3P Grade Selection
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Draft 2

This is a suggested procedure to permit sub-sampling items in a population for grade, by using a 3P weighted selection and follow-up correction process. Specifically, we wanted to develop an estimate first – correct second procedure, for use in determining the amounts of volumes in each of four grades of hardwood trees or logs. The practical problem we're trying to overcome with this procedure is how to predict the amount of volume, by grade, present in a timber stand or log deck, without spending the excessive amount of time & effort required to apply the grading protocol to every hardwood tree or log in a target timber stand or log deck.

Procedure.
1. Estimate the total number of trees or logs that are grade 1 within the target timber stand or log deck.
2. Estimate the total volume of trees or logs that are grade 1 within the target timber stand or log deck.
Repeat steps 1 & 2 for each of the other grades in your grading protocol that you feel **might be represented** in the target timber stand or log deck
3. Make an estimate of the total number trees or log specimens you have time to carefully grade out in your sample. Decide how many of this total number of tree or logs you want to carefully grade in each grade category present in the timber stand or log deck.
    For example, if you have time to grade 18 specimens during your sample, you could decide that 3 of these samples would be for specimens selected in the grade 1 group, 6 of the samples would be in the grade 2, and 9 of the samples would be in the grade 3 group.
4. Design a 3P program, in a spreadsheet like Excel, if you'd prefer, in order to divide the total estimated grade 1 volume by the number of samples you'd like for grade 1 specimens and prepare the program make a 3P selection on a series of tree volume estimates you will enter into the program. Enter your estimate of the total volume and the number of desired samples you determined for the grade 1 category into the program. Repeat this step and **set up a specific 3P program** for each of the other grades that could be present within the target timber stand or log deck.
5. Proceed to make a methodical sweep through the target timber stand or log deck to approach each tree or log, in order to make as consistent an **estimate of the volume** in the specimen as possible. This can be done by simply estimating the DBH of the tree or small end diameter & length of a log and then using a volume generator, such as a look up table, to determine an approximate volume. The volume estimate can be for either gross or net volume and it does not have to be highly accurate, but the estimate method and associated calculations should produce as **consistent volumes** as possible. The less consistent the estimated volumes are the more samples that will be required to correct the estimates, in order to gain an acceptable statistical sample.
6. Make an **estimate of the grade** of the tree or log specimen.
7. Enter the volume estimates into the **specific 3P program set up for the grade you estimated** for that specimen. For example, if you encounter a specimen that you estimate

to be a grade 2, enter your estimate of the volume into the 3P program set up to select your desired number of samples from the grade 2 group.

8. If the 3P program designates that estimate as a sample then proceed with taking sufficient measurements on that specimen to allow accurate calculation of the volume and determination of the grade. Note the measured volume and carefully determined grade of the sampled sample specimen in the spreadsheet program or on a separate record sheet.

If the 3P program does not designate that specimen to sample then proceed with steps 5, 6, & 7 for the next specimen encountered in the field sweep.

9. After volume & grade estimates have been made for all of the specimens in the timber stand or log deck and accurate volumes and grades determined for those specimens selected for sampling, sum all of the estimated volumes made for each separate grade group. Example: Sum all of the estimated volumes for each specimen you estimated as a grade 1(from the entire target stand or log deck), let's use a demonstration figure of 3,000.

10. Enter all of the data collected from each **sampled specimen** from each grade group. Example format for estimated/measured data for specimens in the grade 1 group:

Grd 1 Est Vol	Grd 1 Meas Vol	Grd 1 Ratio	Grd 2 Meas Vol	Grd 2 Ratio
100		0.0	70	0.7
50	40	0.8		0.0
150	140	0.93		0.0
75		0.0	85	1.13
Averages=		0.43		0.46

Notes:
- This table of the first grade group should have the 2 sets of data(measured volume & ratio) for any of the other grades you originally felt might be represented in the timber stand/log deck, such as grade 3 and grade 4. It could be very possible that for all the trees you estimated to be grade 1, none of the sampled specimens ended up grading out as grade 3 or 4. There should then be corrected volumes of **0** determined for grades 3 & 4, following step 12 below.
- Insure that a 0.0 gets entered for each grade ratio, other than the correct grade ratio, please not the 0.0 entries in the above table.
- Use the formula: measured volume / estimated volume = **Ratio**

11. Determine the average ratios for each grade in the group table.

12. Determine the corrected volumes for **each grade** in the table via the formula:
     corrected volume= sum of estimated volume[this is the volume determined in step 9] * average ratio for that grade.
Example- the corrected volume for grade 2 in the table above: 3,000 * 0.46 = 1,380
Repeat steps 11 & 12 for the other grades in the first grade group.
Repeat steps 9-12 for the other grade groups. Example, if you had originally estimated there would be 4 grades present in the target timber stand or log deck then you should end up with an additional 3 group tables, which should have a format as discussed above and you should determine a step 12 corrected volume for each grade in each of these other groups.

13. Sum the corrected grade totals in each category to determine the corrected group volumes. Example- we'll use a total of 2,900 for the grade 1 group total.

14. **Total corrected volume for the timber stand or log deck for a specific grade** = the sum of the step 12 corrected grade totals from each grade group.

15. total corrected volume for the timber stand or log deck = sum of the corrected group volumes from step 13.

16. Determine statistics, including standard deviation, coefficient of variation, and standard error figures for each set of ratios in each grade table.
Example for grade 2 of group 1:

Average Ratio=	0.46
Standard Deviation of the Ratio %=	46
Coefficient of Variation for the the Ratio %=	100
Stardard Error of the Ratio, in %=	50
Standard Error of the Ratio, in units =	690

The SE, in units, = corrected volume * (%SE/100)
Example: the figure of 690 for the SE, in units, means that the grade total for the grade group 1 could be 1,380, + or – 690.

17. Determine the statistics for **all of the ratios** combined in a specific grade group.
Example, the figures from the above demonstration table for group 1:

Estimate Volumes	Ratios
100	0.7
50	0.8
150	0.93
75	1.13
Average group =	0.89

Statistic	**Figure**
Step 13 group total	2,900
Average Ratio	0.89
Standard Deviation, %	19
Coefficient of Variation, %	21
Standard Error, %	10.5
Standard Error, Units	305

Repeat step 17 for the other grade groups.

18. Determine the overall SE, in units for the timber stand or log deck by the formula:
SE, in units = Square Root [(the group 1 standard error, in units)^2 + (the group 2 standard error, in units), etc… for the other groups]

19. Determine the overall SE, in percent, by the formula:
SE, percent = Step 18 SE, in units / step 15 total corrected volume

Ideally, one would strive for a low ratio SE, such as 5% or lower, for the individual corrected grade volume totals as an indication of an effective sample effort. Making poor estimates of the volume or grade and/or using a poor volume generator could result in an excessively high (step 10) ratio SE, which could only be lowered by setting up the 3P program to select more samples initially. We recommend that the user set the 3P selection program to select **double** the number of desired samples, especially for the higher value grades. Then put a temporary mark in the field on every other specimen selected, without actually sampling it. These marked specimens could later serve as "insurance samples", should more samples be needed to gain better statistics for a specific grade.

We have not yet devised or run a test of this procedure.