

# A Key for the Forest Service Hardwood Tree Grades<sup>1</sup>

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*ABSTRACT. A dichotomous key organizes the USDA Forest Service hardwood tree grade specifications into a stepwise procedure for those learning to grade hardwood sawtimber. The key addresses the major grade factors, tree size, surface characteristics, and allowable cull deductions in a series of paired choices that lead the user to a decision regarding tree grade. Subtle grading rules, previously presented as footnotes to the major specifications, are included in the key. It simplifies the process so that the beginner can learn the system quickly, without detailed instruction from experienced tree graders.*

USDA Forest Service hardwood tree grades are used to predict factory lumber grade yields for many commercial hardwood species. The grading system makes it possible to calculate the dollar value of standing timber from the grades and prices of lumber that can be sawn from individual trees. Once familiar with the system, timber graders can provide consistent estimates of timber quality and stand value. The key presented in this paper serves as a teaching aid for those learning to grade hardwood trees. It provides a stepwise procedure for determining the grades of individual trees and organizes the grade specifications so that the beginner is not overwhelmed with choices (Table 1).

Many people find it difficult to learn the tree grading system using existing references, especially when experienced graders are not available to provide detailed instruction. The key overcomes three major problems beginners often encounter when trying to learn tree grading from earlier presentations. First, the key contains the

subtle grade specifications previously presented as footnotes to the major grade factors. This improvement makes the beginner aware of the fine points without disrupting the step-by-step process of grading. Second, the key addresses the grade factors in a sequence that reduces confusion and improves comprehension. Third, the key can be used to learn how to grade hardwood trees without detailed instruction. Field trials have indicated that beginners can use the key to determine the correct tree grade, while those using other references require outside help. This feature of the key allows the beginner to be competent without the delays and costs associated with more formal training. As a result, tree grades can be used to assess tree quality and value in a shorter period of time.

## BACKGROUND

The most difficult part of tree grading is recognizing defect indicators on the surface of the tree. Photographic guides are available for some commercial species. Estimating interior cull deductions is also difficult for the beginner. References are available for making adjustments for sweep, crook, and rot. In addition to learning the grade specifications, the trainee should use and review these references to maintain competence in all aspects of grading and scaling.

## TREE GRADE SPECIFICATIONS

Tree grade is generally determined by characteristics of the best 12-ft grading section in the butt 16-ft log. A 14- or 16-ft grading section may be used if it results in a better grade than the 12-ft section. Field experience with Forest Service tree grades has shown that tree grade is usually defined by characteristics of the bottom 12-ft section or the top 12-ft section in the butt log. Occasionally, however, using a 14- or 16-ft grading section results in a higher grade. A simple rule is to use the grading section that results in the highest tree grade.

Forest Service tree grade specifications involve three major characteristics of the grading section:

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<sup>1</sup> Northern Journal of Applied Forestry. March 1986. 3:19-22.

Table 1. Key for hardwood tree grades based on the second worst face of the best 12-foot section of the butt 16-ft log.

1. Minimum dbh of 15.6 inches (14.6 inches for basswood and ash) .....	2
1. Minimum dbh of 12.6 inches .....	10
1. Minimum dbh of 9.6 inches (If dbh is less than 9.6 inches stop here; tree is below grade) .....	18
2. Clear cuttings total at least 10 feet in 1 or 2 cuttings – each cutting at least 7 feet long .....	5
2. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 7 feet long .....	3
2. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 7 feet long (due to rot only) .....	15
3. Clear cuttings total at least 10 feet in 1 or 2 cuttings – each cutting at least 5 feet long .....	6
3. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 5 feet long .....	4
3. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 5 feet long (due to rot only) .....	15
4. Clear cuttings total at least 10 feet in 1 or 2 cuttings – each cutting at least 3 feet long .....	7
4. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 3 feet long .....	11
4. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 3 feet long (due to rot only) .....	15
5. Dib at top of grading section at least 12.6 inches (11.6 inches for basswood and ash) .....	8
5. Dib at top of grading section less than 12.6 inches (11.6 inches for basswood and ash) .....	17
6. Dib at top of grading section at least 15.6 inches .....	8
6. Dib at top of grading section less than 15.6 inches .....	17
7. Dib at top of grading section at least 19.6 inches .....	8
7. Dib at top of grading section less than 19.6 inches .....	17
8. Total cull deduction, including sweep, crook, and rot does not exceed 9% .....	<b>GRADE 1</b>
8. Total cull deduction exceeds 9% .....	9
9. Cull deduction does not exceed 15% for sweep and crook, and total cull deduction does not exceed 40% .....	<b>GRADE 2</b>
9. Cull deduction for sweep and crook exceeds 15% or total cull deduction exceeds 40% .....	20
10. Clear cuttings total at least 10 feet in 1 or 2 cuttings – each cutting at least 7 feet long .....	17
10. Clear cuttings total less than 10 feet in 1 or 2 cuttings – each cutting at least 7 feet long .....	11
11. Clear cuttings total at least 8 feet in 1 or 2 cuttings – each cutting at least 3 feet long .....	13
11. Clear cuttings total less than 8 feet in 1 or 2 cuttings – each cutting at least 3 feet long .....	12
12. Clear cuttings total at least 8 feet in 1, 2, or 3 cuttings – each cutting at least 3 feet long .....	14
12. Clear cuttings total less than 8 feet in 1, 2, or 3 cuttings – each cutting at least 3 feet long .....	18
13. Dib at top of grading section at least 10.6 inches .....	17
13. Dib at top of grading section less than 10.6 inches .....	20
14. Dib at top of grading section at least 11.6 inches .....	17
14. Dib at top of grading section less than 11.6 inches .....	20
15. Clear cuttings total at least 8 feet in 1, 2, or 3 cuttings – each cutting at least 3 feet long .....	16
15. Clear cuttings total less than 8 feet in 1, 2, or 3 cuttings – each cutting at least 3 feet long .....	18
16. Cull deduction for rot does not exceed 40% .....	<b>GRADE 2</b>
16. Cull deduction for rot exceeds 40% .....	20
17. Total cull deduction, including sweep, crook, and rot does not exceed 9% .....	<b>GRADE 2</b>
17. Total cull deduction exceeds 9% .....	20
18. Clear cuttings total at least 6 feet, all cuttings at least 2 feet long .....	19
18. Clear cuttings total less than 6 feet, all cuttings at least 2 feet long .....	<b>BELOW GRADE</b>
19. Dib at top of grading section at least 7.6 inches .....	20
19. Dib at top of grading section less than 7.6 inches .....	<b>BELOW GRADE</b>
20. Total cull deduction, including sweep, crook, and rot does not exceed 50% .....	<b>GRADE 3</b>
20. Total cull deduction exceeds 50% .....	<b>BELOW GRADE</b>

- (1) size -- diameter breast height (dbh) and diameter inside bark (dib) at the top of the grading section,
- (2) clear cuttings -- the total length of allowable clear cuttings on the second worst face of the grading section, and
- (3) cull deductions -- the percentage of volume deducted for sweep and crook and the percentage of volume deducted for sweep, crook, and rot combined.

As a tree is graded, each of these characteristics is examined to determine whether the tree qualifies for a particular grade. The key addresses each characteristic in a logical, stepwise procedure. In effect, the key systematically tests each characteristic until the tree is graded.

#### Size

Both dbh and dib at the top of the grading section must satisfy the minimum requirements of the assigned tree grade. The first step in determining tree grade is to measure dbh to the nearest inch. For grades 1, 2, and 3 the minimum dbh requirements are 16, 13, and 10 in, respectively. Dib at the top of the grading section, however, is the more important specification for determining grade. This is because dib and another major tree grading characteristic, clear cuttings, are interrelated. Dib at the top of the grading section defines the minimum length or the maximum number of clear cuttings allowed in grades 1 and 2.

Since dib at the top of the grading section cannot be measured directly, it must be estimated from dbh and an assigned form class. Recall that the top of the grading section can be 12, 14, or 16 ft above stump height. For a given dbh, dib will differ at 12, 14, and 16 ft above stump height because of taper. Tables 2 and 3 show the minimum dbh required to meet the dib limitations for Girard form classes 79 and 82, respectively.

To use the tables, locate the appropriate dib limitation in the column of numbers at the left. Then find the position of the grading section across the top of the table. The number shown in the table is the minimum dbh required to meet the dib limitation at that position. For example, the key

indicates a minimum dib of 12.6 in for a tree that measures 15.8 in dbh. The top of the grading section is at 16 ft above stump height and form class is 79. Is the tree at least 12.6 in in dib at 16 ft above stump height? From Table 2, a tree of form class 79 must be at least 16.0 in dbh to have an inside bark diameter of 12.6 in at 16 ft above stump height. Dib at the top of the grading section is less than 12.6 in because the dbh of this particular tree is only 15.8 in.

Table 2. Minimum dbh (in inches) required to meet dib limitations -- trees with form class 79.

Dib	Position of grading section, feet above stump height		
	0 - 12	2 - 14	4 - 16
19.6	23.0	23.9	24.9
15.6	18.3	19.0	19.8
12.6	14.8	15.4	16.0
11.6	13.6	14.2	14.7
10.6	12.4	12.9	13.5
9.6	11.3	11.7	12.2
7.6	8.9	9.3	9.6

Table 3. Minimum dbh (in inches) required to meet dib limitations -- trees with form class 82.

Dib	Position of grading section, feet above stump height		
	0 - 12	2 - 14	4 - 16
19.6	22.4	23.2	24.0
15.6	17.9	18.4	19.1
12.6	14.4	14.9	15.4
11.6	13.3	13.7	14.2
10.6	12.1	12.5	13.0
9.6	11.0	11.4	11.7
7.6	8.7	9.0	9.3

**NOTE:** An alternative to this procedure is to utilize a device such as the Speigel Relaskop to directly measure the diameter outside bark (dob) at the top of the grading section. Once this value has been determined, it can be adjusted for bark thickness, by species, to determine dib at the top of the grading section.

*Mathematically this relationship is:*

*dib = dob - double bark thickness*

*Table A1 gives the double bark thicknesses for 9 hardwood species common to New York.*

Clear Cuttings

To determine the total length of clear cuttings on the grading section, the first step is to identify the grading face of the tree. Visually square the butt log into four faces, using imaginary vertical lines. Arrange the faces so that most defect indicators, such as bumps and knots, are concentrated on one face. The worst face is ignored, and the next-to-worst face becomes the grading face of the tree.

A clear cutting is a portion of the grading face that is free of defects and extends the width of the face. The grade specifications define the minimum length of clear cuttings, the maximum number of cuttings allowed, and the minimum total length of clear cuttings for each tree grade. Clear cuttings must total 5/6, 4/6, and 3/6 of the length of the grading face for grades 1, 2, and 3, respectively. The key assumes a 12-ft grading section. If a longer grading section is used, the minimum total length of clear cuttings should be adjusted according to Table 4.

Cull Deductions

The key also defines maximum allowable deductions for sweep, crook, and rot. Figure 1 shows how most scaling deductions are determined. In calculating percent sweep deduction, the number subtracted from actual sweep varies with log length. When calculating percent deduction for sweep, the numerator is the sweep (in inches) minus 1.5 in for a 12-ft grading section and 2 in for a 14- or 16-ft grading section. Estimating internal rot requires good judgment and a lot of practice. The National Forest Log Scaling Handbook provides detailed instructions for estimating most scaling deductions.

Table 4. Minimum total length (in feet and inches) of clear cuttings required for each grade and length of grading section.

Length of grading section	Minimum total length of clear cuttings		
	Grade 1	Grade 2	Grade 3
12'	10'	8'	6'
14'	11'8"	9'4"	7'
16'	13'4"	10'8"	8'

**USING THE KEY**

Specific instructions on tree grading are presented in "Hardwood tree grades for factory lumber". The key simply organizes all the grade specifications and provides a stepwise procedure for the beginner. For each tree, start at the top of the key and proceed to the step indicated in the right-hand column of numbers. Continue following the key until the tree is graded. At first the beginner should rely on the key and consult Figure 1 to estimate scaling deductions. With more experience, grading can be done from memory.

Table A1. Average bark thickness at top of butt log for several New York hardwoods.

Species	Single bark thickness	Double Bark thickness
Beech	0.215	0.430
Red maple	0.347	0.694
Sugar maple	0.403	0.806
Yellow birch	0.384	0.768
Black cherry	0.400	0.800
Basswood	0.438	0.876
White ash	0.568	1.136
Red oak	0.491	0.982
White oak	0.720	1.440

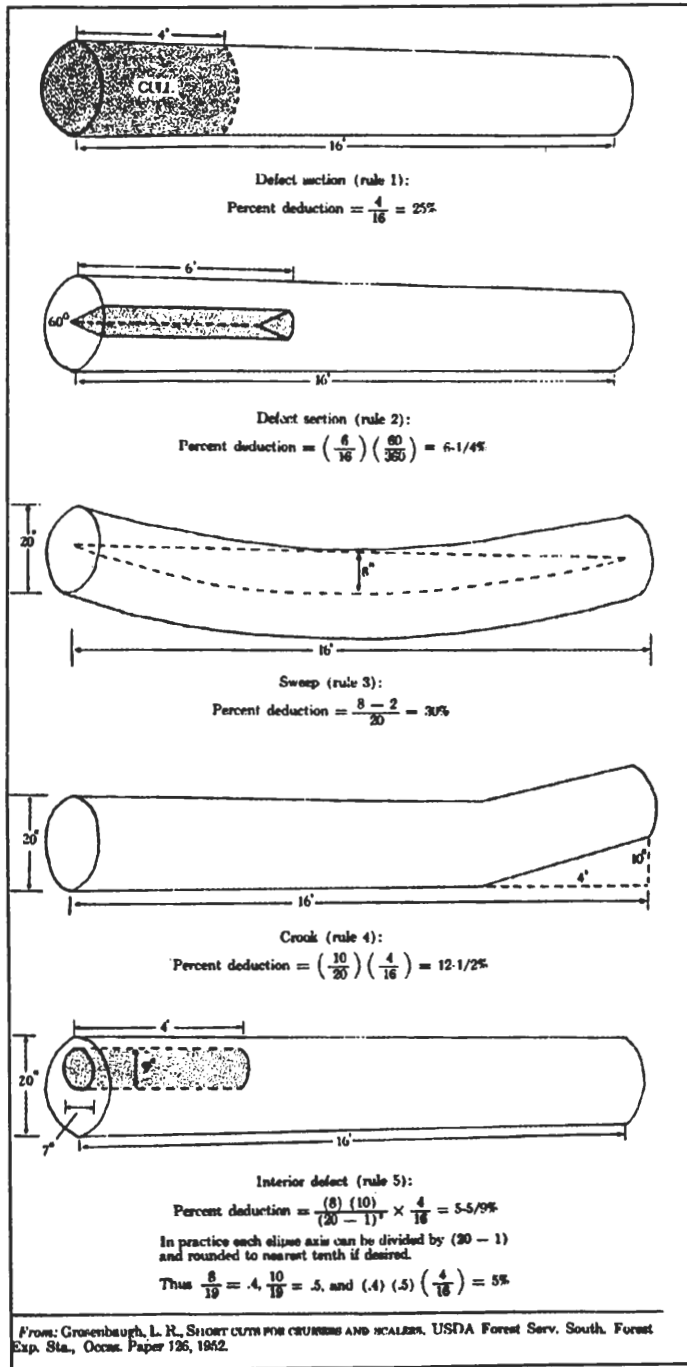
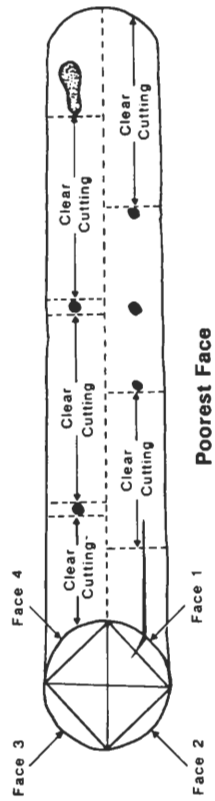


Figure 1. Methods of determining scaling deductions (examples based on a 16-ft log with 20-in scaling diameter).

### Faces and Clear Cuttings

Face grading is used in the evaluation of the surface quality of a log. To accomplish this, the log is visually quartered into four faces in such a manner that the maximum number of defects is concentrated in as few faces as possible. Cuttings are then laid out between defects. Furthermore, these cuttings must be generally free from defects (except where otherwise specified). The grade of the log is then determined by the percentage yield of the prescribed number and size of cuttings (as shown in Appendix I) on the second poorest face.

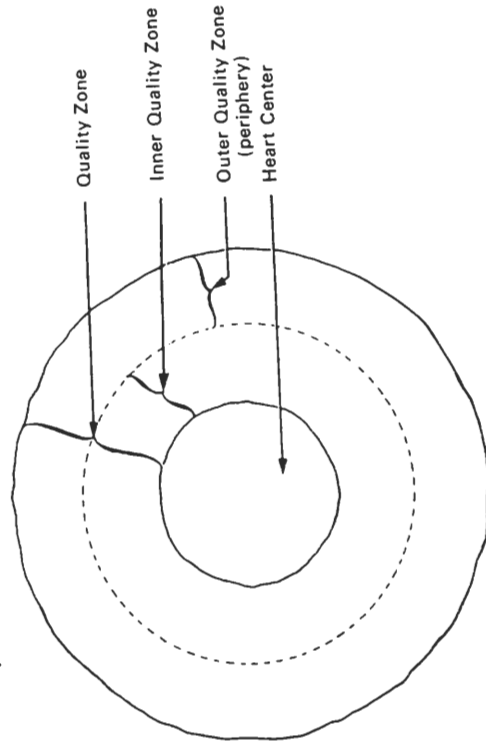
#### Second Poorest Face (Grading Face)



Sketch of log showing faces and cuttings.

### Heart Center and Quality Zone\*

The heart center when considered at the small end of the log, is taken as being a circle with a radius (from the pith) one-fifth of the average diameter. The quality zone, on the other hand, is that portion of the log outside the heart center. The quality zone is divided equally, in terms of radius, into the inner quality zone and the outer quality zone.



Sketch of log end to indicate zones used in log quality determination  
\*Since the original printing of this report, the term, *peripheral zone*, has been replaced by *quality zone*, and the term *periphery*, as used in the text, has been replaced by *outer quality zone*. These changes have been made in this Appendix but not in the text.

Figure 32. A typical medium-size hardwood tree showing how branch knots are overgrown.

