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Marked, biased, filter (MBF): use of digital X-radiography and mark-recapture to partition seed lots based on sampled individual seed quality attributes

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Abstract We report results of preliminary evaluations of marked, biased, filter (MBF), a method for both estimating and improving the effectiveness of separating conifer seeds. MBF integrates elements of X-radiographic seed quality assessment and mark-recapture methods from wildlife population sampling. Given a sample drawn from a population, individual seeds with attributes targeted for separation are labelled with a mark which biases the subsequent removal probability of other, non-marked seeds in the lot during grading and processing, after returning the sample to the population. Bias in the marking filter, in the form of extra mass or density added to seeds, minimizes the likelihood that uncertainty due to sampling error in the prior estimate will result in empty seeds remaining in the population during processing. In two experiments, a ponderosa pine seed lot was partitioned into empty and filled fractions with an air column separator. Powder dye talc was used for marking in the first trial, with low bias (<1%) and a small sample size ($n = 150$) with dry (2% moisture content) and soaked (26% moisture content) seed lots. A second trial conducted with two coats of spray paint used for marking and a larger sample size ($n = 400$) resulted in removal of 100% of non-filled seeds in the population. A simulation was conducted to evaluate sample statistics upon which to base the value of threshold bias, τ , below which seeds in an X-rayed sample should be marked to achieve consistent separation. Estimating the marking threshold based on quantiles of filled seeds most consistently resulted in removal of the non-filled fraction. MBF is a useful method for statistically linking one or more individual seed quality attributes extracted from X-ray image analysis with population-level processing of seed lots.

Keywords Conifer seed · Seed grading · Seed separation · Seed quality · Forest nursery · Mark-recapture · Finite mixture models · Sampling theory · X-ray · Marked seed · Marked, biased, filter

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