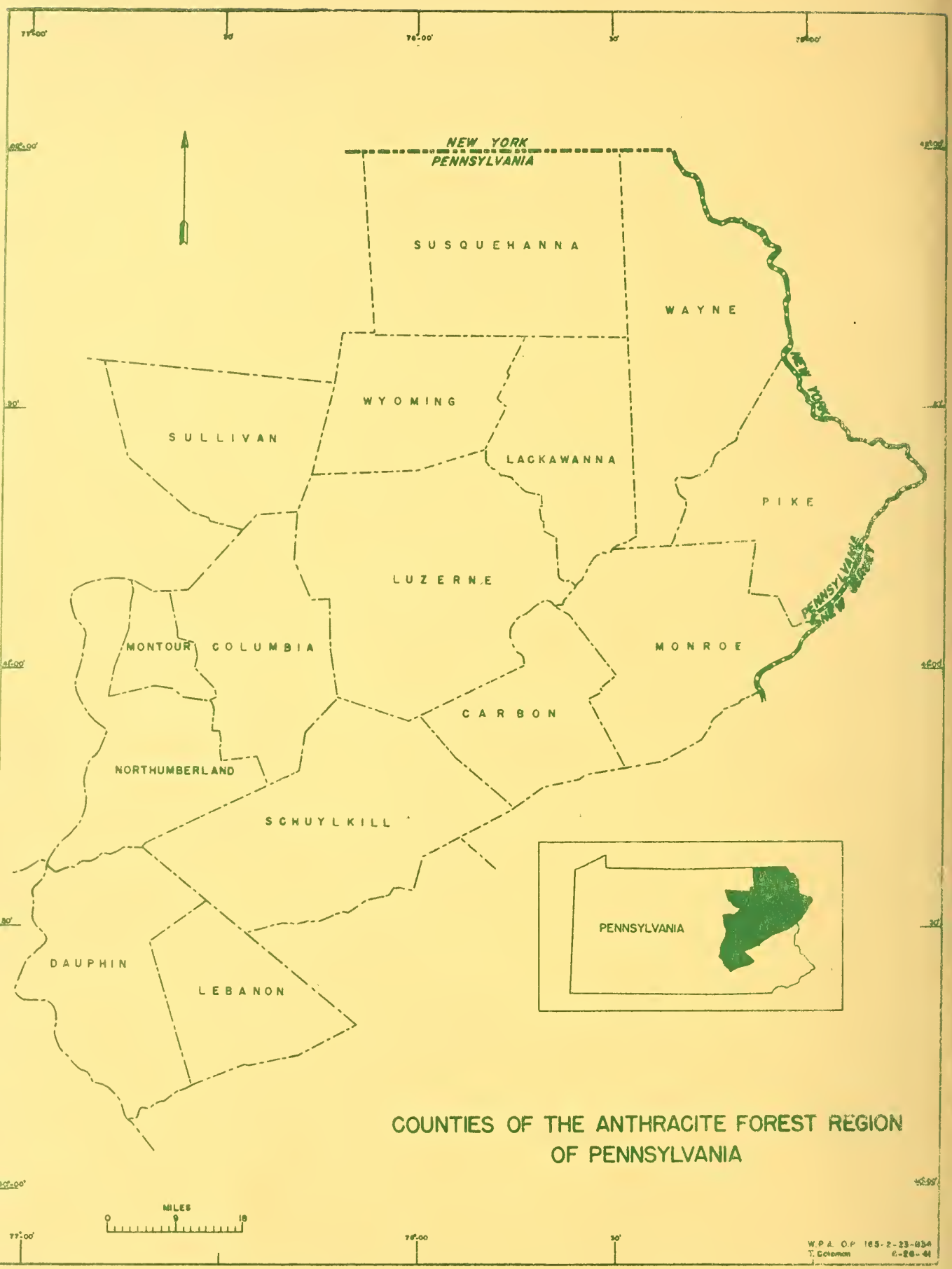
1/ Revised and checked by Southern Forest Experiment Station with Basal Area Table, "Forest Mensuration", by H. H. Chapman.

# ALLEGHENY FOREST RESEARCH ADVISORY COUNCIL

| | |
|---|---|
| Francis R. Cope, Jr., Chairman | Proprietor, Woodbourne Dairy and Orchards, Dimock, Pennsylvania |
| J. R. Schramm, Vice-Chairman | Head, Department of Botany, University of Pennsylvania, Philadelphia, Pa. |
| Charles E. Baer | Deputy Secretary, Department of Forests and Waters, Harrisburg, Pa. |
| Victor Beede | Head, Department of Forestry, Pennsylvania State College, State College, Pa. |
| F. W. Besley | State Forester, Baltimore, Maryland |
| E. O. Ehrhart | Forester, Armstrong Forest Company, Johnsonburg, Pa |
| S. W. Fletcher | Director, Pennsylvania Agricultural Experiment Station, State College, Pa. |
| O. E. Jennings | Head, Department of Biology, University of Pittsburgh, Pittsburgh, Pa. |
| Paul Koenig | Vice-President and General Manager, T. H. Glatfelter Company, Spring Grove, Pa. |
| Louis Krumenacker | Manager, Krumenacker Lumber Company, Stoystown, Pa |
| D. C. Lefevre | Superintendent of Lands, Clearfield Bituminous Coal Company, Indiana, Pa. |
| William H. Martin | Director, New Jersey Agricultural Experiment Station, New Brunswick, N. J. |
| H. Gleason Mattoon | Secretary, Pennsylvania Forestry Association, Philadelphia, Pa. |
| Stanley Mesavage | Forester, Wyoming Valley Chamber of Commerce, Wilkes-Barre, Pa. |
| David W. Robinson | Executive Secretary, Interstate Commission on the Delaware River Basin, Philadelphia, Pa |
| M. B. Saul | Counsel, The Morris Foundation, Morris Arboretum, Philadelphia, Pa. |
| George L. Schuster | Director, Agricultural Experiment Station, Newark, Delaware |
| J. Spencer Smith | President, New Jersey Board of Commerce and Navigation, Tenafly, New Jersey |
| W. S. Taber | State Forester, Dover, Delaware |
| Ezra B. Whitman | Engineer, Whitman, Requardt and Smith, Baltimore, Maryland |
| C. P. Wilber | State Forester, Department of Conservation and Development, Trenton, N. J. |
| Abel Wolman | Professor Sanitary Engineering, Johns Hopkins University, Baltimore, Md. |

---

| | |
|---|---|
| Hardy L. Shirley, Secretary | Director, Allegheny Forest Experiment Station, Philadelphia, Pa. |




# COUNTIES OF THE ANTHRACITE FOREST REGION OF PENNSYLVANIA

W.P.A. O.P. 165-2-23-834
T. Coleman 6-26-41