Michigan Department of Natural Resources

www.michigan.gov/dnr

PRODUCT STANDARDS AND CRUISING MANUAL

Forest Resources Division

IC4057 (Rev. 04/03/2017)

MICHIGAN DEPARTMENT OF NATURAL RESOURCES MISSION STATEMENT

"The Michigan Department of Natural Resources is committed to the conservation, protection, management, use and enjoyment of the State's natural resources for current and future generations."

NATURAL RESOURCES COMMISSION STATEMENT

The Natural Resources Commission (NRC), has the exclusive authority to regulate the taking of game and sportfish, and is authorized to designate game species and authorize the establishment of the first open season for animals. The NRC holds monthly, public meetings throughout Michigan, working closely with its constituencies in establishing and improving natural resources management policy.

For information or assistance on this publication, contact Forest Planning & Operations Section, Forest Resources Division, Michigan DNR, PO Box 30452, Lansing MI 48909-7952.

This publication is available in alternative formats upon request.

IC4057 (Rev. 04/03/2017)

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

Product Standards

Diameter at Breast Height

The diameter of a tree is a key in determining the products within a tree. The first step in determining a tree's products is determining a tree's DBH. Unless one of the following special situations is encountered, measure DBH at 4.5 feet above the ground line, on the uphill side of the tree. Round each measurement down to the last 0.1 inch. For example, a reading of 4.68 inches is read as 4.6 inches. In certain measurement situations, we use two-inch diameter classes, e.g. Mark & Tally. Two-inch classes are defined as follows:

2" Class	Diameter Range
4	4.6 – 5.0
6	5.1 – 7.0
8	7.1 – 9.0
10	9.1 – 11.0
12	11.1 – 13.0
14	13.1 – 15.0
16	15.1 – 17.0
18	17.1 -19.0
20	19.1 – 21.0
22	21.1 – 23.0
24	23.1 – 25.0

Measuring DBH and Using a D-Tape

When using a D-tape, follow the procedures shown in Figure 1.

Special DBH Situations

1. **Forked Tree:** In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. Forks originate at the point on the bole where the piths intersect. To determine the common pith intersection, follow a straight line from the center of each fork until they intersect at the bole. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

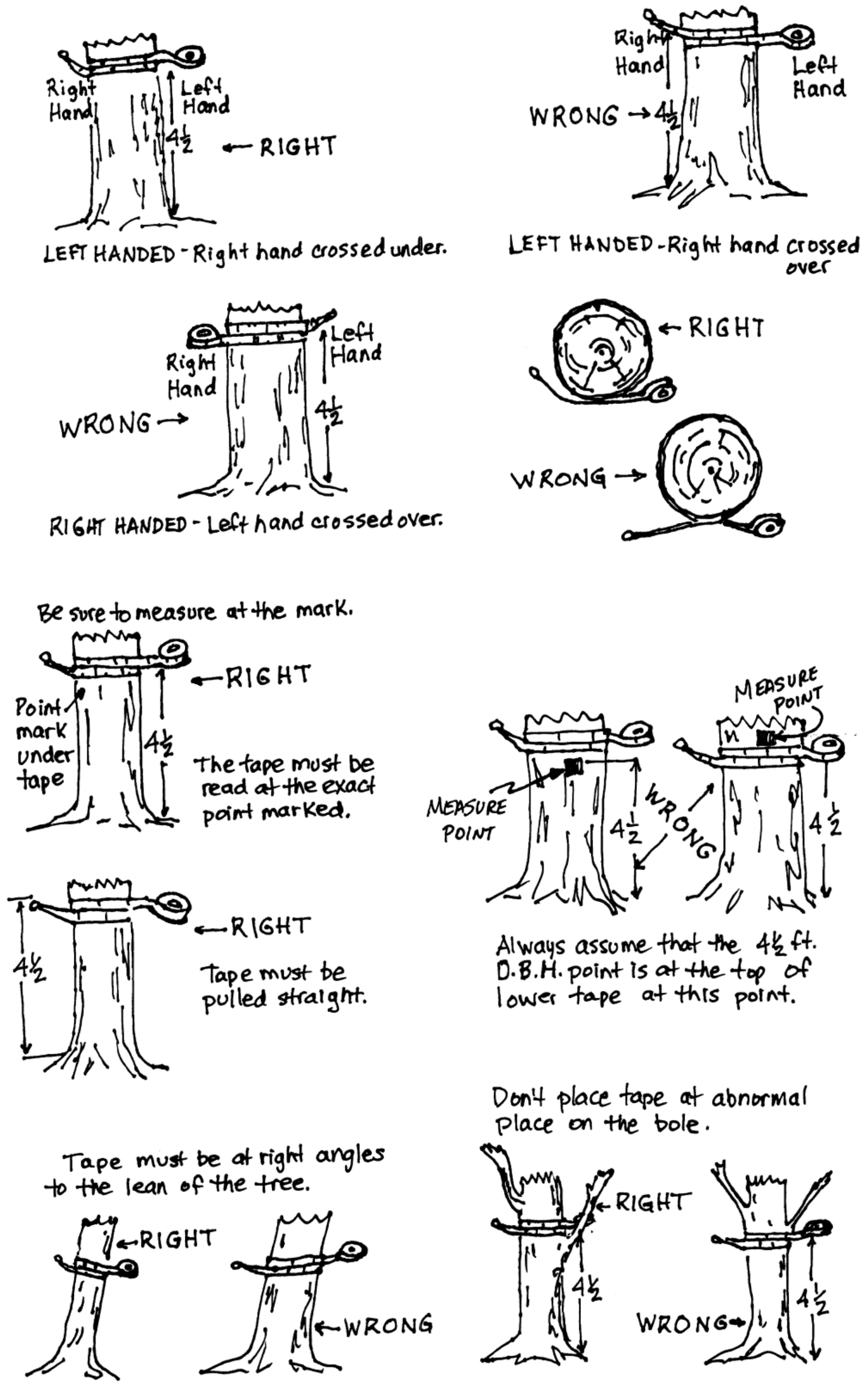


Figure 1 - Proper Technique for Measuring DBH with a D-Tape

a. Trees forked below 1.0 foot. Trees forked below 1.0 foot are treated as distinctly separate trees (Figure 2). The DBH is measured for each stem at 4.5 feet above the ground. When stems originate from pith intersections below 1.0 foot, it is possible for some stems to be within the limiting distance and others to be beyond the limiting distance. If a stem originates from a fork that starts below 1.0 foot, forks again between 1.0 and 4.5 feet (Figure 5-B), the rules in Trees forked between 1.0 foot and 4.5 feet apply.

b. Trees forked between 1.0 foot and 4.5 feet. Trees forked between 1.0 foot and 4.5 feet are counted as separate trees (Figure 3, Figure 5 D-F). The DBH of each fork is measured at a point 3.5 feet above the pith intersection. When forks originate from pith intersections between 1.0 and 4.5 feet, the limiting distance is different for all forks—one fork may be on and another fork may be off the plot.

   Multiple forks are possible, if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 3.5 feet above the common pith intersection (Figure 5-F).

   Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks that may occur on that stem. Measure the diameter of such stems just below the base of stem separation as shown in Figure 5-E (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

c. Trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet count as one single tree (Figure 4). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH.

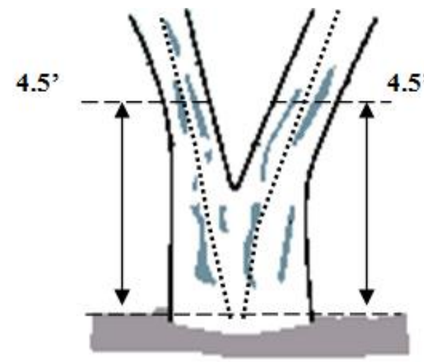


Figure 2 - Trees Forked Below 1.0 Foot

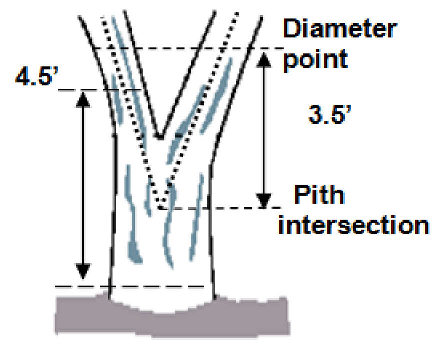


Figure 3 - Trees Forked Between 1.0 Foot and 4.5 Feet

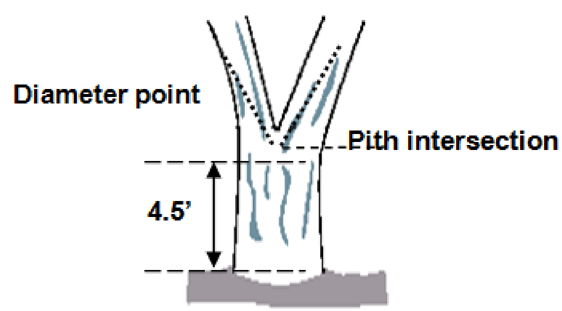


Figure 4 - Trees Forked At or Above 4.5 Feet

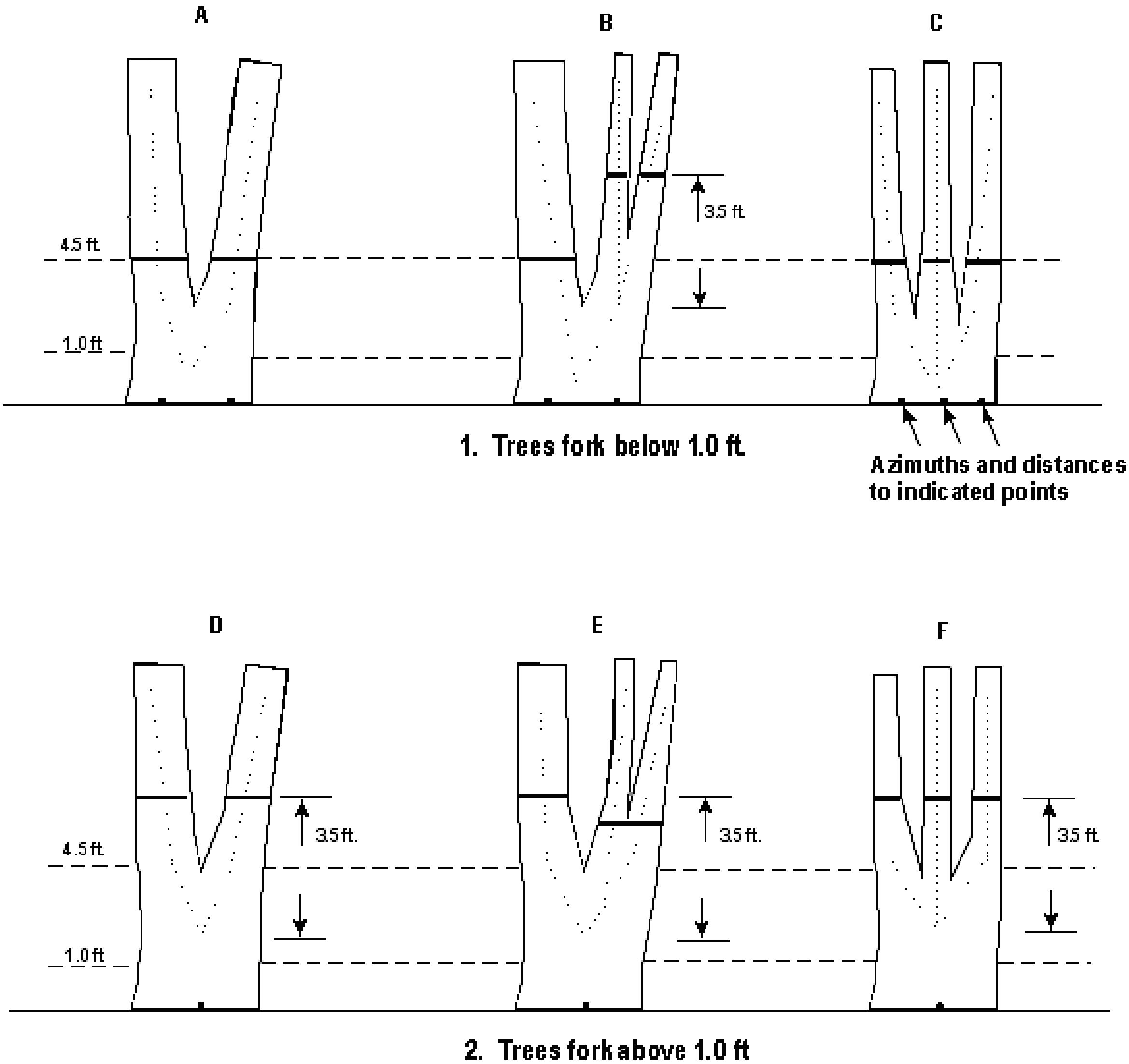


Figure 5 - Summary of Where to Measure DBH

2. **Stump Sprouts:** Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 foot are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 foot and 4.5 feet are measured at 3.5 feet above their point of occurrence.

3. **Tree with Butt-Swell or Bottleneck:** Measure these trees 1.5 feet above the end of the swell or bottleneck, if the swell or bottleneck extends 3.0 feet or more above the ground (Figure 6).

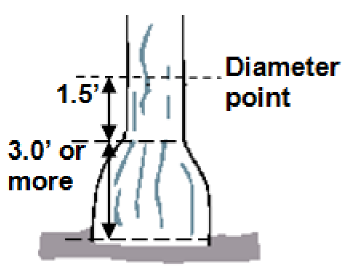


Figure 6 - Bottleneck Tree

4. **Tree with Irregularities at DBH:** On trees with swellings (Figure 7), bumps, depressions, and branches (Figure 8) at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

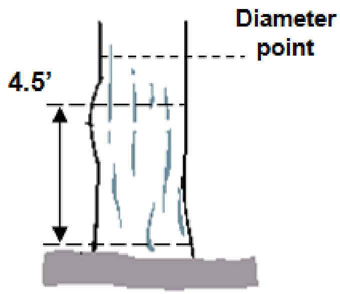


Figure 7 - Tree with Swelling

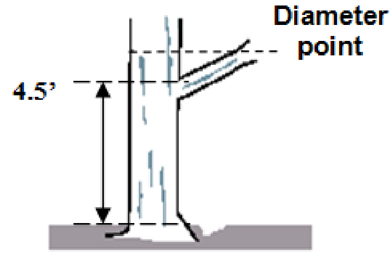


Figure 8 - Tree with Branch

5. **Tree on Slope:** Measure diameter at 4.5 feet from the ground along the bole on the uphill side of the tree (Figure 9).

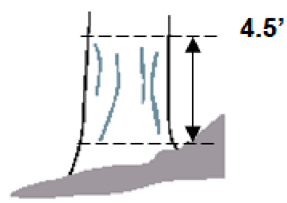


Figure 9 - Tree on a Slope

6. **Leaning Tree:** Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole (Figure 10).

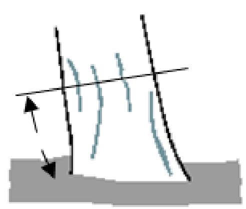


Figure 10 - Leaning Tree

7. **Independent Trees that Grow Together:** I f two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each.

8. **Missing Wood or Bark:** Do not reconstruct the DBH of a tree that is missing wood or bark at the point of measurement. Record the diameter of the wood and bark that is still attached to the tree (Figure 11). If a tree has a localized abnormality (gouge, depression, etc.) at the point of DBH, apply the procedure described for trees with irregularities at DBH (Figures 7 and 8).

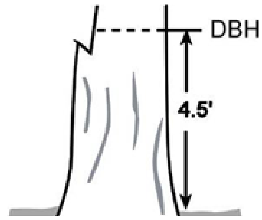


Figure 11 - Tree with Part of Stem Missing

9. **Live Windthrown Tree:** Measure from the top of the root collar along the length to 4.5 feet (Figure 12).

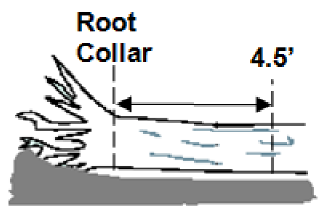


Figure 12 - Tree on the Ground

10. **Tree with Curved Bole (Pistol Butt Tree):** Measure along the bole on the uphill side (upper surface) of the tree (Figure 13).

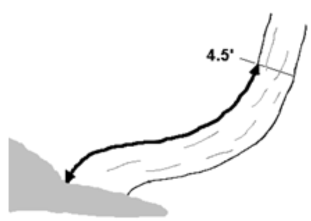


Figure 13 - Tree with Curved Bole (Pistol Butt Tree)

11. **Tree Growing on Objects:** When trees are growing on objects, such as rocks or logs, measure at 4.5 feet above the root crown rather than above the forest floor. (Figure 14). Trees that reside in water much of the year can also produce “prop-like” roots, measure diameter in a similar method at 4.5 feet above the root crown.

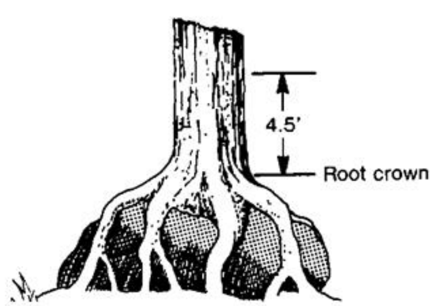


Figure 14 - Trees Growing on Objects (e.g., rocks, logs)

PULPWOOD

LENGTH AND DIAMETER

Cruising units (sticks) are defined as 100” segments down to 4.5” Diameter Outside Bark (DOB.) which do not meet sawlog specifications (i.e., can include log sized sticks). The minimum small end dimension of 4.5” DOB translates to 4.0” Diameter Inside Bark (DIB). Minimum DBH is 4.6” which is in the 6” diameter class (4.6” – 7.0”). Sticks are counted from a 1’ stump. On forked trees, the stump may be higher. Starting with the second stick, pulpwood should be rounded up to a full stick, if the 4.5” DOB point occurs at or beyond 6’ (72”) on a 100” stick (assuming uniform taper, few limbs and no stopper before 100”).

When taper is the only factor limiting the top stick, assuming a 1’ stump and using the 6’ rounding rule, the Merch Height Rounding columns in the following table lists sticks and their associated merchantable height. When a stopper other than taper limits the top stick, assuming a 1’ stump, the Merch Height No Rounding columns in the following table lists sticks and their associated merchantable height.

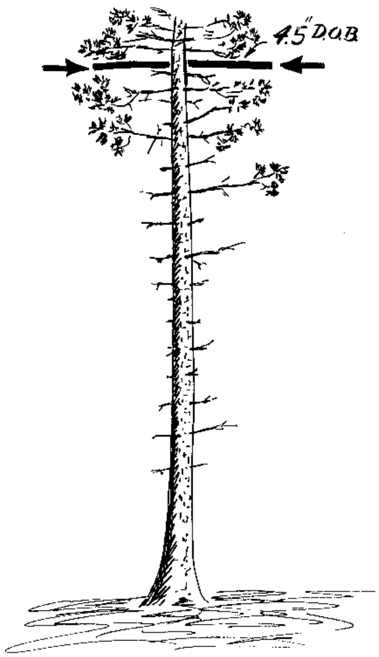
Pulp Sticks	Merch Height (feet & inches) Rounding	Merch Height (inches) Rounding	Merch Height (feet & inches) No Rounding	Merch Height (inches) No Rounding
1	9’ 4”*	112”*	9’ 4”*	112”*
2	15’ 4”	184”	17’ 8”	212”
3	23’ 8”	284”	26’ 0”	312”
4	32’ 0”	384”	34’ 4”	412”
5	40’ 4”	484”	42’ 8”	512”
6	48’ 8”	584”‘	51’ 0”	612”
7	57’ 0”	684”	59’ 4”	712”
8	65’ 4”	784”	67’ 8”	812”
9	73’ 8”	884”	76’ 0”	912”
10	82’ 0”	984”	84’ 4”	1,012”

*This is height from the ground, assuming a 1 foot stump.

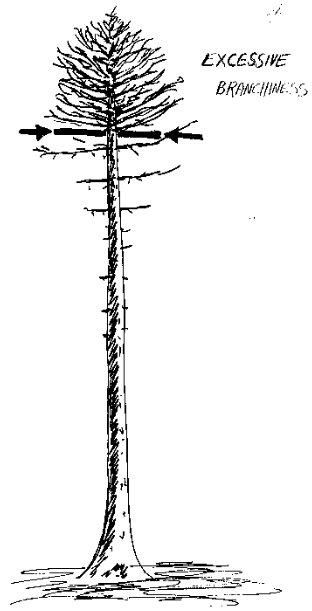
STOPPERS

Defects that end merchantability. Limbs are not generally stoppers (Figure 15).

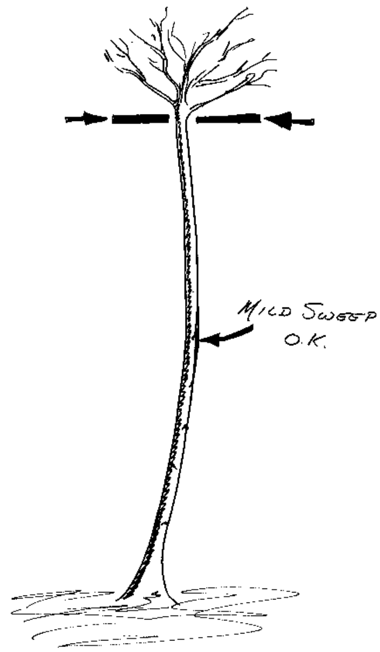
1. 4.5” DOB
2. Dead tops
3. Excessive branching
4. Section of severe crook



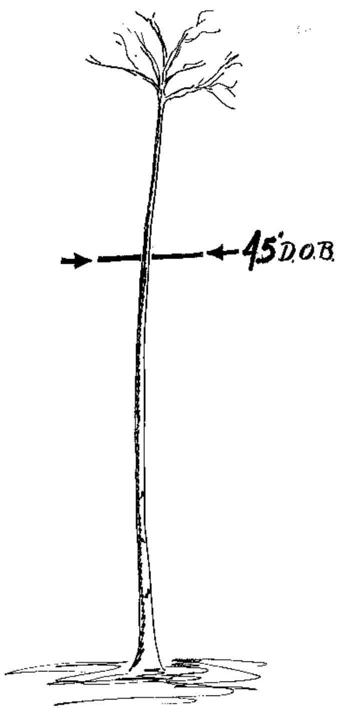
4.5" DOB



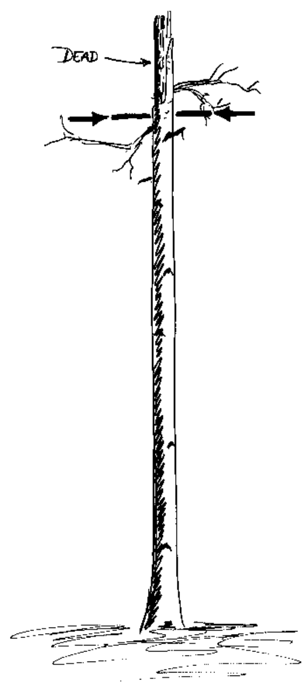
Excessive Branching



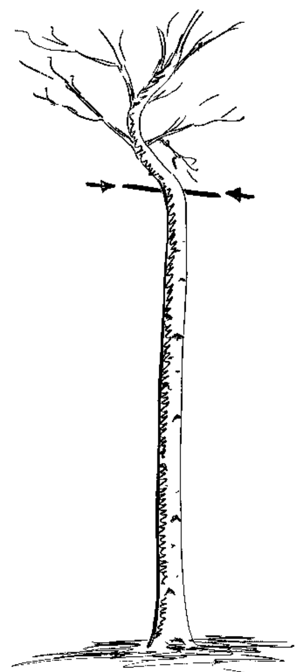
Acceptable



4.5" DOB



Dead Top



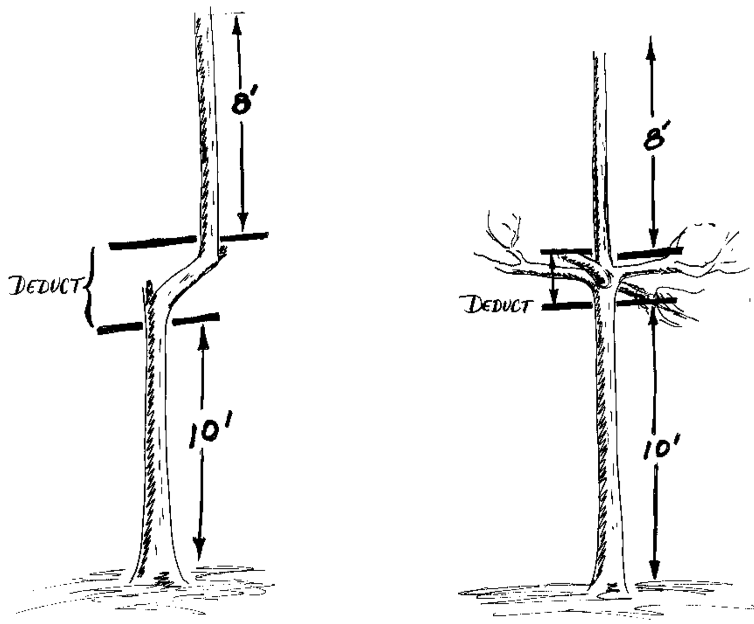
Crook

Figure 15 - Stoppers for Pulpwood

DEDUCTIONS FROM USEABLE HEIGHT

1. Areas of crook or sweep with merchantable wood above and below this point.
2. Excessive branching.

Sections of the tree that contain bad crook or excessive branching should **not** be counted as merchantable. Skip these areas of defect and count as sticks only those parts of the tree that contain relatively straight pulp sticks.



Crook **Excessive Branching**

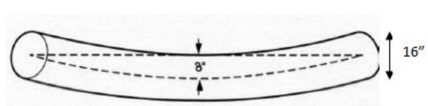
Figure 16 - Deductions from Useable Height for Pulpwood

Excessive Crook or Sweep

a. Small pulp: 100" long, <12" on the small end. Too much crook is defined as not being able to fit through a 24" culvert.

b. Large pulp: 100" long, >12" on the small end. Maximum 100% sweep or crook of small end DIB.

A 16" small end DIB could have as much as 16" of sweep before it is considered cull for pulpwood. The following 16" small end DIB stick has 50% sweep, i.e. 8":



For reference, Verso's 2011 pulpwood specification: "The entire stick, including sweep and crook, must be no larger than will be able to pass through a straight 30" diameter tube 8' long with bark attached". Louisiana-Pacific, in Newberry, has a maximum of 6" in a 100" length.

SAWLOGS

LENGTH AND DIAMETER

Cruising units (logs) are defined as 100” segments with a small end 9.0” DOB (or 8.0” DIB) for the Lower Peninsula and Baraga, and 11.0” DOB (or 10.0” DIB) for the Upper Peninsula. Saw sticks are counted from a 1’ stump. On forked trees or trees with basal defect, the stump may be higher. Hardwood logs will have more than 50% of a particular segment in useable wood (i.e., less than 50% deduction for rot, crook, sweep, scars, seams and cracks or a combination of all defects), for any 100” segment. In addition, the log must be at least a Grade #3 or better. Softwood logs will have more than 50% of a particular segment in useable wood and are not graded. Products that do not meet these standards will be considered pulp or cull.

Lower Peninsula and Baraga, minimum DBH is 9.1” which is in the 10” class (9.1”-11.0”).

Upper Peninsula minimum DBH is 11.1” which is in the 12” class (11.1”-13.0”).

Log Rule: International 1/4 inch rule should be used for all sawlog volume calculations in the Lower Peninsula and in Crystal Falls. Scribner Decimal C is to be used in the Upper Peninsula.

Assuming a 1’ stump, the following table lists saw sticks and their associated merchantable height.

Saw Sticks	Merchantable Height
1	9’ 4”
2	17’ 8”
3	26’ 0”
4	34’ 4”
5	42’ 8”
6	51’ 0”
7	59’ 4”
8	67’ 8”
9	76’ 0”
10	84’ 4”

GRADE #3 OR BETTER HARDWOOD LOGS

Hardwood logs will have more than 50% of a particular 100” segment in useable wood (i.e., less than 50% deduction for rot, crook, sweep, scars, seams and cracks or a combination of all defects), for any 100” segment. In addition, the log must be at least a Grade #3 or better. A Grade #3 log needs at least 2, 2’ clear cuttings in the 3rd best face (Figure 18). A clear cutting is a portion of a face free of defects, extending the width of the face. A face is 1/4 of the surface of the grading section as divided lengthwise (Figure 17). When necessary, realign faces to produce the highest grades (Figure 19).

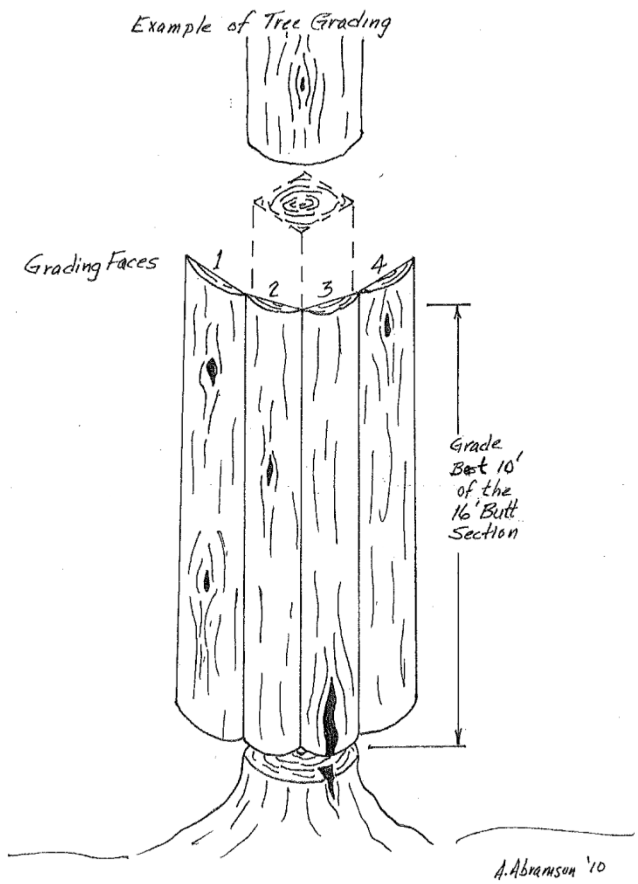


Figure 17 - Dividing a Log into 1/4 Faces

The following is a list of log surface abnormalities that are hardwood tree grading defects.

Bark Distortions – Many log surface abnormalities appear to be only breaks in the normal bark pattern. Overgrown knots, mechanical wounds, holes of all types, ingrown bark, and bird pecks are typical defects under bark distortions which can be definitely established from bark appearance. They are all grading defects. A slight bark distortion consisting of a simple horizontal break across the normal bark pattern is not a grading defect.

Bulge – A general enlargement of a section of the log and a sign of internal rot.

Bump – Bumps usually indicate overgrown knots or other defects. Surface swells (less than 1” rise in 12” of length) can be disregarded as a grading defect.

Burls – A sound, hard, woody protuberance on the log with no protruding limbs, etc.

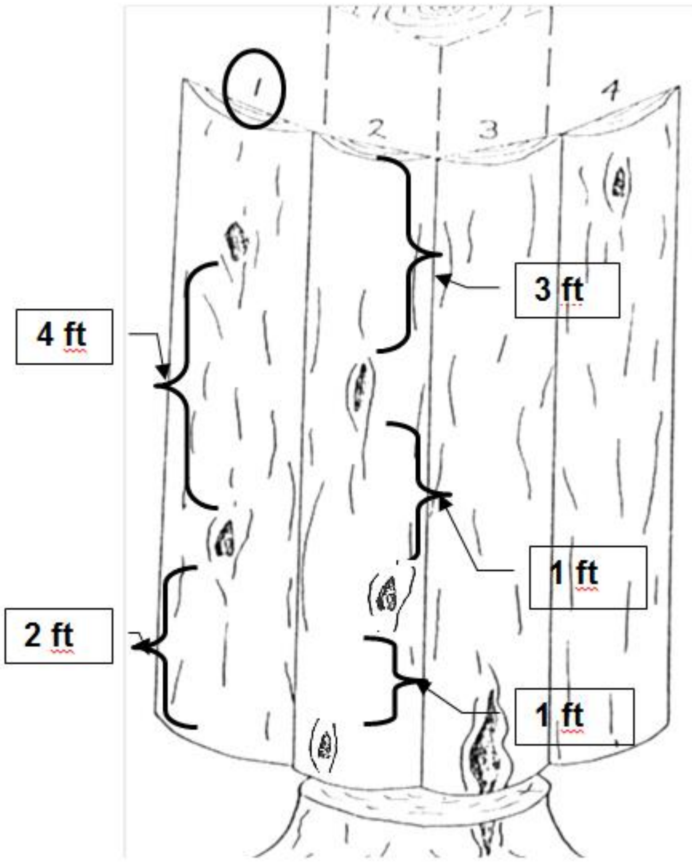


Figure 18 - Identify the 3rd Best Face (Face 1) Which Must Have at Least Two, 2 Feet Clear Cuttings

Butt Scar – Damage at the base of the tree. Scars of recent origin are usually associated with a limited amount of rotten or stained wood. Severe rot is usually associated with older scars. If the scar extends into the log beyond the slab section, the area involved is a grading defect.

Bird Peck – There must be 4 bird pecks within a square foot to affect the tree grade and be considered a defect. First, determine the tree grade without the bird pecks. If the tree grade is determined to be 1 or 2, then downgrade the tree by one grade. If the tree graded out to be a 3 or 4 without the bird pecks, then ignore them as defects and record the initial tree grade.

Canker – A definite, relatively localized lesion, primarily of bark and wood.

Conk – It is the fruiting body of a wood rotting fungus located on the bole of the tree and is an indication of serious internal rot.

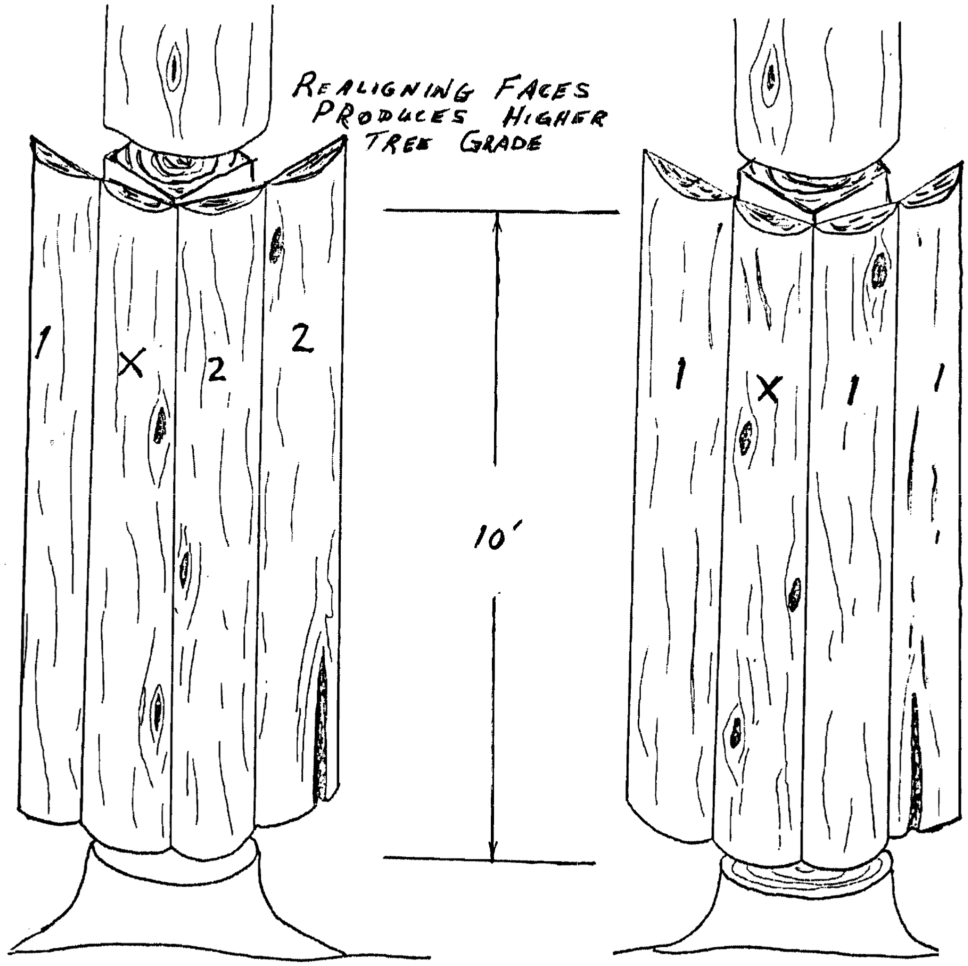


Figure 19 - Realign Faces to Produce Higher Grades

In Figure 19 above, the left face alignment has one Grade 1, two Grade 2s, and one face that does not make grade. The right alignment has three Grade 1s, and one face that does not make grade.

Epicormic Branches and Dormant Bud Clusters – Epicormic branches are found at point on the stem. Dormant bud clusters may develop on the stem any time during the life of a tree. Usually not a defect on pin oak.

Holes – All holes are grading defects.

Knots – Cut or broken-off limbs or sprout branches, green or dead, protruding, flush or depressed but with exposed sound or rotten wood.

Metal – Logs suspected of or know to contain metal should either be long butted or rejected. All metal (except aluminum research tags and nails) is considered an unsound grading defect.

Rot – Wood which has decayed to the point where it is useless.

Seams – Seams are cracks or splits running with the grain for part of or full length of the log. They are generally caused by wind, lightning or frost and extend from the bark to the center of the log. They may be open or completely healed. They are very damaging and especially so when they run spirally around the log. No clear cuttings can be taken on a log face that includes a full-length straight seam or a spiral seam. However, one straight seam can be placed on the edge of one face and ignored. This fixes the location of all other defects.

Wounds – Wounds or injuries that expose sapwood and/or heartwood are defects. The following are a few guidelines for wounds:

- Old wounds are commonly associated with stain, decay, and/or insects and the affected area becomes a defect.
- New "fresh" wounds (less than 1 year old) are disregarded, as long as deterioration is not visible.
- If new or old wounds look superficial, disregard them.

Source: <u>Official Grading Rules for Northern Hardwood and Softwood Logs and Tie Cuts</u> (Effective Sept. 1, 1998).

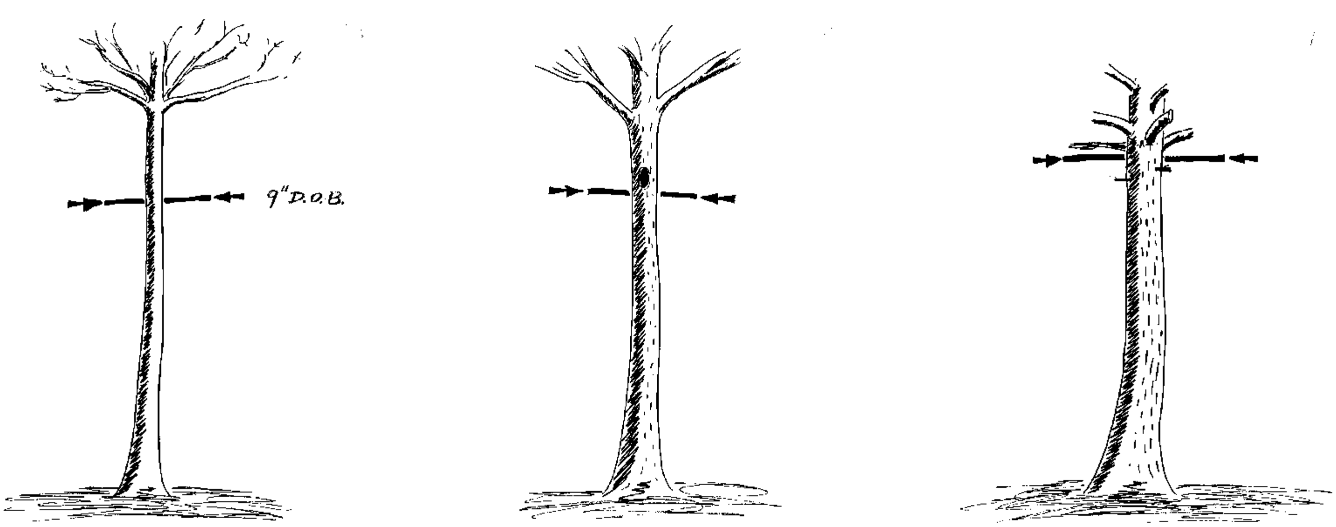
STOPPERS

The point on the bole where sawlog merchantability ends e.g., defects that can be cut out are not stoppers if there is more than 100" of merchantable sawlog material beyond the stopper (Figure 20). Note that all segments identified as sawlogs must meet minimum grade 3 specifications.

1. 9.0" or 11.0" DOB.
2. Forks.
3. Defects (knots, holes, etc.) larger than 1/2 diameter of the tree at that point on the bole.
4. Whorls of limbs or sound knots that total greater than 1/2 the diameter of the bole.

In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem at an angle of 45 degrees or less. Forks originate at the point of the bole where the piths intersect. A section of the bole with "double pith" is typically a sawlog stopper.

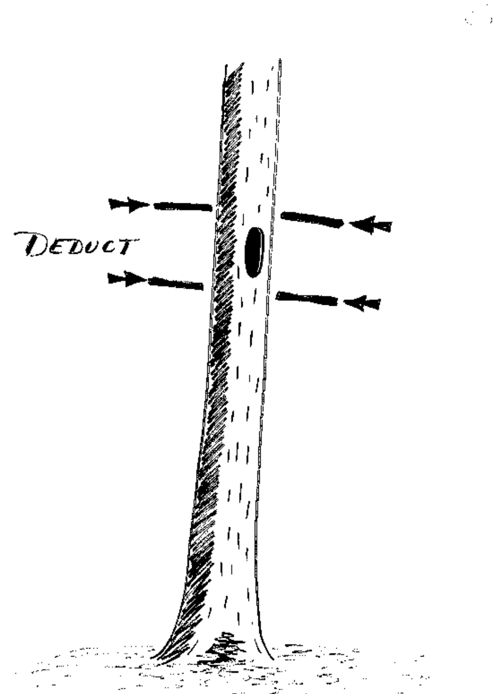
The effect of dead limbs, holes, seams etc., varies greatly from species to species. No standard guidelines can replace knowledge gained locally by observing trees being bucked and sawn.



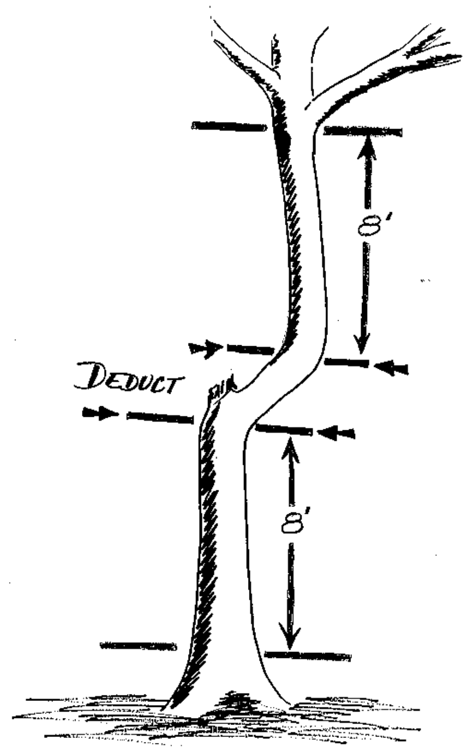
8" DIB or 9" DOB **Hole, Rot, etc.** **Heavy Limbs**

Figure 20 - Stoppers for Sawlogs

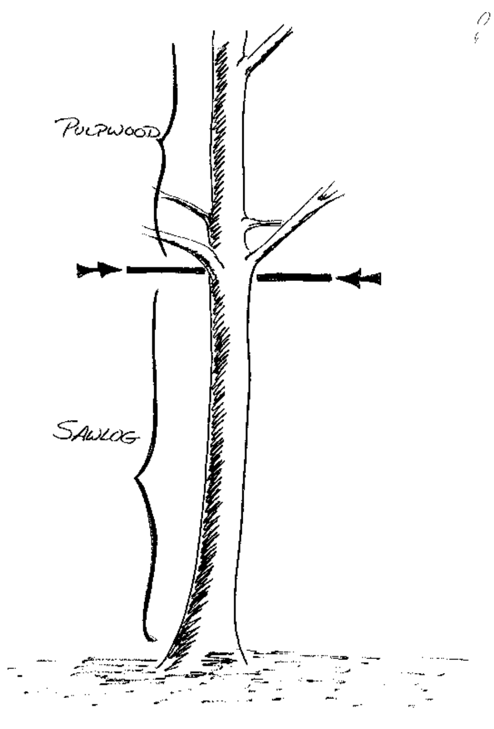
DEDUCTIONS FROM USEABLE HEIGHT



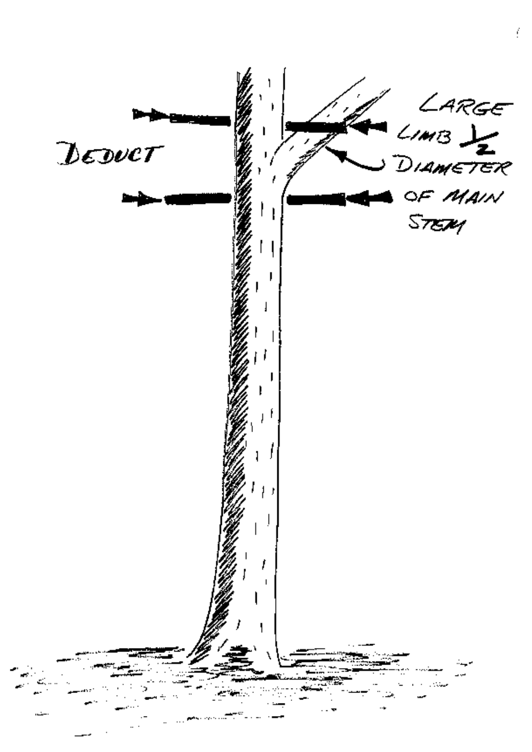
Hole, Rot, etc.



Crook

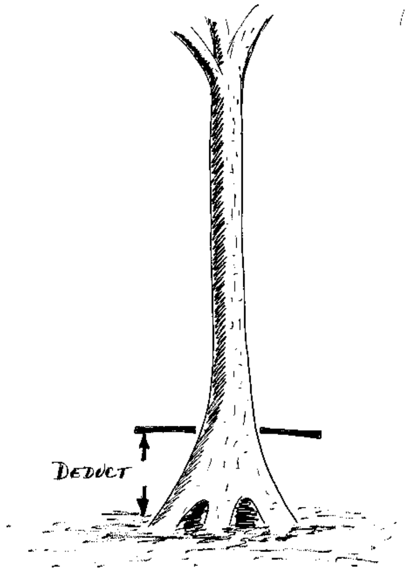


Excessive Limbiness for Sawlogs but not for Pulpwood

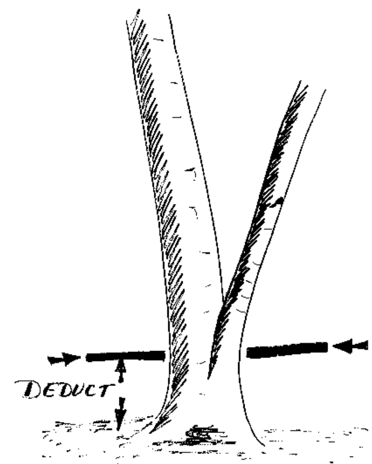


Large Diameter Limb

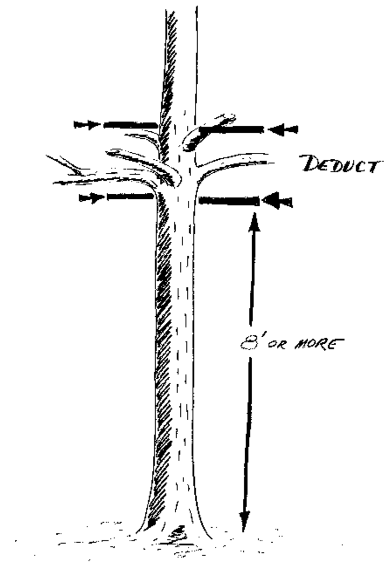
Figure 21 - Deductions from Useable Height for Sawlogs



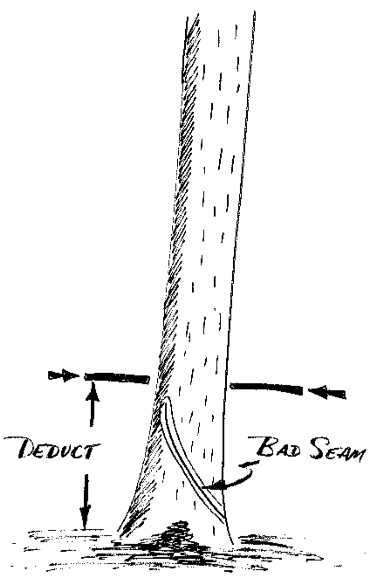
Butt Swell



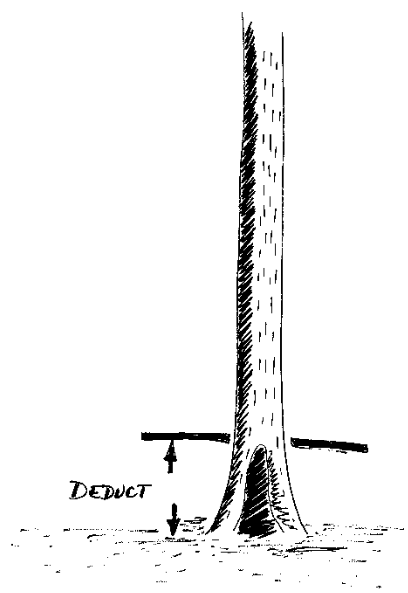
"Junction" Wood



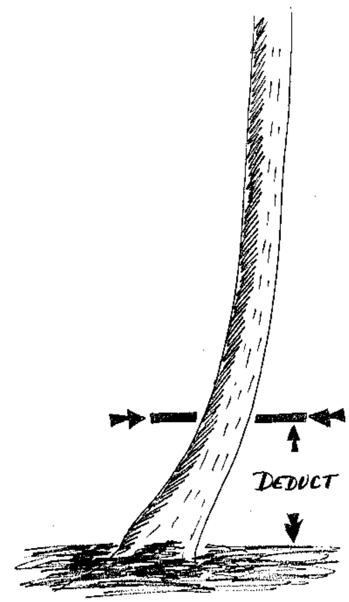
Clump of Limbs



Bad Seam



Catface



Excessive Sweep

Figure 22 - More Deductions from Useable Height for Sawlogs

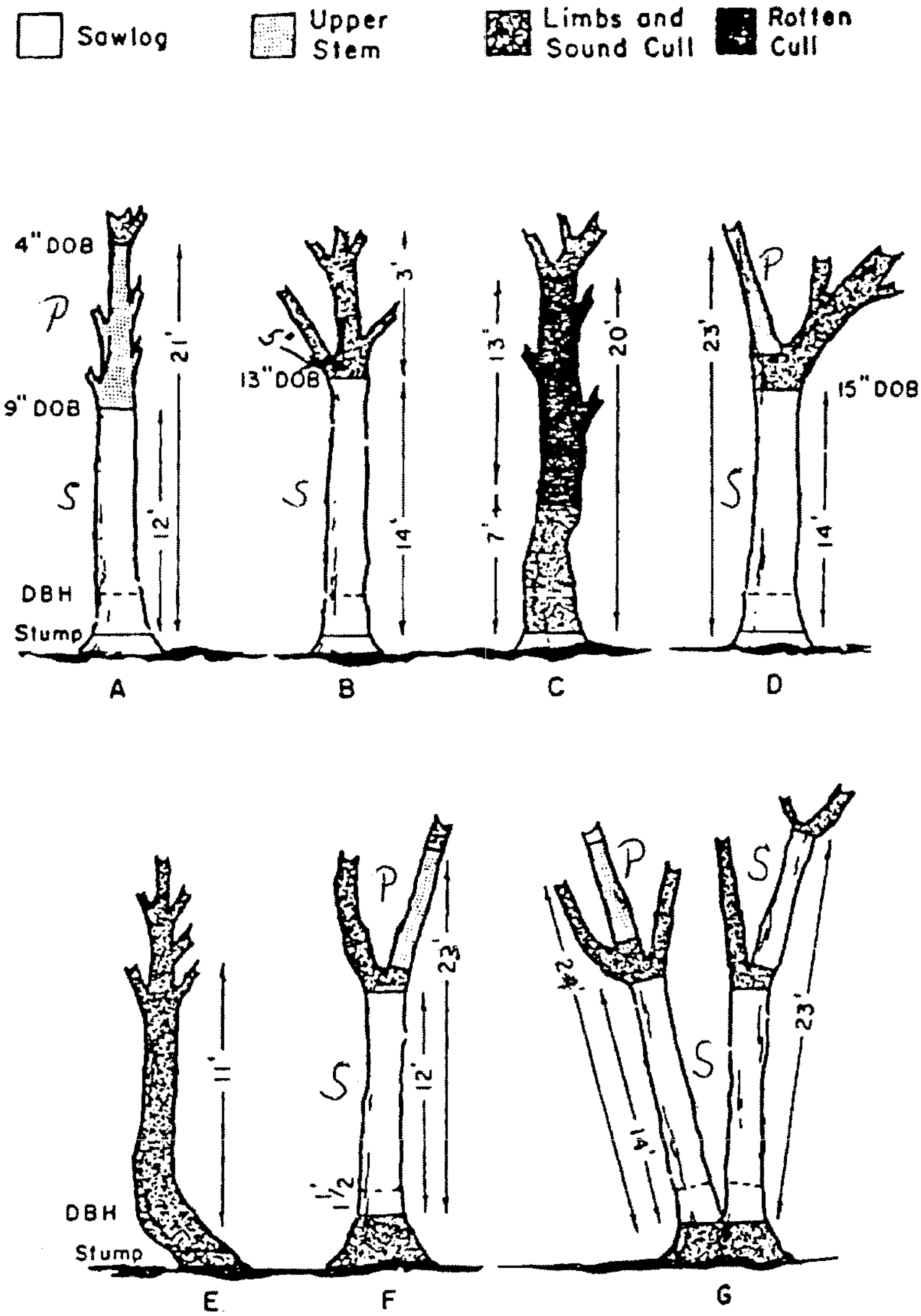


Figure 23 - Measuring Sawlog Trees

SAWBOLTS

Small sawlogs to be used as an optional product. Exact specifications are to be determined locally and stated on the sale proposal. These are measured in units of MBF.

RED PINE UTILITY POLES

Specialized product – *See American National Standards.*

CRUISING MANUAL

VOLUME ESTIMATES CRUISING METHODS

Cruising is the process of estimating timber volumes available on a tract of land. Volumes are normally determined in units of cords, board feet, pieces, or cubic feet. Generally, cruising is done for the following activities:

- Advance Payment Sales
- Scaled Sales
- Volume Agreement Sales
- Land Exchanges
- Trespass and Other Damage Appraisal
- Commercial Forest Act Withdrawal
- Management Plans

Many sampling (cruising) methods to estimate timber volumes are acceptable, provided they are used under proper conditions. The prime requisite for selecting a cruising method is to choose the method that, when combined with proper sample size, will do the job for the lowest cost. It is imperative that we select the method we know how to properly employ. The following is a brief description of the various cruising systems commonly used, and the conditions under which they are most suited.

VOLUME PER TREE CRUISE

1. 100% Tree Measurement

Technically, this is not a sampling method. The cruise is conducted by measuring all of the trees in the cruise area. In some cases, all or a portion of the trees may be judged for grade. This system is best used in situations where the measurement of each tree is either necessary or desirable. The use of this method should be limited to situations where trees-to-cut counts are small or where trees to be cut are distributed so as to make it just as costly to apply a sampling system. It should be typically applied on small marked tree sales where the expected tree count is under 1,500, or in conjunction with a sample cruise to pick up minor but very high valued species that have a high chance of not being picked up in the sample cruise at all.

The application of this system is warranted under the following conditions:

a. Number of trees to be cut is too small for practical sampling.
b. Extreme variation between tree sizes and volumes.
c. Defect occurrence is frequent.
d. Amount of defect is large.
e. Tree value is high.

This system usually involves the measurement of individual trees and estimating the volume of each tree. The use of a good volume table is a key factor in arriving at the right volume.

ADVANTAGES:

a. No sampling error.
b. Easy to understand.

DISADVANTAGES:

a. Usually time-consuming and costly.
b. If volume is calculated from individual tree measurement (DBH, height, defect, etc.), it results in a large amount of data to collect and process.
c. May force cruiser to do a lot of estimating to maintain production.

This method is appropriate for northern hardwood sales. To reduce costs, the 3-P system may be more economical under certain circumstances.

2. Sample Tree Measurement

This type of cruise is usually conducted in situations where the measurement of all trees is neither desirable nor necessary. It is conducted by counting every tree in the cruise area by species and selecting trees to cruise by a random or systematic method set to give a statistically adequate number of sample trees. This method should be used where trees are to be marked or where the stand is extremely variable. All sample trees are measured for gross and net volume. It works well in a marked pine thinning or a stand that is small and very variable. This cruising system is applicable where:

a. The number of trees is large enough to permit a representative sample selection.
b. The variation between trees or groups is not as great as natural occurrence or by stratification.
c. The area is large and not easily definable for other system use.
d. Trees can be readily counted as in marked stands.

Greater care in application of this method is necessary. All individual measurement must be accurately taken and the selection of sample trees must be without bias. Normally, for each selected sample tree, we measure DBH, height, defect, and quality. Volume determination is based on the individual tree volume, multiplied by the number of trees represented by the sample.

ADVANTAGES:

a. Reduces the number of trees to measure when compared to 100% cruises.
b. Fairly easy to understand.

DISADVANTAGES:

a. Sampling error introduced.
b. Tree selection method requires advanced stand knowledge.
c. Check cruise is difficult especially when trees are randomly selected.

VOLUME PER ACRE CRUISE

1. Variable Plot or Point Sampling

Variable plot cruises are best suited for clear-cut sales generally over 20 acres or in a larger partial-cut. In any case, the acreage must be accurate. In point sampling, there is a clear relationship between bias and the number of trees, which should be tallied at each point. A small basal area factor (BASF) requires the tallying of a relatively large number of trees per point and there is a tendency to under-estimate basal area. This bias is due mainly to missing trees because of poor light conditions, distance, dense understory, hidden trees and miss-counting. A statistically adequate number of trees should be measured to determine volume. There is consensus in forestry literature that point sampling is a more efficient technique than fixed plot sampling. It is quick, more convenient and cheaper than other methods. It is also a more reliable way to determine volume on an area basis when properly applied. The efficiency of point sampling can be improved by reducing the number of checked trees. This reduction can be achieved in two ways: 1) selection of a basal area factor which minimizes time and error, and 2) development of an efficient training method to instill proficiency in the use of point sampling. Point sampling is generally applicable in the following situations:

a. Large area with definitive boundaries.
b. Large volume of pulpwood and/or saw timber.

c. Timber not designated by marking.

It is recommended that the 100% tree tally method be used in northern hardwood types where trees are marked for cutting, and the point sampling method be used where trees to be cut are not marked and the plot density does not exceed one plot per acre. Other methods may be used under special conditions.

2. Standard of Accuracy

When using the point sampling system, the number of plots(n) to take in a cruise stratum in order to achieve the desired accuracy can be calculated by the following formula and using desired accuracy from Figure 24, or by the “Rule of Thumb” by Beers and Miller:

Formula:

$$n = \frac{4 * (C)^2}{(RE)^2}$$

Where:

n = Number of plots

C = Coefficient of Variation from:

a. Historical data
b. Nearby similar stand
c. Operation Inventory plot data
d. Several reconnaissance plots taken in the stand to be cruised

RE = Maximum allowable error from Standards of Accuracy -- Figure 24. Use one percentage point less than the maximum allowable error indicated by Figure 24 to allow for discrepancies.

NOTE: Both C and RE to be expressed as a percent, NOT as a decimal.

RULE: “Rule of Thumb” by T. W. Beers and C. I. Miller:

a. Never take less than 10 sample points.
b. If the area is less than 40 acres, take one sample point for each acre (e.g., if 32 acres, take 32 points).
c. If the area contains from 40 to 80 acres, take 40 sample points, plus one sample point for every 2 acres over 40 acres. (e.g., 60 acres would require: 40 + [60-40]/2 = 50 points).
d. If the area contains from 80 to 200 acres, take 60 points, plus one sample point for every 4 acres over 80 acres. (e.g., 100 acres would require: 60 + [100-80]/4 = 65 points).
e. For area greater than 200 acres, use the formula.

Use the Formula or “Rule of Thumb”, whichever indicates the lower number of plots with the following exceptions:

a. Generally do not take more than one plot per acre.
b. Never take less than 10 plots on an area of 10 acres to 40 acres.
c. For sale area of 40 acres or more, take a minimum of 30 plots.

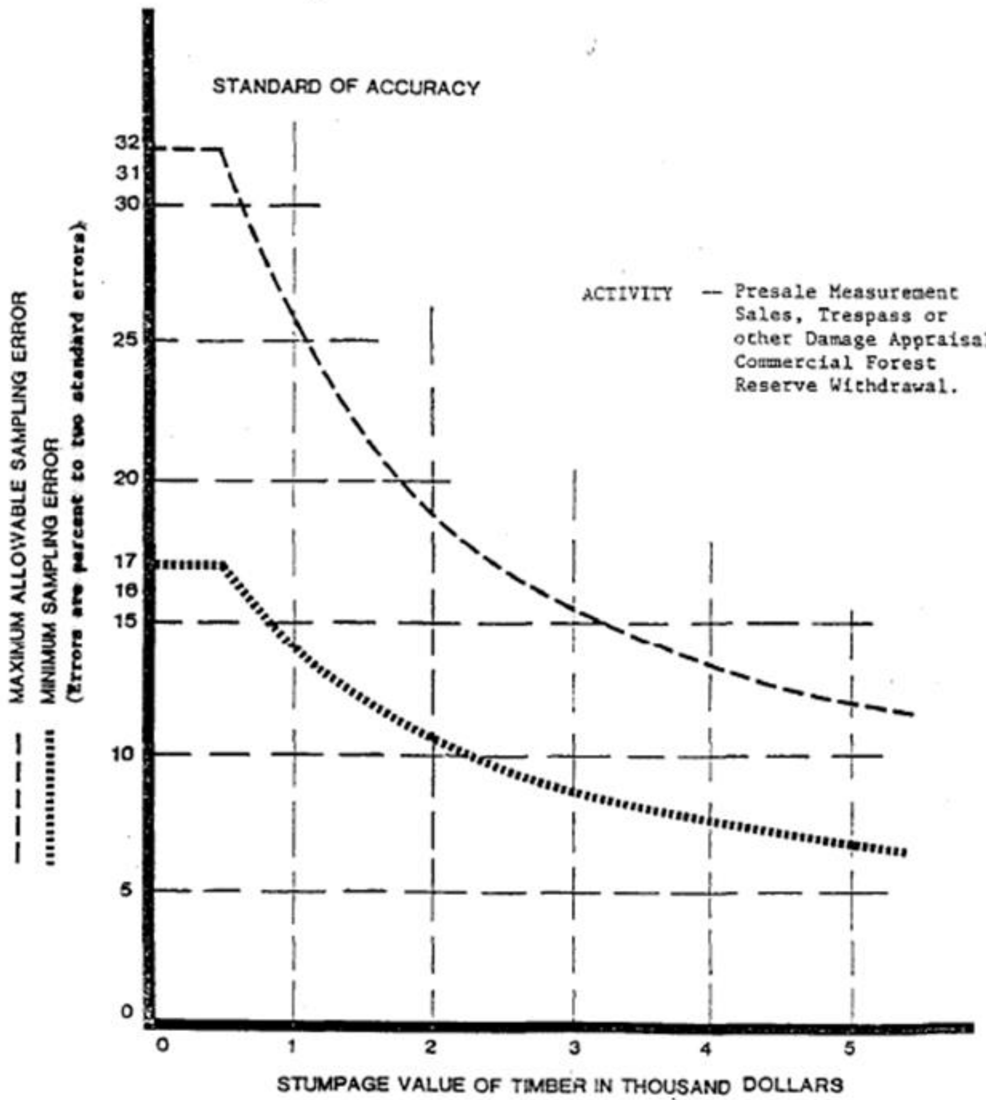


Figure 24 - Desired Accuracy

Stratification

Stratification is the process in which the units of a sampled population are grouped together on the basis of similarity of some characteristics. Each group or stratum is then sampled, and the group estimates are combined to give the total estimate. For example, if a sale consists of two stands, one is an R6 thinning and the other is an A6 clear-cut. Each one of these stands will be designated as a separate stratum. The volume is computed for each stratum and the total is combined.

The following general rules should be used for stratification:

One Stand Sale

1. Generally, one stand sales are designated as one strata, unless the stand can be divided into two or more separate stratum which are more uniform in basal area or volume per acre.
2. If the sale consists of one stand, but is cruised by two methods, then each method of cruise will be a separate stratum. For example, an M6 stand where sawlogs are cruised by total tally and the pulpwood by cumulative tally, then each cruise method should use a separate stratum. The compartment stand number and other information are the same, with the exception that the stratum number will be different. The proposal will indicate that the acreage is two times the actual acres of the stand. The User, following the cruise data entry, must correct the acreage on the proposal to the actual acres of the stand.

Multiple Stand Sale

1. If the stands are the same cover type and size density, indicating less variability in basal area and volume per acre, then the sale can be one stratum and each stand will be given the same stratum number. A typical example is a sale consisting of several stands of A6 that are to be clearcut.
2. If the stands are the same cover type but different size densities, then the stands should be divided into stratum. For example, two stands of A6 and two stands of A4. The A6 stands will be one stratum and the A4 stands will be another stratum.
3. If the stands are of a different cover type and/or different treatments, each stand should be designated as a separate stratum. Consider the following stands:

Stand	Cover Type/Size Density	Treatment
1	A6	Clearcut
5	J5	Clearcut
6	M6	Thinning
8	R6	Thinning
10	P6	Thinning

Each of these stands will be given a separate stratum number, and you will have five strata.

Point Sample Cruising

Recording Data Sampling

1. Each tree must be measured for DBH and DBH determines whether a tree is “in” or “out”.
   a. DBH is measured in accordance with Section 1 of the Product Standards, Diameter at Breast Height (DBH). In deep snow, the cruiser must compensate for snow depth.
   b. The limiting distance for a tree is determined by its DBH and the basal area factor (BAF) being used.
   c. A tree is “in” if it is within the limiting distance, given its DBH.
   d. Limiting distance is measured from plot center horizontally to the center of the tree at the location where DBH was measured.

e. True borderline trees are very rare. If DBH is rounded down to the nearest 1/10 inch and limiting distance is measured to the smallest unit on a logger's tape, e.g., 1/100 of a foot, true borderline trees are extremely uncommon.

f. The Limiting Distance Table (LDT) is the final word on "in" and "out" trees. A tree may appear "in" with the instrument, but be "out" by the LDT and visa-versa. This occurs because the instrument "assumes" the tree is a perfect cylinder, when in reality the tree may be wapiti sided. Whether a tree is "in" or "out" is based on the DBH and the distance from the center of the tree at DBH to the point center, not on what is seen through the prism/angle gauge.

g. One of the biggest errors you can make in point cruising is to miss a tree or add a tree. Each tree on a point sample represents numerous trees on an acre; therefore, an incorrect call on a borderline tree is an incorrect call on many trees. For example, a 12" dbh "in" tree measured with a 10 BAF prism represents 12.74 trees/acre. If this was red pine tree containing 4 saw sticks (to a 7.6" DIB), then this would represent about 1,274 board feet per acre (International ¼"). If red pine was going for $200/mbf, then the tree represents a value of $255/acre.

2. Cumulative Tally

Total trees and total sticks, and the total sawlog trees and total sawlog sticks, will be recorded per species, per plot, for each "in" tree. Use Form R4039-1 Cumulative/V-Bar Tally Card. If there are no sawtimber trees, leave the appropriate fields blank or zero. If there are only sawtimber trees and sticks, the total number of trees and sticks is the same as the number of sawtimber trees and sticks. Use this method for sales with 90% or more of the volume in pulpwood. For sales with a significant portion of sawlogs and you are point cruising, use the VBAR tally method. The Cumulative tally method only gives you a rough estimate of sawlog volume.

3. VBAR Tally

The number of pulpwood sticks and the number of sawtimber logs and the number of trees for each combination of number of pulpwood sticks and number of sawtimber logs, will be recorded per species, per plot, for each "in" tree. Use Form R4039-1 Cumulative/V-Bar Tally Card. If the number of pulpwood sticks or number of sawtimber logs is zero, you may leave the appropriate field blank. If you are point cruising, use this method for sales with a significant portion of sawlogs.

4. Basal Area Factor (BAF)

a. When point sampling, use a BAF that matches stand density. Research has shown that approximately 4 to 8 "in" trees per point on average works best. For a single cruise area (strata), use the same BAF for the entire area. Before cruising the area, determine which BAF will average 4 to 8 "in" trees per plot. Therefore, cruisers should carry multiple prisms/angle gauges or a relaskop. Contractors should use the BAF specified in the prescription.

A December 19, 1986 memo from Chief Webster, gave the following direction:

> Research has indicated that under certain circumstances the use of a 20 factor cruising can be more accurate than the 10 factor prisms and angle gauges that we have used in the past. Trials in the field have also shown a time savings of up to 25 percent. The 20 factor reduces the number of trees sampled by half and results in all trees sampled being closer to the plot center. This reduces the number of borderline and hidden trees and reduces the chance of error in individual tree measurements. In lightly stocked stands there is a danger of the 20 factor resulting in under sampling.
>
> To take advantage of this new information we are requesting that 20 factor basal area prisms be used on all stands with a basal area of 100 square feet and greater. Stand basal area can be determined from operation inventory data but should be verified as being over 100 square feet by the first few plots of the cruise. If the stand appears to be under 100 square feet in basal area, the cruise should be done with 10 factor.

According to Ken Xydias in his article Cruise Design Strategies (The Consultant, Summer 1995, p. 22- 23):

As a plot grows larger, its boundaries become harder to define. Even though a prism plot doesn't have fixed boundaries, it's thought of in that way. A smaller factor prism will show more "in" trees, and we have to look farther from the plot center to make sure they are all tallied. Actually, the chances increase that trees will be missed, especially in brushy conditions. A smaller factor also will show more border trees that must be measured precisely to determine if they are actually "in" or "out".

b. All prisms/angle gauges should be calibrated. Except for more expensive instruments, such as a relaskop, the BAF will not always match that listed on the package, though they are usually guaranteed at ±1%. The reason we calibrate our prism/angle gauges is to discover their inaccuracies, not to cruise with an "odd" gauge instrument.

c. All cruisers should carry a Limiting Distance Table (LDT)/Plot Radius Factor (PRF) Table for the BAF they are using. Therefore, cruisers should carry multiple LDTs.

d. Borderline trees must always be checked. No matter how accurate the instrument, your eye has limitations. Do not count every other borderline tree as "in" or "out". This would create a bias.

e. TSale can handle any BAF to two decimal places.

f. For ease and clarity of quality control, we should use the following BAFs: 5.00, 10.00, 20.00 and 40.00.

   1. Regardless of the accuracy of your prism/angle gauge, the decision on whether a tree is "in" or "out" is based upon the LTD, not on your prism. There is only one correct "answer" for any one tree.
   2. All contractors must cruise with a 5.00, 10.00, 20.00 or 40.00 LDT.
   3. The reason we calibrate our point cruising instruments is to discover their inaccuracies, not to cruise with an "odd" gauge instrument.
   4. DNR staff with a 9.85 BAF calibrated prism could cruise with a 9.85 LDT, and TSale would accept the data. If DNR staff points are check cruised, the check cruiser would need to cruise with a 9.85 BAF LTD.
   5. It would be more straightforward, if DNR staff with a 9.85 BAF prism cruised with a 10.00 LDT and adjusted their "eyes" accordingly.

5. Boundary or Edge Points

The point cruising method is designed to work where trees from all directions and distances could potentially be "in". When a point center falls near the boundary of a unit, only those trees that are in the unit can be considered. This means that there are directions where trees from all distances cannot be considered. This problem commonly referred to as "edge-effect bias" or "boundary overlap", can introduce a bias in the point cruise statistics, if it is not treated properly. These types of points are called "boundary points" or "edge points". Points falling near forest edges must be adjusted for, particularly in small stands or long narrow stands. Failure to adjust for edge trees will result in a biased sampling method which will underestimate timber stand volume, because trees near the edge are less likely to be selected on a per unit stand/sale area basis.

Current literature suggests a number of ways to handle boundary points, e.g. half point, quarter point, mirage point, reflection and walkthrough. The common practice of either rejecting sample points that fall near the boundary or moving such points away from the boundary can be detrimental and lead to bias.[1] When point sampling, staff should use the walkthrough method[2] which diminishes or eliminates the need to work outside the tract and accommodates irregular boundaries easily. Under typical conditions, the walkthrough method eliminates the boundary overlap bias associated with most objects near the border and reduces it for the remaining objects.

[1] Sampling at the stand boundary: A comparison of the statistical performance among eight methods. T.G. Gregoire; C.T. Scott. In Proc. XIX IUFRO World Congress, Aug. 5-11, 1990, Montreal. Publ. FWS-3-90, VPISU, Blacksburg, VA.

[2] A Walkthrough Solution to the Boundary Overlap Problem. Mark J. Ducy; Jeffrey H. Gove; Harry T. Valentine. Forest Science; Aug 2004; 50, 4; Sciences Module pg. 427

Walkthrough: For any tree that is "in", measure the distance from the point center to the tree, then measure that same distance beyond the tree. In other words, walk through the tree the same distance the tree is from point center. If the ending point is outside the boundary, the tree is recorded a second time (Figure 25.).

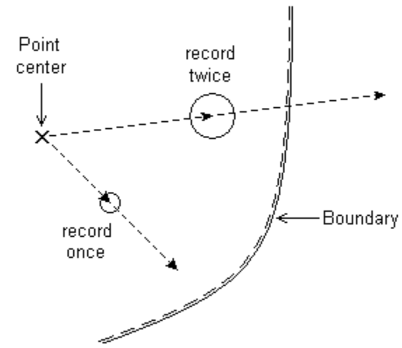


Figure 25 - Walkthrough Point

Table 1 - A Decision Key for Field Implementation of the Walkthrough Method

The key is entered whenever a tallied object appears close to the boundary.[3]

I. Is it possible that the tallied object is closer to the boundary than to the sample point?
- Ia. NO – No action needed. Tally the object normally.
- Ib. YES – Proceed to II.

II. Measure the distance from the sample point to the object – call the distance ***x*.** Now measure the distance from the object to the boundary, continuing on the same bearing. Call this distance ***y*.** Is ***y*** less than ***x***?
- IIa. NO – No action needed. Tally the object normally.
- IIb. YES – Proceed to III.

III. Does the boundary curve back across the walkthrough line?
- IIIa. NO – Walkthrough point must be outside the tract. Double-tally the object.
- IIIb. YES – Proceed to IV.

IV. Move to the walkthrough point, so that the distance to the object equals the previously measured distance along the same bearing, or to a point where that location can be clearly identified. Is the walkthrough point inside the tract?
- IVa. NO – Double-tally the object.
- IVb. YES – Tally the object normally.

[3] A Walkthrough Solution to the Boundary Overlap Problem. Mark J. Ducy; Jeffrey H. Gove; Harry T. Valentine. Forest Science; Aug 2004; 50, 4; Sciences Module pg. 427

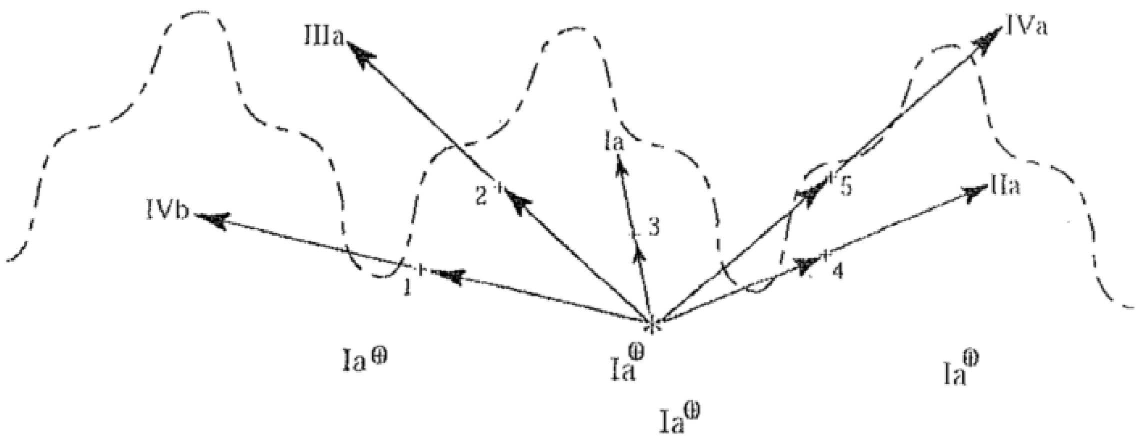


Figure 26 - Graphic Illustration of the Walkthrough Method

Five sample objects (+), lying close to the boundary, have been tallied from a sample point (*). The arrows indicate the layout of the walkthrough points for each object; the outcome on the key in Table 1 is indicated for each walkthrough point. Objects 1, 3, and 4 are tallied normally; objects 2 and 5 are double-tallied. Four objects (>) lie "close to the boundary", but in positions where they would be single-tallied, and no measurements would be needed.

The walkthrough method works well with curved or irregular boundaries. It also works even if a person cannot go beyond the boundary, i.e. the boundary is a fence, lake or cliff.

PULPWOOD ESTIMATION

1. Single stem trees that contain only pulpwood (Figure 26., Example A).
   a. Count the number of pulpwood sticks. Record as total sticks.
2. Multi stemmed trees that contain only pulpwood (Figure 26., Examples C & D).
   a. Count the number of 100" sticks in the dominant stem. Count the total number of 100" sticks contained in the miscellaneous merchantable limbs. Take 1/3 of this (rounded off to the nearest whole number) and add to the main stem total for total number of recordable pulpwood sticks. Record as total sticks.
   b. The dominate stem is the one that contains the greatest value.

SAWLOG ESTIMATION

1. Single stem trees that contain only sawlogs.
   a. Count the number of sawlog sticks. Record as total sticks.
2. Single stem trees that contain sawlogs and pulpwood. (Figure 26., Example B).
   a. Count the number of sawlog sticks. Record as sawlog sticks.
   b. Count the number of sawlog and pulpwood sticks. Record as total sticks.

MIXED PRODUCT ESTIMATION

1. Trees that contain sawlogs and pulpwood in the dominant stem, but also contain pulpwood in other stems or limbs. We often call this "other" wood miscellaneous merchantable pulpwood (Figure 26., Examples E, H, & J).
   a. Count the number of 100" sawlogs in the dominant stem and record as sawlog sticks.
   b. Count the number of 100" pulp sticks in the dominant stem.

c. Count the miscellaneous pulpwood sticks in the rest of the tree, divide by 3 and round to the nearest whole number. Add to this number the count of pulpwood sticks in the dominant stem and the count of sawlogs in the dominant stem. Record the result as the total number of sticks.

d. Note that the dominant stem is the one that contains the greatest value.

2. Forked Trees

a. Forks less than 4.5 feet above the ground: cruise each stem as a separate tree.

b. Forks greater than 4.5 feet above the ground and multi forked/multi topped trees that contain entirely pulpwood (Figure 26., Examples C & D).

1. Count the total number of sticks in the dominant stem.
2. Count the miscellaneous pulpwood sticks in the rest of the tree, divide by 3 and round to the nearest whole number. Add to this number the count of pulpwood sticks in the dominant stem.
3. Record the result as the total number of sticks.

c. Forks over 4.5 feet where one stem contains sawlogs and the other stem(s) pulpwood (Figure 26., Example G).

1. The sawlog stem is considered dominant due to higher value.
2. Count the number of sawlogs in the dominant stem and record as total sawlogs.
3. Count the number of pulpwood sticks in the dominant stem.
4. Count the miscellaneous pulpwood sticks in the rest of the tree, divide by 3 and round to the nearest whole number. Add to this number the count of pulpwood sticks in the dominant stem and the count of sawlogs in the dominant stem.
5. Record the result as the total number of sticks.

d. Forks over 4.5 feet where both stems contain at least one sawlog (Fig. 26., e.g. F, I, K).

1. Count all sawlogs below the fork (if any).
2. Count all sawlogs above the fork; divide by 2, rounding up to the nearest whole log.
3. Add to this number the count of sawlogs below the fork and record as total sawlogs.
4. Count the number of pulpwood sticks in the dominant stem.
5. Count the miscellaneous pulpwood sticks in the rest of the tree, divide by 3 and round to the nearest whole number. Add to this number the pulpwood sticks in the dominant stem and the total sawlogs.
6. Record the result as the total number of sticks.

Point Sample Cruising Examples

Example (A) Two, 100” pulpsticks. Record as 1 tree and 2 total sticks.

Example (B) One, 100” sawlog and one 100” pulpstick. Record as 1 tree with 2 total sticks and 1 log stick.

Example (C)

1. Three, 100” pulpsticks going up the dominant stem.
2. Two, 100” miscellaneous pulpsticks in the other stem. Using the $^1/_3$ Rule, divide the two sticks by 3. This equals 0.66 which rounds to one miscellaneous pulpstick.
3. Record as 1 tree with 4 total sticks.

Example (D)

1. Three, 100” pulpsticks going up the dominant stem.
2. One, 100” miscellaneous pulpstick in the other stem. Using the $^1/_3$ Rule, divide the one stick by 3. This equals 0.33 which rounds to zero miscellaneous pulpsticks.
3. Record as 1 tree with 3 total sticks.

Example (E)

1. Two, 100” sawlogs.
2. One, 100” miscellaneous pulpstick in the branches. Using the $^1/_3$ Rule, divide the one stick by 3. This equals 0.33 which rounds to zero miscellaneous pulpsticks.
3. Record as 1 tree with 2 total sticks and 2 log sticks.

Example (F)

1. There are no 100” sticks below the fork. The tree has 3, 100” sawlogs above the fork. Since there are sawlogs in multiple stems above the fork, count all sawlogs above the fork and use the ½ Rule. Take ½ of the total sticks above the fork and round to the nearest whole number. In this case, 3 divided by 2 equals 1.5, which is rounded to 2.
2. The fork that has 2 sawlogs is the dominant stem (most value). The fork that has 1 sawlog and 1 pulp stick is considered miscellaneous for the purpose of counting pulpsticks. There is 1 pulpstick in the miscellaneous fork and using the $^1/_3$ Rule, this rounds to 0.
3. Record as 1 tree with 2 total sticks and 2 log sticks.

Example (G)

1. The limb or fork that contains 2, 100” sawlogs is considered dominant because of value. The only sawlogs in the tree are in this dominant stem, so the ½ Rule <u>does not</u> apply.
2. The limb that contains 2, 100” pulpsticks is considered miscellaneous. The $^1/_3$ Rule applies, so the 2 sticks are divided by 3 which equals 0.66 and is rounded up to 1.
3. Record as 1 tree with 3 total sticks and 2 log sticks.

Example (H)

1. The dominant stem contains 2, 100” sawlogs and 2, 100” pulpsticks.
2. The miscellaneous limb contains 1, 100” pulpstick. Using the $^1/_3$ Rule gives 0.33 which is rounded to 0.
3. Record as 1 tree with 4 total sticks and 2 log sticks.

Example (I)

1. Tree has 1, 100” sawlog below the fork.
2. Tree has 2, 100” sawlogs above the fork, 1 per limb so the ½ Rule applies.

Example (A) Two, 100” pulpsticks. Record as 1 tree and 2 total sticks.

Using the ½ Rule, divide the number of sawlogs above the fork by 2, which gives you 1.

3. This tree has 2 recordable 100” sawlogs.
4. Either stem could be dominant, so there is 1, 100” pulpstick in the dominant stem. The other 100” pulpstick is considered miscellaneous and using the $^1/_3$ Rule will round to 0.
5. Record as 1 tree with 3 total sticks and 2 log sticks.

Example (J)

1. Dominant stem contains 1, 100” sawlog and 2, 100” pulpsticks.
2. Other limbs are miscellaneous pulp and contain 3 pulpsticks. Using the $^1/_3$ Rule, 3 divided by 3 gives you 1 pulpstick.
3. Record as 1 tree with 4 total sticks and 1 log stick.

Example (K)

1. This tree has 1, 100” sawlog below the fork.
2. This tree has 2, 100” sawlogs above the fork. Using the ½ Rule, divide by 2, which gives you 1 log above the fork.
3. This tree has 2 recordable sawlogs.
4. This tree has 2 pulpsticks in the dominant stem.
5. Other limbs are miscellaneous pulp and contain 2 pulpsticks. Using the $^1/_3$ Rule, 2 divided by 3 equals 0.66 which rounds to 1 pulpstick.
6. Record as 1 tree with 5 total sticks and 2 log sticks.

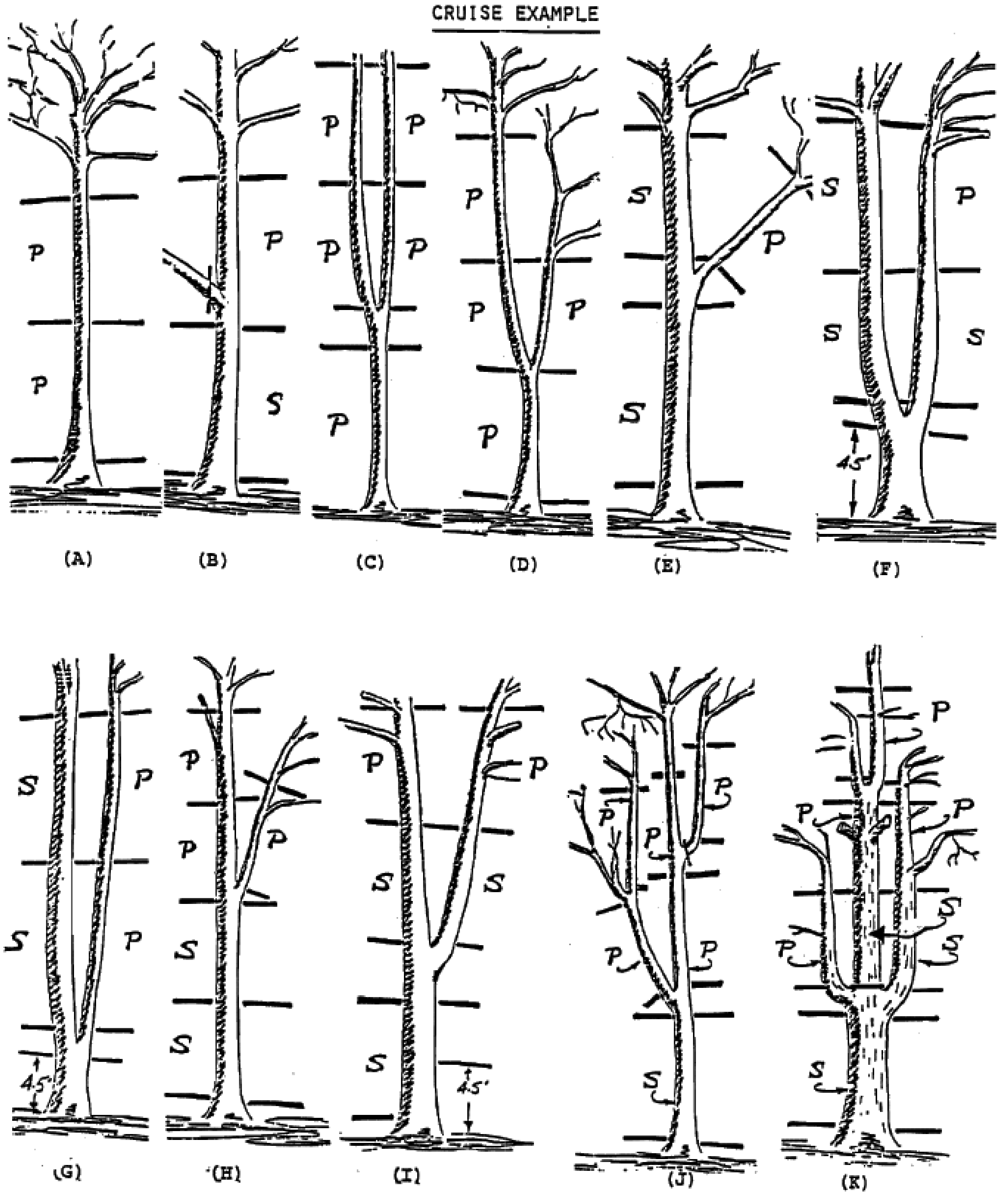


Figure 27 - Cruise Examples

100% TALLY CRUISING

MARKING TALLY OR MARK AND TALLY

In a sawtimber tree, record DBH and the number of sawtimber logs, and the number of pulp sticks in the sawtimber section; do not record pulpwood beyond the sawtimber section. In a pulpwood tree, record DBH and the total number of pulpwood sticks. Use Form R4039-2 Marking Tally (Large Pulp) Card. Sticks are recorded on a per tree basis. Pulpwood sticks beyond the sawtimber section are not recorded because residual pulpwood volumes are calculated as a function of the log volume (i.e., all sawtimber trees are assumed to have some residual pulpwood volume). DBHs must be an even number. The smallest DBH is 6", and the minimum sawtimber DBH is 10".

In Mark and Tally, any percentage of the trees marked can be tallied, from 1% to 100% (in whole numbers). TSale will then compute volumes based on the appropriate multiplying factor. For example, if you indicate that you are cruising only 5% of the stand, the volume for each tree you tally is multiplied by 20.

PULPWOOD ESTIMATION FOR SINGLE STEM AND MULTI-STEM TREES THAT CONTAIN ONLY PULPWOOD

1. Measure the diameter at 4.5 feet, and count the number of sticks.
2. If the lower portion of the tree is unmerchantable due to rot, estimate the diameter 4.5 feet up from where the first merchantable stick begins.
3. For each tree, record species, diameter and number of pulpwood sticks.

SAWLOG ESTIMATION FOR SINGLE STEM AND MULTI-STEM TREES

1. Record diameter at 4.5 feet, and number of sawlog sticks.
2. If the lower portion of the tree is unmerchantable due to rot or swelling, estimate the diameter 4.5 feet up from where the first merchantable log begins.
3. For each tree, record species, diameter and number of sawlog sticks.
4. It is not necessary to count the pulpwood sized sticks above sawlogs. Pulpwood volume above the logs is computed based on a ratio of sawtimber.

MIXED PRODUCT SPECIAL CASE

If a large pulpwood stick (log sized less than grade 3) occurs in the sawlog sized portion of a tree, this must be tallied for the proper volume to be calculated. In this case, record the number of sawlogs, but also the number of large pulpwood sticks. For example, an 18" sugar maple with 4 sticks in the sawlog sized portion of the tree where the 1st, 3rd and 4th sticks are considered pulp, 1 sawlog stick and 3 pulpwood sticks would be recorded. Since the first stick is pulpwood, the DBH would be estimated from the first sawlog (Figure 27).

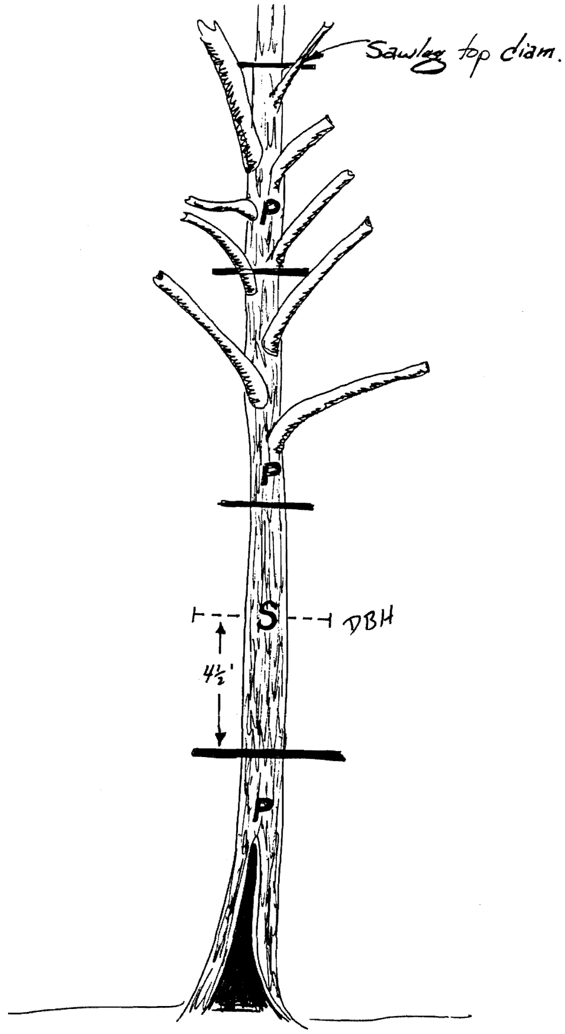


Figure 28 - Sawtimber Tally Tree with Large Pulp

CHECK CRUISING

INSPECTION FOR ACCURACY OF VOLUME ESTIMATION IN MARKED STANDS

For sawlog trees, where the number of sawlog sticks are shown by the number of paint dots on the bole, the accuracy of the sawlog cruise will be checked by the use of check-points. The number of check-points to be established in any area will be equal to at least 10% of the check area, e.g. a 40 acre check area will require at least 4 check-points. These points will be randomly distributed across the check area. These points may also be used to inspect for adherence to the marking prescription, as described below.

On each check-point, all sawlog trees that are "in" will be measured and tallied. The Check Cruiser's sawlog tally of each tree will be compared to the Cruiser's paint dot tally. Trees will be compared on a one-to-one basis (Check Cruiser to Cruiser) and points will be assigned to each tree based on how the paint dots compare to the Check Cruiser's tally of the same tree. One point will be subtracted for each stick difference between the Cruiser and the Check Cruiser. For example, a perfect score would occur when the Cruiser's dot tally equals the Check Cruiser's dot tally (in this case, no points would be missed). A Check Cruiser tally of 5 and a Cruiser's paint dot tally of 3 would produce a score of 2.

Each check-point will have a score for total points missed and total sticks. The check-points will then be summed for total points missed and total sticks. The final score will be determined by the percent of total points missed to total sticks. If the Cruiser's score falls between 0%-20%, then the Cruiser's dot tally will be considered accurate. If the Cruiser's score is greater than 20%, the dot tally will be considered inaccurate.

Example:

Marked Sawlog Check Cruise[1]

Point	Cruiser's Logs	Check Cruiser's Logs	Difference
1	2	2	0
1	3	3	0
1	1	1	0
2	0	1	1
2	2	1	1
2	3	4	1
3	1	2	1
3	2	2	0
3	3	3	0
TOTAL	--	19	4

[1] From form R4039-3 Marking Prescription & Sawlog Check.

SCORE: $4/19 * 100 = 21\%$ **Note: ≤ 20% to pass.**

1. For pulpwood trees, where the trees were sampled by point cruising with cumulative tally, the Check Cruiser will check the accuracy of the cruise by inspecting at least 10% of the cruise points. The number of check-points to be established in any one check area will be equal to at least 10% of the check area acreage, e.g. a 40 acre check area will require at least 4 check points.

   On the check-point, all pulpwood trees that are "in" will be measured and tallied by species. The Cruiser's tally card will be compared to the Check Cruiser's tally and points will be assigned to the Cruiser-tally based on a comparison with the Check Cruiser tally. One point will be assigned for each stick count difference and for each tree count difference by species between the Cruiser and the Check Cruiser. If a species is miss-identified, but the tree was cruised, points off for that tree will only be recorded once (see example). A perfect score for a check-point would occur when the Cruiser's sticks and trees by species equal the Check Cruiser tally (in this case, no points would be assessed). A Check Cruiser tally of 10 sticks and 3 trees for sugar maple and 3 sticks and 1 tree for red maple compared to a Cruiser tally of 8 sticks and 2 trees for sugar maple and 2 sticks and 1 tree for red maple would produce a score of 4.

   The final score will be determined by taking the sum of all the Cruiser's points and comparing them to the Check Cruiser total (all sticks plus all trees by all species). If the Cruiser score falls between 0%-20%, then the Cruiser tally will be considered accurate. If the Cruiser's score is greater than 20%, the tally will be considered inaccurate.

Example:

Cumulative Tally Check Cruise for Marked Pulp (form R4039-5)

Point	Species	Cruiser		Check Cruiser		Difference	
		Total Trees	Total Sticks	Total Trees	Total Sticks	Total Trees	Total Sticks
6	01	1	2	1	2	0	0
6	03	2	4	2	4	0	0
6	04	1	1	1	1	0	0
6	05	1	3	1	3	0	0
13	01	1	4	1	3	0	1
13	03	2	7	1	4	1	3
13	04	1	2	1	2	0	0
16	03	1	3	1	2	0	1
16	05	2	7	1	3	1	4
16	06	0	0	1	4	0[1]	0[1]
TOTAL	--	--	--	11	28	2	9
				39		11	

[1]On point 16, the Cruiser called a white ash a basswood. Note that she had 2 basswood trees with 7 sticks, when she should have cruised 1 basswood with 3 sticks and 1 white ash with 4 sticks. Since the points off for calling a white ash a basswood were taken on the basswood line of the tally sheet, there are no additional points taken on the white ash line of the cruise sheet. This is done to prevent "double jeopardy" for missing a species.

SCORE: Total Trees & Sticks Score: 11/39 ∗ 100 = 28% **Note: ≤ 20% to pass.**

2. For pulpwood trees, where the trees were sampled on a ratio basis, e.g. 1:50, and the number of sticks in any particular tally tree are shown by the number of slash marks on the bole, the Check Cruiser will check for accuracy by sampling at least 25% of the pulpwood tally trees, e.g. 10 tally trees will be checked in an area where 40 were sampled.

   Trees will be compared on a one-to-one basis (Check Cruiser to Cruiser) and points will be assigned to the Cruiser-tallied tree based on how the tree compared to the Check Cruiser's tally of the same tree. One point will be assigned for each stick difference between the Cruiser and the Check Cruiser. For example, a perfect score would be when the Cruiser slash tally equals the Check Cruiser slash tally (in this case, no points would be assessed). A Check Cruiser tally of 5 and a Cruiser tally of 3 would produce a score of 2.

   The final score will be determined by taking the sum of all points and comparing these to the Check Cruiser total tally. If the Cruiser score falls between 0%-20%, then the Cruiser tally will be considered accurate.

Example:

Marked and Sampled Pulp Check Cruise (form R4039-4)

Tree #	Cruiser's Sticks	Check Cruiser's Sticks	Points Off
1	3	3	0
2	2	1	1
3	4	3	1
4	6	6	0
5	3	3	0
TOTAL	N/A	16	2

SCORE: $2/16 * 100 = 12\%$ **Note: ≤ 20% to pass.**

INSPECTION FOR ADHERENCE TO THE MARKING PRESCRIPTION

1. Evaluation Factors. For marked stands, the Check Cruiser will randomly locate points within the marked area to check for adherence to the marking prescription. These points may be the same points as used for inspecting volume estimation. The following factors will be considered in determining whether or not a stand has been satisfactorily marked:

   a. Residual basal area. The cumulative cross sectional area in square feet of trees measured at DBH remaining after a harvest.

   b. Crop trees. A crop tree is a tree of any species that contains a straight, single stem capable of producing at least 16 feet of clear lumber. It also is a tree that has a large, full-bodied crown that occupies a dominant or co-dominant position in the overstory and contains no apparent major defects. If no tree can be found to meet the criteria, then the best tree available in any one place will be designated as the crop tree (called "best tree in place").

   c. Must-cut trees. A must-cut tree is defined as a tree that is adjoining a crop tree with a crown that is found to interfere and impact the crown of the crop tree.

2. Evaluation Criteria. The check-points described above will be placed randomly by the Check Cruiser throughout the marked area to check for residual basal area, crop trees and must-cut trees. A 10 BAF prism will be used on these "point sample" check plots. The number of check-plots to be established in any one check area will be equal to at least 10% of the check area acreage, e.g. 40 acres will require at least 4 check plots.

   a. Acceptable residual basal area will be defined as within ±10 square foot of the basal area goal for the check area. In addition, at least 70% of the plots sampled must come within this 10 square foot target.

      There are exceptions to the "±10 square foot " rule. A Check Cruiser can accept plots that fall outside this limit, if the Check Cruiser feels there is an acceptable silvicultural justification. For example, if the prescription calls for marking to 80 square feet, and the initial BA of the point is 60 square feet, and one tree with Eutypella canker was marked so that the residual BA is 50 square feet, this point could be considered acceptable.

   b. The Check Cruiser, on each individual check plot, should be able to identify at least one crop tree. At least 70% of all plots sampled should contain at least one crop tree.

      In hardwood stands where marking for crop tree release, the Check Cruiser, on each individual check plot, should be able to identify at least 2 must-cut trees adjoining a crop tree in situations where crop trees are greater than 9" DBH. In situations where crop trees are less than 9" DBH, the

Check Cruiser should be able to identify a 7 foot wide “release zone” around the crown of a crop tree. All the trees that make up this release zone will be considered must-cut trees and should be marked. Overall, at least 70% of plots sampled should contain at least 2 must-cut trees or one 7 foot release zone.

If any of these three check items (residual BA, crop trees, must-cut trees) fall outside of the tolerance levels as outlined, the area will be considered improperly marked.

Some marking jobs, especially in hardwoods, can be quite variable. Because of this variation, the prescription may define procedures that vary from the standards. If this occurs, then the prescription standards take precedent.

Example:

Marking Prescription Quality Check[1]

Point	Initial BA	Residual BA	Within Target?	Crop Tree	Must Cut	
		Target = 80	±10%		≥9” DBH	<9” DBH
1	100	80	Y	Y	Y	
2	120	100		Y		
3	80	70	Y	Y	Y	
4	90	90	Y			
5	120	80	Y	Y		Y
6	130	100		Y	Y	
7	60	50	Y[2]	Y	Y	
8	90	80	Y	Y		Y
9	80	70	Y	Y	Y	
10	70	50				
	94[3]	77[3]	7	8	5	2
					7	

[1] From form R4039-3 Marking Prescription & Sawlog Check.

[2] BA is low, but crop tree released with a must cut tree. O.K. point. (The Check Cruiser should make footnotes to explain exceptions.)

[3] Note that these averages include all points, even the point with low initial BA (60) and residual BA (50). The Check Cruiser does not use these numbers to evaluate the quality. These numbers are only calculated for general information. The evaluation of acceptable residual BA is done in the column “Within Target”. In this case, it is based on 7 out of 10 points being a “Yes”. It is not based on the average residual of 77 square feet.

Residual BA: $7/10 * 100 = 70\%$ **Note: 70% to pass.**
Crop Trees: $8/10 * 100 = 80\%$ **Note: 70% to pass.**
Must Cut Trees: $7/10 * 100 = 70\%$ **Note: 70% to pass.**

Inspection for Accuracy in Cumulative V-BAR Tally Cruised Stands

Where the trees were sampled by point cruising with cumulative V-BAR tally, the Check Cruiser will check the accuracy of the cruise by inspecting at least 10% of the cruise points. The number of check-points to be established in any one check area will be equal to at least 10% of the check area acreage, e.g. a 40 acre check area will require at least 4 check points.

On the check-point, all trees that are "in" will be measured and tallied by species – total trees and sticks and total sawlog trees and sawlog sticks will be recorded. The Cruiser's tally card will be compared to the Check Cruisers tally. Points will be assigned to the Cruiser-tally based on a comparison with the Check Cruiser tally. One point will be assigned for each stick and each tree difference, by species, between the Cruiser and the Check Cruiser. If a species is misidentified, but the tree was cruised, points off for that tree will only be recorded once (see example). A perfect score for a check-point would occur when the Cruiser's sticks and trees, by species, equal the Check Cruiser tally (in this case, no points would be assessed). A Check Cruiser tally of 10 sticks and 3 trees for sugar maple total trees and 3 sticks and 1 tree for sugar maple sawlog trees compared to a Cruiser tally of 8 sticks and 2 trees for sugar maple total trees and 2 sticks and 1 tree for sugar maple sawlog trees would produce a score of 4.

The final score will be determined by taking the sum of all the Cruiser's points and comparing them to the Check Cruiser total (all sticks plus all trees). If the Cruiser score falls between 0%-20%, then the Cruiser tally will be considered accurate. If the Cruiser's score is greater than 20%, the tally will be considered inaccurate.

Example:

Cumulative Tally Check Cruise (form R4039-6)

		Cruiser's				Check Cruiser's				Points Off			
		Total		Logs		Total		Logs		Total		Logs	
Pt	**Sp**	**Tr**	**St**	**Tr**	**St**	**Tr**	**St**	**Tr**	**St**	**Tr**	**St**	**Tr**	**St**
1	01	1	1	1	1	1	1	1	1	0	0	0	0
8	03	5	20	2	4	4	16	2	4	1	4	0	0
8	05	1	6	0	0	0	0	0	0	1	6	0	0
8	06	0	0	0	0	1	6	0	0	0[1]	0[1]	0	0
	--	--	--	--	--	**6**	**23**	**3**	**5**	**2**	**10**	**0**	**0**
						37				**12**			

[1]On point 8, the Cruiser called a white ash a basswood. Note that she had 1 basswood tree with 6 sticks and no white ash trees. She should have cruised 0 basswood trees and 1 white ash with 6 sticks. Since the points off for calling a white ash a basswood were taken on the basswood line of the tally sheet, there are no additional points taken on the white ash line of the cruise sheet. This is done to prevent "double jeopardy" for missing a species.

SCORE: $12/37 * 100 = 32\%$ **Note: ≤ 20% to pass.**

Inspection for Accuracy in V-BAR Tally Cruised Stands

Where the trees were sampled by point cruising with V-BAR tally, the Check Cruiser will check the accuracy of the cruise by inspecting at least 10% of the cruise points. The number of check-points to be established in any one check area will be at least 10% of the check area acreage, e.g. a 40 acre check area will require at least 4 check points.

On the check-point, all trees that are "in" will be measured and tallied – number of pulpwood sticks and the number of sawlog sticks and the number of trees for each combination of number of pulpwood sticks and number of sawlog sticks by species. When all check-points are measured, the volume will be determined for the total Check Cruiser check points and for the Cruiser's measurement on those same check-points.

The final score will be determined by comparing the Cruiser's check-point volume to the Check Cruiser check-point volume. If the Cruiser volume is within 10% of the Check Cruiser volume, the Cruiser tally will be considered accurate. If the Cruiser's volume is more than 10% off from the Check Cruiser volume, then the tally will be considered inaccurate.

STICK COUNT TABLE

Stick Count	1	2	3	4	5	6	7	8	9	10
Pulp - Rounding	9' 4"	15' 4"	23' 8"	32' 0"	40' 4"	48' 8"	57' 0"	65' 4"	73' 8"	82' 0"
Total Pulp or Saw	9' 4"	17' 8"	26' 0"	34' 4"	42' 8"	51' 0"	59' 4"	67' 8"	76' 0"	84' 4"

CRUISE CARDS

Cumulative/V-Bar Tally Card (see next page)

Marking Tally (Large Pulp) Card (see last page)

Michigan Department of Natural Resources
Forest Resources Division

CUMULATIVE/V-BAR TALLY CARD

Sale Name			Cruised by		
Unit Number			Stand Number		
Town		Range	Section		
V-BAR					
PLOT	**SPEC.**	**STICKS**	**LOGS**	**PRODUCT**	**TREES**
-OR-					
CUMULATIVE		**TOTAL 100"**		**LOG 100"**	
PLOT	**SPEC.**	**TREES**	**STICKS**	**TREES**	**STICKS**

R4039-1 (Rev. 08/03/2012)

Michigan Department of Natural Resources
Forest Resources Division

CUMULATIVE/V-BAR TALLY CARD

Sale Name			Cruised by		
Unit Number			Stand Number		
Town		Range	Section		
V-BAR					
PLOT	**SPEC.**	**STICKS**	**LOGS**	**PRODUCT**	**TREES**
-OR-					
CUMULATIVE		**TOTAL 100"**		**LOG 100"**	
PLOT	**SPEC.**	**TREES**	**STICKS**	**TREES**	**STICKS**

R4039-1 (Rev. 08/03/2012)

Michigan Department of Natural Resources
Forest Resources Division

Marking Tally (Large Pulp) Card

Cruiser		Date
Comp	Stand	Acres
Tally Ratio	Pulp	Sawlogs

BAF	Species: Pulp to 9" or 11" DOB				Species: Pulp to 9" or 11" DOB				Species: Pulp to 9" or 11" DOB			
DBH	0	1	2	3	0	1	2	3	0	1	2	3
10\1												
2												
12\1												
2												
14\1												
2												
3												
16\1												
2												
3												
4												
18\1												
2												
3												
4												
5												
20\1												
2												
3												
4												
5												
6												
22\1												
2												
3												
4												
5												
6												
24\1												
2												
3												
4												
5												
6												

R4039-2 (Rev. 03/10/2017)

Michigan Department of Natural Resources
Forest Resources Division

Marking Tally (Large Pulp) Card

Cruiser		Date
Comp	Stand	Acres
Tally Ratio	Pulp	Sawlogs

BAF	Species: Pulp to 9" or 11" DOB				Species: Pulp to 9" or 11" DOB				Species: Pulp to 9" or 11" DOB			
DBH	0	1	2	3	0	1	2	3	0	1	2	3
10\1												
2												
12\1												
2												
14\1												
2												
3												
16\1												
2												
3												
4												
18\1												
2												
3												
4												
5												
20\1												
2												
3												
4												
5												
6												
22\1												
2												
3												
4												
5												
6												
24\1												
2												
3												
4												
5												
6												

R4039-2 (Rev. 03/10/2017)