Book review

Tree and Forest Measurement. West, P.W. Springer. 167 p. 17 illus., 9 tabs. €29.95 exclusive of VAT and carriage charges, softcover. ISBN 30540-40390-6.

West is clearly an experienced lecturer as his text is succinct and very readable. The book presents a list of very useful and up-to-date references. He presents an elementary exposé of basic forest mensuration techniques for diameter, height and stem wood volume estimation of individual standing and felled trees.

Tree and Forest Measurement includes a very welcome chapter on tree biomass and the difficulties in developing functions for roots, leaf and whole-tree biomass. The chapter on stand measurement provides a useful exposé on the use of point sampling in basal area and volume per hectare estimation. The use top height of a stand at any age in estimating the site productive capacity and site index from top height-age functions is very relevant in Ireland. West states that the quadratic mean diameter "is largely historical and it is becoming a less important stand measurement today". This is certainly not the case in forestry in Ireland or Great Britain.

He presents the three classic graphs of the cumulative volume per hectare (m^3 ha^{-1}) function and the derived functions for mean and current annual increment (m^3 ha^{-1} a^{-1}) versus age (years). However, nowhere in the text is reference made to the age of maximum mean annual increment or the associated concept of yield class, which define the age of biological maturity and the sustained yield of the stand respectively. The last topic covered in the book was the plane survey. He provides an analysis of direction (°), slope (°) and distance (m) data to compute X and Y coordinates for all points in a plane survey and the use of triangular sub-sections to compute the area (m^2 or ha). The above topics are important to all with a professional interest in the measurement of trees, stands and land.

West then delves into stem volume and taper functions. Eight stem volume functions, from the international literature, for different species are presented. Each function provides an estimate of individual tree volume to tip (m^3) as a function of diameter at breast height (m) and height (m). Six of the eight functions provide underbark volume estimates, which contrasts with the overbark volume estimates widely used in Ireland and Great Britain. Examples of taper functions for different species are also presented, which model the rate of change in upper stem diameter (m) as a function of any height along the stem (m). Using integral calculus estimates of total volume (m^3) and or volume or length assortments may be easily estimated from the taper functions before trees are felled. West emphasises the greater utility associated with taper functions compared to volume functions.

Elementary sampling concepts and measures of variability including the mean, Y_M, variance, V_M, and confidence intervals, C_M, are presented, albeit with non-standard statistical notation. The chapter on sampling theory quantifies the sampling efficiency associated with six common sampling designs which were used, for illustrative purposes, to estimate the mean stem wood volume (m^3) using a sample size of n=15 from a population of size N=107 trees. The methods of sampling illustrated are: simple random

sampling, sampling with probability proportional to size (PPS), sampling with probability proportional to prediction (3P), stratified random sampling, model-based sampling and bootstrap sampling. The sampling efficiency for each of the six sampling designs was evaluated by comparison of the 95% confidence intervals for the mean and or total for each method of sampling. For the data analysed the model-based sampling design produced the most precise estimates of the population mean and total with a 95% sampling error percent of 9.4% compared to 70% for simple random sampling, 17.1% for PPS sampling, 14.6% for 3P sampling, 45.4% for stratified random sampling and 12.5% for bootstrap sampling. West's text indicates where each method of sampling is appropriate. He also provides practical advice on conducting a forest inventory.

West emphasises the necessity for computing confidence intervals for estimates arising from sampling designs in forest inventory. However, no statements of precision are presented for the predicted values or estimated parameters for any of the stem volume, taper or growth functions presented. All estimates should indicate their precision at a specified level of confidence.

Springer, the publisher, used the same font for both text and equations, with all equations presented on one line. This detracts from the presentation, which could easily have been rectified had all the equations had been formatted using an equation editor. Lecturers, in particular, and indeed all professionals, must always be aware of the danger of propagation of errors. The use of non-standard statistical notation and units of measurement, such as m^2/ha and m^3/ha/year, in this book only serve to propagate such errors. Throughout this book the term parameter is used to refer to "a variable in an equation". However, the term 'parameter' in forest biometrics refers to a true, usually unknown, characteristic of a population, the determination of which requires data on all n observations in the population. A parameter may be estimated from an unbiased 'statistic' or 'estimate' computed from a randomly selected sample of n observations. Population parameters are usually represented by Greek letters, while sample statistics are represented by lowercase Latin letters. West's use of the term 'parameter' throughout the text is inconsistent with the normal statistical definition and use of the term.

The chapters on individual tree, stand and land measurement are very relevant to all with an interest in tree, forest and land measurement and I commend this book for this. The chapters on stem volume, taper equations and sampling designs are clearly of more relevance to professional foresters with specific requirements for more specialized knowledge. Overall, *Tree and Forest Measurement* is a useful addition to the library of the professional forester and is affordable.

This book has relevance in Ireland at the present time given the considerable body of research on biomass expansion factors sponsored by COFORD, the introduction of the site index by Coillte for selected commercial species, and the National Forest Inventory being undertaken by the Forest Service, Department of Agriculture and Food.

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