HETEROGENEITY IN A POPLAR STAND AND ESTIMATION OF THE MEAN VOLUME INDEX

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ABSTRACT

For a small poplar stand of 81 Robusta trees (2 years old), contour mapping and trend surfaces are calculated. These statistical techniques can be informative for showing heterogeneity and can be helpful for estimating the mean of the parameters concerned.
They can yield better estimates than random sampling in the stand. As parameter, the Volume Index is used for demonstrative purposes.

1. INTRODUCTION

The development of individual plants within a stand is partially determined by external factors, biotic as well as abiotic ones. These factors not only have an important impact upon the estimation of yields per unit area (Cannell, 1980) but they can also produce misestimation in parameters such as total photosynthesis capacity, foliage coverage, biomass production.

In this paper, two statistical techniques are discussed : contour mapping and trend surfaces. Both should be used as an indication for heterogeneity and as stratification factor for estimating the parameters of interest.

The application is illustrated for the Volume Index (V.I.) and compared to random sampling.

2. MATERIALS AND METHODS

The stand consists of 81, two years old 'Robusta' trees (*Populus deltoides* x *Populus nigra*), planted in square connection. The stand is part of a larger one, consisting of 405 trees, belonging to five different clones. Although for such a small stand, heterogeneity could easily be observed by eye and all trees could be measured, the stand only serves here for demonstration purposes.

Contour mapping is produced, using the method of Lodwick and Whittle (1970), combined with linear interpolation. For smoothing, distance weighted least squares is used following an algorithm of Mclain (1974), as the measurements contain an error term.
The trend surfaces ar calculated as multiple regression, with the coordinates (number of rows and columns) as independent variables and V.I. as dependent one. Isolines are produced by cutting the calculated surface, perpendicular to the x-axis.

A random number generator (Press et al., 1986) is used for sampling the stand. Samples consisting of 4, 8, 12 and 16 trees are selected. These numbers represent respectively 5 %, 10 %, 15 % and 20 % of the total stand. The sampling procedure is carried out without replacement.

3. RESULTS AND DISCUSSION

In figure 1 the isolines for a V.I. of 2, 4, 6 and 8 are given. This map is digitized and the area, within each quadrant, limited by the isolines are expressed as percentages of the total area of that quadrant. The procentual contribution for each area is given in table 1.

Table 1 : Procentual contribution of the isolated areas.

Area	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
> 8	7.54	0.00	0.00	0.16
8 > > 6	64.18	46.43	2.78	41.50
6 > > 4	28.28	52.93	69.31	58.34
< 4	0.00	0.64	27.91	0.00
Mean	6.510	5.922	4.766	5.835

The map and the table show a heterogeneity, as the isoline with value 8 does not occur in quadrant II or III for a small part in quadrant IV. In Quadrant II, 46 % of the area has a V.I. value between 9 and 8 and 53 % of the area has a V.I. value between 4 and 6. In quadrant III 69 % of the area has a V.I. value between 4 and 6 and 28 % is less than 4.

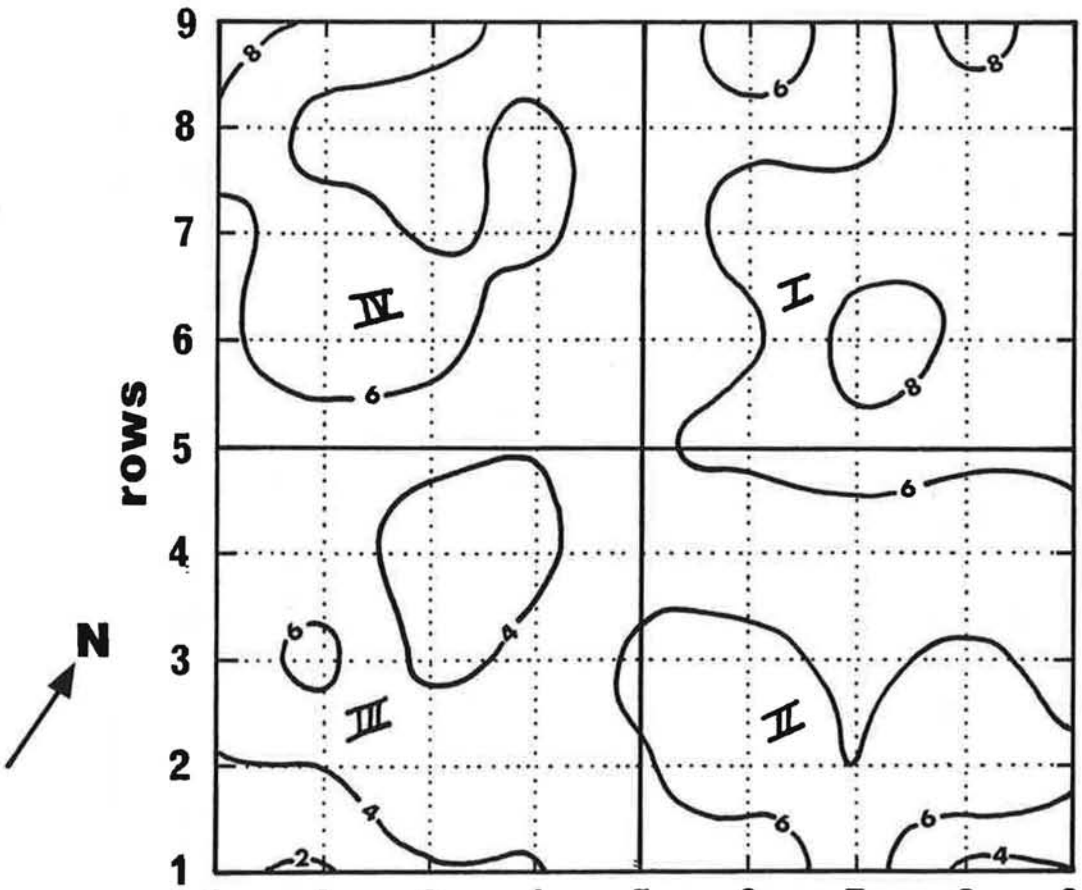

Figure 1 : isolines for a volume index of 2, 4, 6 and 8.

In figure 2, the linear trend is shown. This trend illustrates a continuous decreasing value for the V.I. in the North-South direction. A quadratic trend surface shows the same pattern.

Knowledge of the contour maps and the trend surface can be helpful for estimating mean V.I., as the different areas can be used as weighing factors. The true mean V.I. is calculated as 5.700 over 81 trees. Using the results of table 1 and taking the V.I. values themselves for the open classes and the intermediate values within the classes, a mean V.I. of 5.761 is obtained which overestimates the true mean by 1.07 %. Using the trend surface, counting the trees with a belt and multiplying this count by the mean of the belt, a mean V.I. was obtained of 5.694 which is only an underestimation of the true mean by 0.11 %.

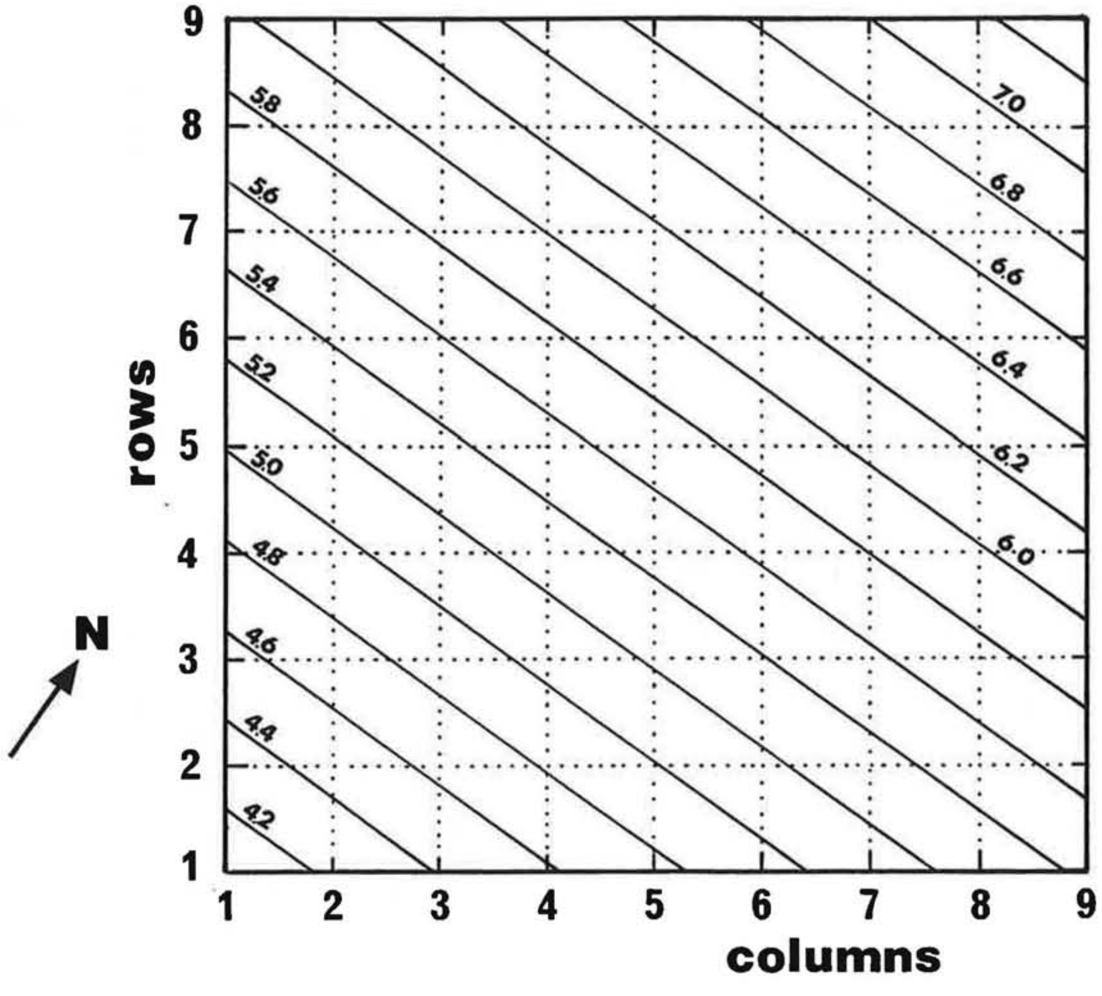

Figure 2 : linear North-South gradient of the Volume Index.

A fixed number of trees (4, 8, 12 and 16) is selected using a random number generator, and that selection is repeated 100 times. The results of the stimulated sampling is given in Table 2. The relative deviation (ignoring sign) is calculated within each class, weighed by the number of individuals in the class and averaged over all classes. These deviations are : 16.56 % ; 10.73 % ; 8.60 % and 7.48 % for respectively 4, 8, 12 and 16 trees. Individual sample means can however deviate to a much large extend.
Using the experimental distribution of samples of size, it an be calculated that the probability , of a misestimation of about 12 % is 0.55. For samples of sizes 8,12 and the probabilities are respectively 0.33 ; 0.18 and 0.13.

Table 2 : Experimental distribution of the mean V.I. using random sampling.

classes	Number of Trees			
	4	8	12	16
2.50-2.99	1	-	-	-
3.00-3.49	1	-	-	-
3.50-3.99	7	1	-	-
4.00-4.49	10	4	-	-
4.50-4.99	17	17	9	7
5.00-5.49	10	26	26	27
5.50-5.99	15	22	26	34
6.00-6.49	20	19	30	26
6.50-6.99	7	7	6	6
7.00-7.49	7	3	3	1
7.50-7.99	5	1	-	-

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