3P Sample Scaling

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Agenda

- Introduction
- Brief History
- 3P Sample Selection
- 3P Scaling Procedures
- Sample Expansion
- Pros and Cons
Introduction

• 3P Log Scaling is a Two Stage Sampling Method for Sample Scaling

• Sample Load Scaling with 3P Subsample

• Two Variations currently in use by USFS:
  3P Sample Load
  3P Sample Weight
3P Log Scaling – Brief History

• Currently Used by the USFS in the Rocky Mountain and Intermountain Regions: Colorado, Idaho, South Dakota, Utah and Wyoming.

• 3P Sampling first developed by Lew Grosenbaugh in the 1960’s.
3P Log Scaling – Brief History

- 3P Log Scaling was first tested in the late 1960’s and early 1970’s in Idaho and Oregon.

- Region 2 began to explore 3P Log Scaling in the early 1970’s in part to reduce scaling costs while retaining or improving accuracy.
3P Log Scaling – Brief History

• By 1974 Region 2 held the first formal 3P Sample Log Scaling training in Cortez, CO.

• In 1976, at the request of the Federal Timber Purchasers Association an independent review and evaluation of 3P Scaling was conducted by MSC, Inc. of Boulder, CO.
3P Log Scaling – Brief History

• “The basic 3P sampling plan is a highly efficient procedure which produces good estimates of population values with relatively small sample sizes when compared with simple random sampling. It is a highly creative, conceptual scheme, which when appropriately applied, would be highly recommended…”

Robert H. Taylor, MSC, Inc.
Two Stage Sampling Method

- First Stage – Sample Loads are randomly selected from the total population of loads.

- Second Stage – Sample (Measure) logs are selected from the logs in each of the Sample Loads.
3P Sampling

• In general, the 3P scaling procedure is to estimate the gross volume of each log and scale those logs selected as samples.

• 3P = Probability is Proportional to Prediction

• As applied to log scaling: the probability of a log being selected as a sample log is proportional to the estimated (predicted) gross log volume (KPI).
3P Sample Selection

- In practice the scaler predicts the gross log volume (KPI) by estimating the small end diameter, taper and length.
3P Sample Selection

• The KPI is entered into the scaling program which compares it to a random number generated from a specially constructed list.

• If the KPI is $\geq$ the random number, the log is selected as a measure log.
3P Sample Selection

- Screen-shot example of 3P Scaling Data Entry using FSScaler

FSScaler Data Entry

<table>
<thead>
<tr>
<th>Log</th>
<th>P</th>
<th>S</th>
<th>SP</th>
<th>KPI</th>
<th>SD</th>
<th>LN</th>
<th>LD</th>
<th>HIT</th>
<th>RND</th>
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<tbody>
<tr>
<td>100</td>
<td>1</td>
<td>1</td>
<td>ES</td>
<td>14</td>
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<td>40</td>
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</table>

KPI ≥ RND = HIT
3P Sample Selection

- As each sample log is scaled, the measured (scaled) volume is divided by the predicted volume resulting in a Measured/Predicted ratio.

- The variability of the Measured/Predicted Ratio for each sample log is what drives the 3P sampling frequency. Smaller CV = less samples.

- R2 sets the 3P sampling frequency (KZ) to sample approximately 10% of the total logs in a sample load.
## Measured to Predicted Ratio

<table>
<thead>
<tr>
<th>No.</th>
<th>KPI</th>
<th>Gross</th>
<th>Net</th>
<th>Gross M/P Ratio</th>
<th>Net M/P Ratio</th>
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<tbody>
<tr>
<td>5</td>
<td>35</td>
<td>32</td>
<td>28</td>
<td>0.9143</td>
<td>0.8000</td>
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<td>26</td>
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<td>43</td>
<td>37</td>
<td>1.0750</td>
<td>0.9250</td>
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<td>32</td>
<td>17</td>
<td>20</td>
<td>11</td>
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<td>0.6470</td>
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<td>22</td>
<td>28</td>
<td>24</td>
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<td>1.0909</td>
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<tr>
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<tr>
<td>68</td>
<td>18</td>
<td>22</td>
<td>18</td>
<td>1.2222</td>
<td>1.0000</td>
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<tr>
<td>70</td>
<td>65</td>
<td>63</td>
<td>58</td>
<td>0.9692</td>
<td>0.8923</td>
</tr>
</tbody>
</table>

Mean M/P Ratios= 1.0786 0.8736
3P Sample Expansion

- The mean M/P ratio is used to adjusted the total estimated volume ($\sum \text{KPI}$).

<table>
<thead>
<tr>
<th></th>
<th>Sum KPI</th>
<th>M/P Ratio</th>
<th>Adjusted Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross</td>
<td>2026.7 CCF</td>
<td>1.0786</td>
<td>2186.0 CCF</td>
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<tr>
<td>Net</td>
<td>2026.7 CCF</td>
<td>0.8736</td>
<td>1770.5 CCF</td>
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</tbody>
</table>
3P Sample Expansion

- Individual logs are stratified by species and product types.
- Individual Net Ratios per sample groups adjust for variation in defect between species.
- Defect is averaged over all sample logs per sample group.
3P Sample Expansion

• USFS - Scaled volume is reported and adjusted monthly per calendar quarter.

• All reported volume (Sum KPI) within a calendar quarter is adjusted by the mean Gross and Net M/P ratios at the end of a quarter.
3P Sample Expansion

• For Sample Load 3P – Average sample load volume is applied to non-sample loads.

• For Sample Weight 3P – weight to volume ratios are calculated from the total weight and total volume of all sample loads.

• Weight factors are applied to the net weights of all loads to calculate total volume hauled.
Application – Pros

• 3P Sample Log Scaling is used for the majority of stick scaling in R2.

• Very efficient method for small diameter, low value material with large number of pieces per load.

• Works well for sales with 1-2 species and/or similar stumpage rates for different species.
Application - Pros

• Increase in production scaling.

• Improved accuracy for measure logs.

• Gross Volume estimates for each log result in accurate population estimates.
Application - Cons

• Not used for development of weight factors for total weight sales.

• Sample scaling may not be appropriate for high value species.

• May not work well for smaller sales or non-representative loads.
Application - Cons

• Without a separate KZ, minor species or product groups may have fewer samples.

• Hard to predict exact number of sample logs per load.

• May not work well for sales with large variation in defect.
3P vs. Conventional Scaling

• Given sufficient amount of volume, 3P sample scale will be very close to conventional sample load scale.

• USFS 3P certification requires a check scale of 3P scale against conventional scale: must be within 2% of net volume and 1% of gross volume per 20 loads.
Questions ?