

A Method to Determine the Minimum Number of Litter Traps in Litterfall Studies¹

ABSTRACT

Litterfall was collected in a 0.64 ha area for three months, using 25 litter traps. Resampling methods were used to calculate the total litterfall mass grand mean and coefficient of variation (CV) for each month using different numbers of litter traps (2–25). Based on the variation of those two statistics, it was possible to determine the minimum number of litter traps necessary to achieve accuracy (variation in grand mean) and precision (magnitude of CV).

Key words: accuracy; Atlantic Forest; litterfall; litter traps; methods; precision; sampling effort.

FINE LITTERFALL IS COMMONLY USED TO ESTIMATE NET PRIMARY PRODUCTIVITY (NPP), the most important component of the aboveground biomass increment (Clark, Brown, Kicklighter, Chambers, Thomlinson & Ni 2001). The relative ease and low cost of assessing fine litterfall make it the most commonly used measurement in NPP studies.

Proctor (1983) has pointed out some difficulties related to litterfall sampling. One of the most problematic is determining the number of litter traps that should be placed in an area. The number and density of litter traps used in studies of litterfall is variable; usually from 10 to 30 litter traps are used to sample areas of variable sizes (Haase & Hirooka 1997, Lopes *et al.* 1994, Louzada *et al.* 1995, Martins & Rodrigues 1999, Moraes *et al.* 1994, Morellato 1992, Portes *et al.* 1996, Ramos & Pellens 1994, Stocker *et al.* 1995). Generally, no information is given to justify the number of litter traps used, and consequently, the estimation of fine litterfall can be highly uncertain. A minimum of 20 litter traps was recommended by Proctor (1983) and is generally considered an acceptable number (Stocker *et al.* 1995); however, some estimate of sampling effort is needed because this can be expensive and time-consuming, and the effort may not be justified. Ideally, studies should be based on pre-sampling, and confidence intervals should be established (Clark, Brown, Kicklighter, Chambers, Thomlinson, Ni, & Holland 2001).

Here, I propose a pre-sampling method to estimate the minimum number of litter traps needed to obtain a representative sample of an area, and have concluded that this estimate should be specific, appropriate to the spatial and temporal variation of litterfall in each area.

The study site was located near the Serra dos Órgãos National Park (22°28'S, 42°60'W) in the municipality of Guapimirim, Rio de Janeiro State, Brazil. The area is in the Serra do Mar Coastal Forest, a subdivision of the Atlantic Forest Biome (Dinerstein *et al.* 1995). A 0.64 ha square grid was established at 748 m elevation as part of an ongoing study of small mammal populations that began in April 1997. The grid had 25 points 20 m apart, and during August, September, and October 2000, one litter trap was located at each point. Litter samples were collected at the beginning of each month, oven-dried at 80°C for 24 hours in the laboratory, and weighed to the nearest 0.01g. These 25 points were used in a bootstrap presampling procedure to determine the effect of varying litter trap numbers on the litterfall estimate. Twenty-five replications were made for each sample size (number of litter traps), ranging from 1 to 25, and mean litter biomass was calculated for each replication. The grand mean and the coefficient of variation (CV) of means were calculated for each sample size.

During the entire study of small mammal populations, only five points of the grid had permanent litter traps, those aligned diagonally along the grid. The variation of litterfall estimated from these five points was the result of temporal and sampling variation combined, and it was compared to the sampling variation associated with different sample sizes.

Considering only September and October, the grand mean showed a large variation when using less than 10 litter traps (Fig. 1). In September, the grand mean varied from 26.98 to 20.26 g using 2 and 6 litter traps, respectively. Using 10 litter traps or more, the grand mean oscillated between 23.00 and 25.00 g. October showed a more variant pattern, when the grand mean varied from 41.83 g using 5

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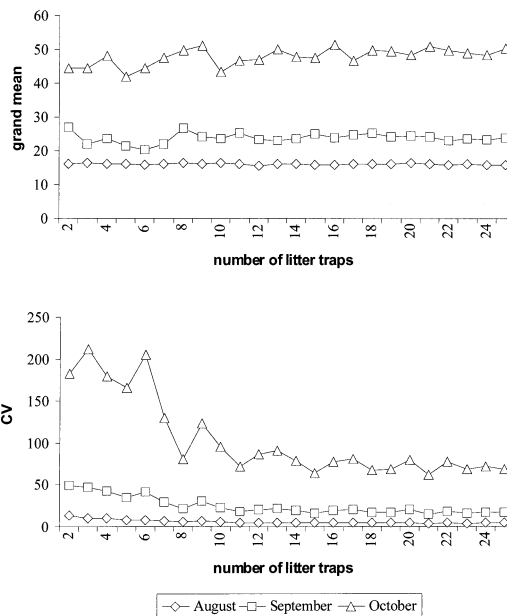


FIGURE 1. Grand mean and coefficient of variation for different numbers of litter traps used during each month.

litter traps to 51.23 g using 9 litter traps. The grand mean stabilized around 48.00 and 50.00 g, using 17 or more litter traps. In August, there was almost no variation, and the grand mean oscillated between 15.00 and 16.50 g.

The CV reduced in magnitude after sample sizes of 5 litter traps or more during all three months (Fig. 1). September had the highest CVs, reaching more than 80 percent with the smallest sample size; however, with sample sizes of 5 or more litter traps, the CVs were generally lower than 30 percent. Sample sizes of 8 and 9 litter traps in September were exceptions to the general trend. August and October had similar CVs, always lower than 30 percent using 5 litter traps or more.

The CVs obtained from bootstrapping were much lower than the temporal variation of litterfall obtained from the 5 permanent litter traps. The CV was lowest (96.14%) in 2000, but increased to nearly 150 percent in 1997 and 1998.

The simple plot of the grand mean and the CV of sample means against sample size allows an efficient choice for the number of litter traps, above which there is little gain in accuracy and precision. The accuracy of the estimate could be interpreted as the variation in the grand mean, and the precision as the magnitude of the CV. In this study area, accuracy did not increase much after a sample size of 10 litter traps, and precision after a sample size of 5. Obviously, accuracy and precision will increase with more trapping effort, but costs will rise as well. In our example, 20 litter traps would represent doubling the trapping effort and costs, but with only a small gain in accuracy and an even smaller gain in precision.

The variation in litterfall within any of the years of study was higher than the variation obtained with sampling sizes of 5 or more litter traps, in any of the three months. Thus, in spite of the sampling variation, 5 litter traps were sufficient to detect seasonal variations in litterfall.

The higher variances using up to 4 litter traps in September and October showed that it is reasonable to use more than one time period due to the temporal variability of litterfall. If pre-sampling had been done only in August, the wrong conclusion could have been reached regarding litter trap numbers due to the low variability during this month.

The pre-sampling method described can be used to evaluate the minimum sample size necessary to detect litterfall production and variation in a study area. It avoids unnecessary costs of using large numbers of litter traps, and allows an objective choice for determining the adequate number. Considering the

0.64 ha grid used in the study site, 5 litter traps were enough to estimate litterfall production and its variation. Studies in other sites could calculate their own minimum sample size, which depends on the total area sampled and the temporal and spatial variation in litterfall production.

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