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Operator bias with optical wedges in point sampling

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Operator bias with Optical Wedges in Point Sampling

Point sampling, or sampling with probability proportional to size (PPS), is an efficient technique often used in timber cruising, but care must be taken to avoid operator bias. Several types of angle gauge (e.g., relascope, thumb, etc) require that the operator's eye is at the plot centre (Avery and Burkhart, 1994).

However, when using an optical wedge or prism, the angle is subtended at the prism, not the eye, and the prism should form the central point (the operator should rotate about the prism). If the prism is held at an arm's length while the operator rotates on the ball of his foot, substantial bias may result. It is instructive to calculate this bias.

PPS samples a circular area πR^2, where R is the critical distance ($R=D/2\sqrt{BAF}$) for a tree of D cm diameter and a basal area factor of BAF m²/ha. But incorrect technique may lead to a doughnut-shaped area:

$$\pi(R+k)^2 - \pi k^2 = \pi R(R+2k) \quad 1$$

where k is the radius from the central point to the prism (i.e., length of operators arm). Thus the bias (Actual/Expected -1) will be

$$\frac{\pi R(R+2k)}{\pi R^2} - 1 = \frac{2k}{R} = \frac{4k\sqrt{BAF}}{D} \quad 2$$

The bias is always positive (since the area sampled is bigger than the usual formula assumes), and depends on tree size. It may be negligible if only trees of commercial sizes are considered, but bias may be considerable if smaller trees are tallied. The bias affects both basal area and stocking estimates, and improper use will inflate estimates of regeneration or advance growth.

In many instances of improper use, the prism may be held at arm's length ($k\approx0.5m$) and the bias may be $2\sqrt{BAF}/D$. If the BAF is small ($\leq2m²/ha$) and minimum size for sampling is large ($\geq40cm$ dbh), then the bias may be negligible, especially if the distance to border-line trees is measured. However, when inventories use large BAFs and sample small trees, this may lead to considerable bias. Inventories in the tropics commonly use BAF=10 m²/ha, and may sample trees as small as 3 cm dbh, and this may lead to overestimates of 200% in the smallest size class.

If you use an optical wedge in point sampling, take care that the wedge forms the central point, and measure distances to borderline trees. It is good practice to cut a stick to mark the central point, to hold the optical wedge on the top of the stick, and to walk around the stick when determining trees to be sampled.

REFERENCE

AVERY, T.E. and BURKHART, H.E. 1994. Forest measurements, 4th edition. McGraw-Hill, N.Y. 408 p.