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Statistical analysis of ratio estimators with measurement error in the auxiliary variate: a forestry application

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Forest inventory relies heavily on sampling strategies. Ratio estimators use information on an auxiliary variable (x) to improve the estimation of a parameter of a target variable (y). We evaluated the effect of measurement error in the auxiliary variate on the statistical performance of three ratio estimators of the target parameter total τ_y. Monte Carlo simulations were conducted over a population of more than 14:000 loblolly pine (*Pinus taeda*) trees, using tree volume (v) and diameter at breast height (d) as the target and auxiliary variables, respectively. In each simulation three different sample sizes were randomly selected. Based on the simulations, the effect of different types (systematic and random) and levels (low to high) of measurement errors in x on the bias, variance, and mean square error of three ratio estimators was assessed. The ratio-of-means estimator perform the best, even better than an unbiased estimator. The mean-of-ratio estimator was found highly biased (20%). Neither the accuracy of ratio estimator is affected by type and level of measurement error nor its precision. Our results show that ratio estimator's statistical performance is fairly resistant to the presence of either systematic or measurement error in the auxiliary variate.

KEYWORDS: Sampling, forest inventory, Monte Carlo simulation, bias, variance.

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