

Unit C: Forest Management

Lesson 3: Measuring Timber Stands

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Explain how to calculate board feet.
2. Explain how to measure basal area in standing trees.
3. Explain how to determine tree volume.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed with use of this lesson plan
- <http://www.cwc.ca/Resources/E-Tools/BoardCalc.htm>

List of Equipment, Tools, Supplies, and Facilities

Writing surface
PowerPoint Projector
PowerPoint slides
Transparency Masters
Tree scale sticks
Wedge prisms
Diameter tapes
Tree volume tables

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide #2):

- Basal area
- Board foot
- dbh
- Diameter at breast height
- Log rules
- Lumber overrun
- Taper
- Wedge prism

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Like a grain producer who measures the production of their crops in bushels, the forester measures production in board feet. In order for the forester to make this calculation the understanding of certain terms and the acquisition of certain skills are necessary. Lead discussion to the first objective of the lesson

Summary of Content and Teaching Strategies

Objective 1: Explain how to calculate board feet.

(PowerPoint Slide #3)

I. A **Metric Board foot** is a unit of measurement represented by a piece of rough wood 2.54 cm thick by 30.48 cm wide by 30.48 long; with a total volume of 2359.74 cubic cm. In surfaced or finished lumber, width and thickness are based on measurements before surfacing or other finishing.

(PowerPoint Slide #4)

A. Board feet of a piece of lumber can be calculated by multiplying the length of the piece \times the width of the piece \times the thickness divided by 2360. In this formula the measurements are measured in centimeters.

(PowerPoint Slide #5)

B. To determine the board feet in several pieces of lumber that are equal in size, determine the board feet in one piece then multiply that number by the number of similar size pieces.

****Use TM: C3-1 or PowerPoint Slide #6 to aid in discussion on this topic. Bring in some lumber pieces and have the students measure them and tell you the board feet.**

Objective 2: Explain how to measure basal area in standing trees.

(PowerPoint Slide #7)

II. The **basal area** (cross-sectional area of a tree at breast height expressed in square meters) is commonly measured to determine the level of stocking of a stand of trees, the amount of timber to remove in thinning an overstocked stand, and timber volume calculations. Basal area may be determined in a number of ways.

(PowerPoint Slide #8)

A. Basal area may be determined by physically measuring each tree with a Biltmore stick, a diameter tape, or calipers. A table is then used to determine the basal area from the recorded measurements.

(PowerPoint Slide #9 shows an example of a table used to determine basal area.)

(PowerPoint Slide #10)

B. One of the easiest methods for estimated basal area is by using angle gauges in optical tree-measuring devices. One type of angle gauge is a **wedge prism**.

(PowerPoint Slide #11)

A wedge prism can be used to determine which trees should be counted and tallied in a timber sample and which should not. Prisms are ground to specified basal area factor size. The factors generally vary from 0.7 to 15.2 m²/ha, but the most common size is 2.3 m²/ha.

(PowerPoint Slide #12)

Multiplying the basal area factor of the prism used at a given point in a timber times the number of trees counted with the prism will directly give the square meters of basal area per hectare of the trees around that point.

(PowerPoint Slide #13)

When a series of points is taken in a timber stand, average the figures for basal area per hectare from all sampling points to obtain the average basal area per hectare for the entire stand. Write out equations.

**** Use TM: C3-2 and TM: C3-3 or PowerPoint Slide #14 TM: C3-4 or PowerPoint Slide #15 to aid in discussion on this topic. If there are trees nearby have students figure out the basal area.**

Objective 3: Explain how to determine tree volume.

(PowerPoint Slide #16)

III. Tree volume tables are available to facilitate estimating the number of metric board feet, cubic meters, or cords in standing trees. The volume tables are designed to indicate a specific volume for a tree of a certain **diameter at breast height (dbh)** and height.

(PowerPoint Slide #17)

A. Tree volume tables that give the merchantable content of the standing timber are generally derived from **log rules**, or tables that measure the volume of individual logs. Volumes indicated on log rules are derived by formulas or graphic means.

(PowerPoint Slide #18)

There are over 50 different log rules used in the world, and the values assigned to trees or logs vary considerably.

(PowerPoint Slide #19)

The more common rules are the Doyle, Scribner, International, Maine, Spaulding, and Herring.

(PowerPoint Slide #20)

1. The Doyle rule indicates less volume for small-diameter logs than does the other commonly used rules. The **lumber overrun**, or the production of more lumber than the log rule allows, tends to be high for logs less than 71 cm, but it is excessive for logs less than 40 cm.

(PowerPoint Slide #21)

In this rule, an arbitrary deduction is made for lumber processing losses from the volume of a cylinder. The Doyle rule is most frequently used for the purchase of sawtimber and sawlogs.

(PowerPoint Slide #22)

2. The Scribner rule is derived by graphic means and estimates the amount of 2.5 centimeter lumber that can be sawn from logs of specific dimensions.

(PowerPoint Slide #23)

This rule, like the Doyle rule, is most frequently used for the purchase of sawtimber and sawlogs. Many forest agencies have adopted this rule for timber sale purposes. The Scribner rule gives a lumber overrun for large logs.

(PowerPoint Slide #24)

3. The International log rule, like the Doyle, is derived by a formula and is the only rule that adds volume for taper. **Taper** is a term that describes the gradual diminution of diameter in a tree trunk.

(PowerPoint Slide #25)

It provides one of the highest estimates of volume of any of the log rules and closely approaches the actual quantity of lumber that can be cut from a tree or log without the normal provision for a slight lumber overrun.

(PowerPoint Slide #26)

This rule is no longer used for making timber sales, but it continues to be useful for forest survey and research purposes.

Review/Summary: Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions on PowerPoint Slide #27 can also be used.

Application: Determine the basal area and lumber volume of a local wooded area. Contact your local forester for assistance.

Evaluation: Use the following sample test to evaluate the students' comprehension of the material covered in this lesson.

Answers to Sample Test:

Part One: Matching

1. d
2. b
3. a
4. e
5. c
6. f

Part Two: Completion

1. angle gauges
2. formulas; graphic
3. Doyle
4. Doyle; Scribner
5. International

Part Three: Short Answer

1. 36.68
2. 32.51
3. 74.21

Test

Unit C Lesson 3: Measuring Timber Stands

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|---------------|-------------------|----------------|
| a. Board foot | c. Log rules | e. Taper |
| b. dbh | d. Lumber overrun | f. Wedge prism |

- _____ 1. The production of more lumber than the log rule allows.
- _____ 2. Diameter at breast height.
- _____ 3. A unit of measurement represented by a piece of rough wood 1 foot square and 1 inch thick.
- _____ 4. A term that describes the gradual diminution of diameter in a tree trunk.
- _____ 5. Tables that measure the volume of individual logs.
- _____ 6. Can be used to determine which trees should be counted and tallied in a timber sample and which should not.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

- 1. One of the easiest methods for estimated basal area is by using _____ in optical tree-measuring devices.
- 2. Volumes indicated on log rules are derived by _____ or _____ means.
- 3. The _____ rule indicates less volume for small-diameter logs than does the other commonly used rules.
- 4. The _____ and _____ rules is most frequently used for the purchase of sawtimber and sawlogs.
- 5. The _____ log rule is no longer used for making timber sales, but it continues to be useful for forest survey and research purposes.

TM: C3-1

CALCULATING BOARD FEET

Definition: One metric board foot that is 2.54 cm thick by 30.48 cm wide by 30.48 long; With a total volume of 2359.74 cubic cm.

Formula: bf = length × width × thickness divided by 2360. (These measurements are done in centimeters)

Example 1: The number of bf in a board that is 3.657 m long, 14 cm wide, and 1.9 cm thick is determined as follows:

$$14 \text{ cm} \times 1.9 \text{ cm} \times 365.7 \text{ cm} = 9,727.62 \text{ cc}$$

$$\frac{9,727.62}{2360} = 4.12 \text{ board feet}$$

Example 2: The number of bf in a board that is 4.267 meters long, 89 mm wide, and 38 mm thick is determined as follows:

$$8.9 \text{ cm} \times 3.8 \text{ cm} \times 426.7 \text{ cm} = 14,430.99 \text{ cc}$$

$$\frac{14,430.99}{2360} = 4.12 \text{ board feet}$$

Note: To determine the bf in a stack of boards when all the boards are of equal size, determine the bf in one board and multiply that by the number of boards.

TM: C3-2

BASAL AREA OF TREES BY DBH CLASSES

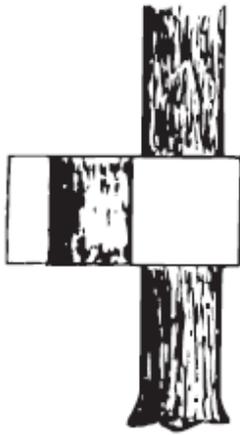
	Average stand height (meters)													
	6	8	10	12	14	16	18	20	22	24	26	28	30	32
2	0	0	0	0	2									
4	0	<u>3</u>	<u>6</u>	<u>9</u>	<u>13</u>									
6	5	<u>9</u>	<u>14</u>	<u>19</u>	<u>23</u>	28								
8	9	<u>16</u>	<u>22</u>	<u>28</u>	<u>34</u>	<u>40</u>								
10	14	<u>22</u>	<u>30</u>	<u>37</u>	<u>45</u>	<u>53</u>	61							
12	19	<u>28</u>	<u>37</u>	<u>47</u>	<u>56</u>	<u>65</u>	<u>75</u>	84						
14	23	<u>34</u>	<u>45</u>	<u>56</u>	<u>67</u>	<u>78</u>	<u>89</u>	<u>99</u>						
16	28	<u>40</u>	<u>53</u>	<u>65</u>	<u>78</u>	<u>90</u>	<u>103</u>	<u>115</u>						
18		<u>47</u>	<u>61</u>	<u>75</u>	<u>89</u>	<u>103</u>	<u>116</u>	<u>130</u>						
20		<u>53</u>	<u>68</u>	<u>84</u>	<u>99</u>	<u>115</u>	<u>130</u>	<u>146</u>	161					
22		<u>59</u>	<u>76</u>	<u>93</u>	<u>110</u>	<u>127</u>	<u>144</u>	<u>161</u>	<u>179</u>					
24		<u>65</u>	<u>84</u>	<u>103</u>	<u>121</u>	<u>140</u>	<u>158</u>	<u>177</u>	<u>196</u>	214				
26		<u>71</u>	<u>92</u>	<u>112</u>	<u>132</u>	<u>152</u>	<u>172</u>	<u>193</u>	<u>213</u>	<u>233</u>				
28		<u>78</u>	<u>99</u>	<u>121</u>	<u>143</u>	<u>165</u>	<u>186</u>	<u>208</u>	<u>230</u>	<u>251</u>				
30		<u>84</u>	<u>107</u>	<u>130</u>	<u>154</u>	<u>177</u>	<u>200</u>	<u>224</u>	<u>247</u>	<u>270</u>	293			
32		<u>90</u>	<u>115</u>	<u>140</u>	<u>165</u>	<u>189</u>	<u>214</u>	<u>239</u>	<u>264</u>	<u>289</u>	<u>314</u>	338		
34		<u>96</u>	<u>123</u>	<u>149</u>	<u>175</u>	<u>202</u>	<u>228</u>	<u>255</u>	<u>281</u>	<u>307</u>	<u>334</u>	<u>360</u>		
36		<u>103</u>	<u>130</u>	<u>158</u>	<u>186</u>	<u>214</u>	<u>242</u>	<u>270</u>	<u>298</u>	<u>326</u>	<u>354</u>	<u>382</u>	410	
38		<u>109</u>	<u>138</u>	<u>168</u>	<u>197</u>	<u>227</u>	<u>256</u>	<u>286</u>	<u>315</u>	<u>345</u>	<u>374</u>	<u>404</u>	<u>433</u>	
40			<u>146</u>	<u>177</u>	<u>208</u>	<u>239</u>	<u>270</u>	<u>301</u>	<u>332</u>	<u>363</u>	<u>394</u>	<u>425</u>	<u>456</u>	
42			<u>154</u>	<u>186</u>	<u>219</u>	<u>251</u>	<u>284</u>	<u>317</u>	<u>349</u>	<u>382</u>	<u>414</u>	<u>447</u>	<u>480</u>	
44			<u>161</u>	<u>196</u>	<u>230</u>	<u>264</u>	<u>298</u>	<u>332</u>	<u>366</u>	<u>400</u>	<u>435</u>	<u>469</u>	<u>503</u>	
46				<u>205</u>	<u>241</u>	<u>276</u>	<u>312</u>	<u>348</u>	<u>383</u>	<u>419</u>	<u>455</u>	<u>490</u>	<u>526</u>	
48				<u>214</u>	<u>251</u>	<u>289</u>	<u>326</u>	<u>363</u>	<u>400</u>	<u>438</u>	<u>475</u>	<u>512</u>	<u>549</u>	
50				<u>224</u>	<u>262</u>	<u>301</u>	<u>340</u>	<u>379</u>	<u>417</u>	<u>456</u>	<u>495</u>	<u>534</u>	<u>573</u>	
52					<u>273</u>	<u>314</u>	<u>354</u>	<u>394</u>	<u>435</u>	<u>475</u>	<u>515</u>	<u>556</u>	<u>596</u>	
54					<u>284</u>	<u>326</u>	<u>368</u>	<u>410</u>	<u>452</u>	<u>494</u>	<u>535</u>	<u>577</u>	<u>619</u>	
56					<u>295</u>	<u>338</u>	<u>382</u>	<u>425</u>	<u>469</u>	<u>512</u>	<u>556</u>	<u>599</u>	<u>642</u>	
58					<u>306</u>	<u>351</u>	<u>396</u>	<u>441</u>	<u>486</u>	<u>531</u>	<u>576</u>	<u>621</u>	<u>666</u>	
60					<u>317</u>	<u>363</u>	<u>410</u>	<u>456</u>	<u>503</u>	<u>549</u>	<u>596</u>	<u>642</u>	<u>689</u>	
62					<u>327</u>	<u>376</u>	<u>424</u>	<u>472</u>	<u>520</u>	<u>568</u>	<u>616</u>	<u>664</u>	<u>712</u>	
64						<u>388</u>	<u>438</u>	<u>487</u>	<u>537</u>	<u>587</u>	<u>636</u>	<u>686</u>	<u>736</u>	
66						<u>400</u>	<u>452</u>	<u>503</u>	<u>554</u>	<u>605</u>	<u>656</u>	<u>708</u>	<u>759</u>	
68						<u>413</u>	<u>466</u>	<u>518</u>	<u>571</u>	<u>624</u>	<u>677</u>	<u>729</u>	<u>782</u>	
70						<u>425</u>	<u>480</u>	<u>534</u>	<u>588</u>	<u>642</u>	<u>697</u>	<u>751</u>	<u>805</u>	
72						<u>438</u>	<u>494</u>	<u>549</u>	<u>605</u>	<u>661</u>	<u>717</u>	<u>773</u>	<u>829</u>	
74						<u>450</u>	<u>507</u>	<u>565</u>	<u>622</u>	<u>680</u>	<u>737</u>	<u>795</u>	<u>852</u>	
76						<u>462</u>	<u>521</u>	<u>580</u>	<u>639</u>	<u>698</u>	<u>757</u>	<u>816</u>	<u>875</u>	
78						<u>475</u>	<u>535</u>	<u>596</u>	<u>656</u>	<u>717</u>	<u>777</u>	<u>838</u>	<u>898</u>	
80						<u>487</u>	<u>549</u>	<u>611</u>	<u>674</u>	<u>736</u>	<u>798</u>	<u>860</u>	<u>922</u>	
82							<u>563</u>	<u>627</u>	<u>691</u>	<u>754</u>	<u>818</u>	<u>881</u>		
84							<u>577</u>	<u>642</u>	<u>708</u>	<u>773</u>	<u>838</u>	<u>903</u>		
86								<u>658</u>	<u>725</u>	<u>791</u>	<u>858</u>	<u>925</u>		
88									<u>742</u>	<u>810</u>	<u>878</u>			
90									<u>759</u>	<u>829</u>	<u>898</u>			
92									<u>776</u>	<u>847</u>	<u>919</u>			
94									<u>793</u>	<u>866</u>				
96									<u>810</u>	<u>885</u>				
98										<u>903</u>				
100										<u>922</u>				

$Cubic\ meters/hectare = 0.38791 * MBA * MHT - 9.21137$
 Where: MBA = Average stand basal area in square meters/hectare and: MHT = Average stand height in meters.
 Standard error of estimate: 1.47 cubic meters/hectare.
 Values underlined indicate extent of data.

STEPS IN USING A WEDGE PRISM

- 1. Hold the prism at eye level directly over the point to be used to sample the timber stand.**
- 2. Look through the prism, and count the number of trees that should be tallied. The face of the largest edge of the prism should be at right angles to the line of sight, and the top edge of the prism should be horizontal to the level ground.**
- 3. Multiply the tree count at this point by the basal area factor of the prism to get the basal area per hectare in square meters around this sampling point.**

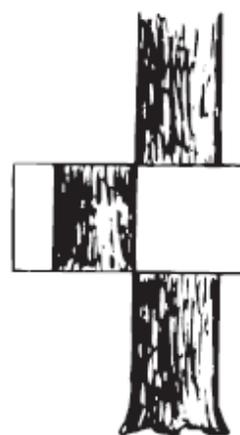
THE WEDGE PRISM



Don't tally



Tally



Borderline
tally every other one

(Courtesy, Interstate Publishers, Inc.)