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“Resilience of agricultural systems against crises”

Rare Tree Species in Limestone Mountain Forests of Northern Vietnam

THE LONG NGO^{1,2}, DIRK HÖLSCHER²

¹*Hung Vuong University, Forestry Department, Vietnam*

²*Georg-August-Universität Göttingen, Burckhardt Institute: Tropical Silviculture and Forest Ecology, Germany*

Abstract

In consequence of land use changes, some tropical tree species that have always been rare become endangered due to their shrinking habitat and population. In this study, we analysed five species, which are named in the red list, in terms of their abundance on limestone mountains in northern Vietnam. Three of these species (*Excentrodendron tonkinense*, *Chukrasia tabularis* and *Garcinia fagraeoides*) are largely restricted to such limestone mountain forests and considered typical to this environment, whereas two studied species (*Parashorea chinensis* and *Melientha suavis*) have a wider distribution range. We asked about the appropriate method to estimate their population density, how many trees there might be, and on which sites they preferably occur. In an old-growth forest of 6.5 km², a random sampling approach was applied as well as adaptive cluster sampling, which is specifically designed for rare events and spatially clustered distributions. In these species, adaptive cluster sampling resulted in higher mean values of trees per unit ground area and lower variances than random sampling. Considerable numbers of trees were found for all the species. The three limestone mountain forest species increased in abundance with steepness of the slope, increase in rock-outcrop cover and decrease in soil depth; in short, with the severity of site conditions. The two species with a wider distribution range (*Parashorea* and *Melientha*) did not occur on very severe sites. We conclude that adaptive cluster sampling is an appropriate method for estimating the population density of these rare tree species in this study region, a national park, where some of the red list species still occur, and the typical limestone forest species are particularly found on severe sites.

Keywords: Adaptive cluster sampling, limestone mountains, random sampling, red list, trees