C. L. BATCHELER
Forest Research Institute, P.O. Box 31-011, Christchurch.

SHORT COMMUNICATION

NOTE ON MEASUREMENT OF WOODY PLANT DIAMETER DISTRIBUTIONS

Summary: A modified plant diameter measurement protocol is suggested for demographic analysis. The conventional diameter at breast height (1.35m) is used for stems ≥ 2.6m tall whereas those ≤ 2.6m tall are measured at half their height. The diameter equivalent to the combined cross sections of an the stems is used as the measure of size.

Keywords: Plant demography, diameter distribution, demographic pattern.

Introduction

Forest ecologists use the frequency distribution of d.b.h. (diameter at breast height, 1.35 m above ground) of the stems of woody species to describe age/size structures and draw inferences about regeneration strategies, synchrony of climatic events, mortality patterns and the effects of animal browsing (e.g. recent New Zealand studies by Allen, Payton and Knowlton, 1984; Mark, 1963; Mark and Sanderson, 1962; Stewart and Veblen, 1982; Veblen and Stewart, 1980; P. Wardle, 1978; J. Wardle, 1970; 1984).

Even if it is assumed that diameter distributions are equivalent to age distributions (but see Harper, 1977; Ogden, 1978; Veblen and Stewart 1980), the d.b.h. convention is not particularly appropriate for demographic analysis. Most obviously, it cannot be applied to stems less than 1.35 m tall. One contemporary solution to the problem partitions woody forest plants into four groups and applies different protocols to each of them (Allen and McLennan, 1983): trees, defined as those > 3 cm d.b.h. and >2 m tall, are measured at breast height; saplings, < 3 cm d.b.h. and > 1.35 m, are counted; 'understorey' plants which exceed 15 cm tall are counted in sub-plots by 16-45 cm, 46-75 cm, 76-105 cm, 106-135 cm and > 135 cm height classes; plants less than 15 cm are recorded in sub-plots as present or absent.

Although such measurements can be spliced into a statement of apparent demographic pattern (e.g. Allen, Payton and Knowlton, 1984), the procedure is complex and the criteria of size are not constant throughout the life cycle of plants. Accordingly, Batcheler and Craib (1985) suggested the use of a simple extension of the d.b.h. protocol by which stems ≥ 2.6 m are measured at breast height, whereas those < 2.6 m tall are measured at half their height. The measurement, d.b.h.h. (diameter at breast height or half height), yields a continuous range of size of all plants in a population.

Second, in dealing with shrubby species, Batcheler and Craib recognized that recording each stem as a plant results in high estimates of density and low estimates of mean plant basal area. They therefore adopted a procedure by which where more than one stem occurs at the d.b.h.h. measurement point, each stem is measured and the size of the plant is represented by the diameter equivalent to the combined cross sections of the stems.

Results

The effect of these procedures is demonstrated by data for species which were encountered at least 100 times on 71 variable area plots during a survey in 1981 at Cupola Basin, Nelson Lakes National Park. They were mountain beech *(Nothofagus solandri* var *cliffortioides),* silver beech *(N. menziesii),* and three shrubby species, mountain toatoa *(Phyllocladus alpinus),* weeping matipo *(Myrsine divaricata)* and *Coprosma pseudocuneata*.

Except in one case, treatment by stems or plants gave similar d.b.h.h. distributions for the beeches (Fig. 1), consistent with their typically single-stemmed habit. Those for mountain beech, with 2 modes at < 1 cm (ie 'seedlings') and 4-16 cm, were conspicuously different to the continuous distributions for silver beech. However, treatment differences were revealed in the high-altitude group where the mountain beech are relatively shrubby. Here analysis by stems suggested a greater number of smaller individuals, slightly skewing the distribution and creating a sharp mode in the 4-8 cm class (compare Figs. lA and IB).

However, the effects of 'stems' and 'plants' analyses were very pronounced when applied to the shrubby species (Fig. 2). For mountain toatoa (46% single-stemmed and 3.4 stems/plant), analysis by

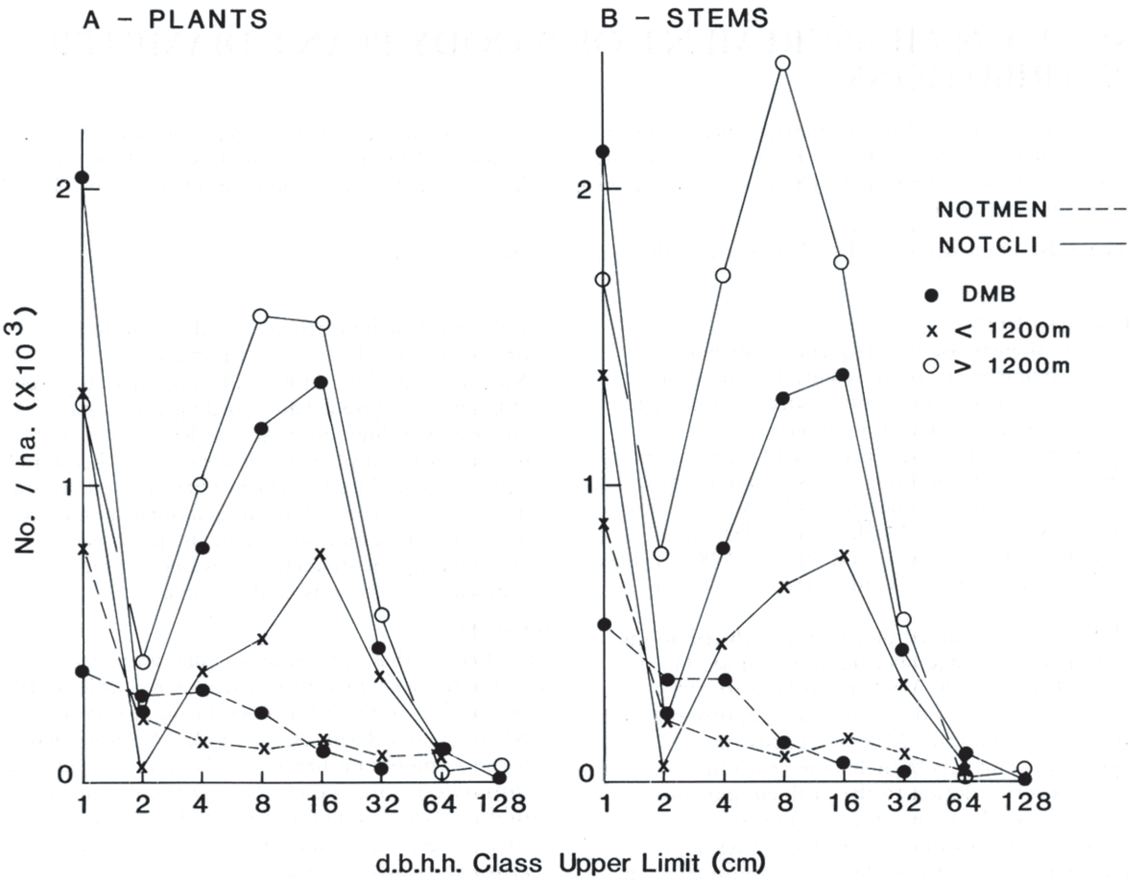

Figure 1: *Distribution of d.b.h.h. of mountain beech (NOTCLI) and silver beech (NOTMEN) at Cupola Basin, by plants (A) and stems (B) in each size class. Distributions are presented for plots at which mean canopy height exceeded 5m in 'dry mountain beech' (DMB), other plots below 1200m altitude, and other plots above 1200m (Batcheler and Craig, 1985). Distributions are in log, classes.*

plants suggested an 'open V-shaped' distribution, whereas analysis by stems suggested an abrupt 'reverse J', with a very high density of small individuals and a low density of large ones. For weeping matipo (62% single-stemmed and 2.1 stems/ plant), treatment by stems gave more than double the density of the < 1 cm class suggested by analysis by plants, but only 17% of the comparable density in the 4-8 cm class. Qualitatively similar differences between the two treatments were also found for *Coprosma pseudocuneata* (49% single-stemmed and 2.9 stems/plant) in all three forest groups.

Discussion

Both treatments suggest behaviour patterns of the beeches which are firmly established in the literature. For mountain beech, they portray a species in which regeneration at Cupola was held in check by competition from the larger trees or, perhaps, browsing by deer (see Kirkland (1961) for red beech and Wardle (1984)). In contrast, the patterns

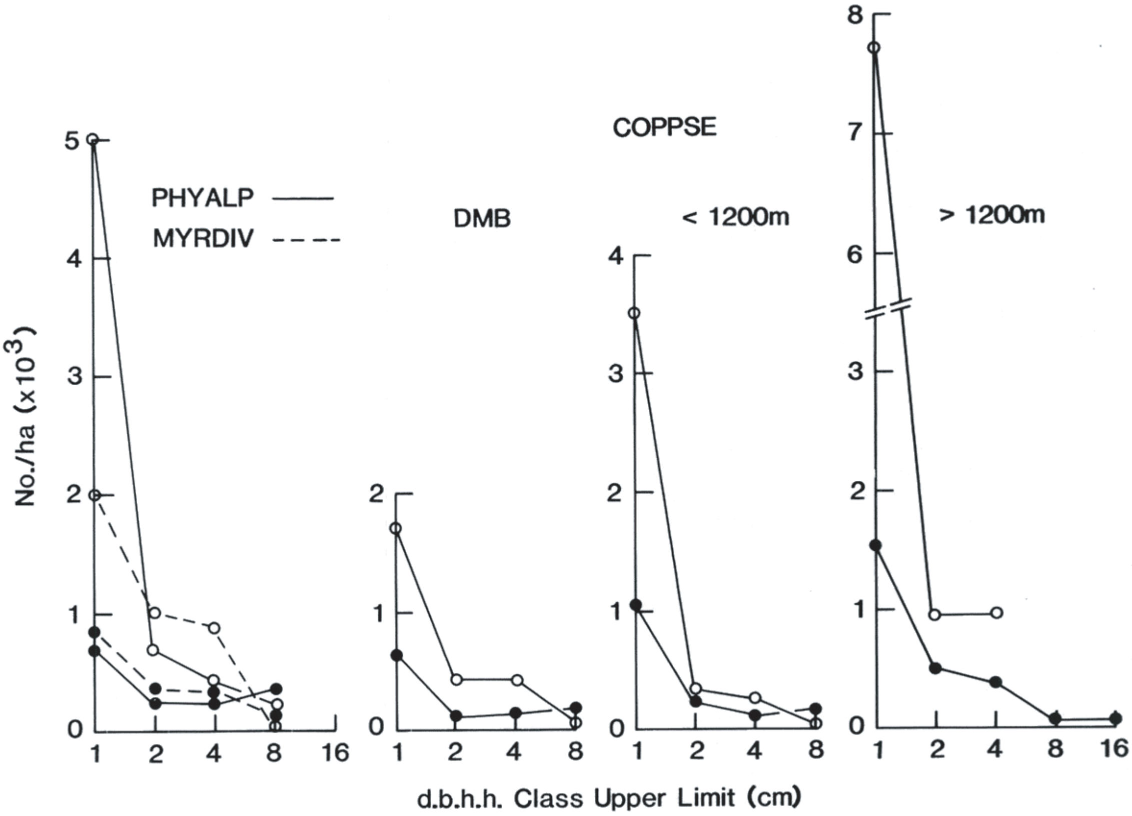

Figure 2: *Distributions of d.b.h.h. of mountain toatoa (PHYALP), weeping matipo (MYRDIV) and* Coprosma pseudocuneata *(COPPSE) at Cupola Basin, by numbers of plants (solid circles) and stems (open circles),* in *the three forest groups given for Figure* 1. *Over 100 stems of weeping matipo and mountain toatoa were recorded only* in *the < 1200m and> 1200m forest groups respectively.* Coprosma pseudocuneata *was common* in *all three forest groups.*

suggested by the silver beech data are diagnostic of continuous regeneration and growth (Wardle 1984).

For the shrubs however, the two treatments conveyed quite different impressions. Analysis by stems indicates a fairly dense population of small shrubs, whereas analysis by plants suggests smaller populations, with higher proportions of large individuals.

Clearly, there are two major elements of the problem: should stems or plants (the organism) be regarded as the demographic entity; and where should they be measured?

The 'stem'/'plant' problem is tricky. Allen, Payton and Knowlton (1984), Wardle (1970, 1984) Coleman, Gillman and Green (1980), Mark (1963) and Atkinson (1962) defined each stem as a plant, at least where branching occurred below 1.35 m. Some colleagues argue that this convention is generally appropriate because reproductive strategies and potentials of populations are often of primary interest. But when the intention is to describe their apparent age, or infer something of the chronology of regeneration-pulses or catastrophes, it would seem preferable to regard the whole plant as the organism.

Likewise, although measurement of d.b.h. is a valuable convention for the construction of timber volume tables, I cannot find a definitive argument in the literature which justifies its use in demographic analysis. Since by definition a plant which forks above 1.35 m is recorded as one, whereas a plant which forks below 1.35 m is treated as two or more, the convention must imply some universal and self-evident connection between the heights of breasts and branches. Otherwise, it must be regarded as an anthropocentric convenience which should be thoroughly reconsidered.

Measurement at some standardized proportion of the plant's height or just above ground (eg. Mark, 1963) are alternative possibilities, but both entail practical problems in tall forests and when dealing with fluted stems and irregular butt shapes; hence the d.b.h.h. compromise. It is at least practicable, and data are easily partitioned if desired to make results comparable with those reported from conventional d.b.h. surveys.

Thus Craib and I favour the suggested procedures, but we recognize that the topic is worth further investigation.

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