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RESPONSE OF RADIATA PINE BRANCH CHARACTERISTICS TO SITE AND STOCKING

J.D. TOMBLESON, J.C. GRACE
AND C.S. INGLIS

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EXECUTIVE SUMMARY

RESPONSE OF RADIATA PINE BRANCH CHARACTERISTICS TO SITE AND STOCKING

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Branch characteristics of *Pinus radiata* were examined over a range of site qualities and final crop stockings in Kaingaroa Forest. Branch Index for the 2nd log (5.7 - 11.2 m) was found to decrease with increasing site quality and stocking. Mean internode length was found to increase with improving site quality. However, no obvious relationship with final crop stocking was evident.

INTRODUCTION

Knot size is one of the most important characteristics affecting the commercial use of wood (Brazier, 1977). For *Pinus radiata* D. Don, Whiteside (1982) found that sawn timber grades could best be predicted from the mean diameter of the largest four branches for the nominated log length, one branch being selected from each quadrant (termed branch index). In conjunction with the above study, Inglis and Cleland (1982) derived regression equations to predict branch index for the first three 5.5 m log lengths. These equations were subsequently revised (Inglis, 1989) and incorporated into STANDPAK (Whiteside, 1989). Branch index for the 1st 5.5 m log (0.2 - 5.7 m) is predicted from quadratic mean diameter at age 20 years, initial stocking and predominant mean height at time of final thinning. Branch index for the 2nd log (5.7 - 11.2 m) is predicted from quadratic mean diameter at age 20, predominant mean height at the time of final thinning and site index. Branch index for the 3rd log (11.2 - 16.7 m) is predicted from quadratic mean diameter at age 20, predominant mean height at time of final thinning, site index, crop age, and final stocking. While the model of Inglis (1989) was found to give adequate precision over a range of silvicultural conditions, the data set used in constructing the model was biased towards final crop stockings between 200 and 400 stems/ha. Also little consideration was given to the mechanisms of branch growth and death in developing the model. The maturation of three final-crop stocking trials at Matea, Goudies and Northern Boundary in Kaingaroa Forest (Fig. 1) covering a range of site indices and low final crop stockings (Table 1) (see Maclaren, 1989 for further details) provided an opportunity to check the reliability of the model of Inglis (1989) and re-examine the influence of stocking and site index on branch characteristics using a well designed experiment.

METHODS

At each site and stocking (Table 1) branch diameters were measured on a sample of 24 trees, the sample size suggested by Inglis and Cleland (1982). To obtain this sample size, every plot tree at final-crop stockings of 250 stems or less was measured. Above 250 stems/ha eight consecutively numbered trees were measured from three plots.

Four quadrants were marked at the base of each tree. Quadrant 1 always faced magnetic north. Using a hand-held caliper the diameter of every branch was measured for each whorl on the 2nd log (5.7 - 11.2 m) Internode lengths for each log were obtained by measuring the height to the bottom and top of each whorl . Internode lengths were included in the calculation of mean internode length for a given tree if the whorl top was greater than 5.7 m and the whorl base was less than or equal to 11.2 m.

For a branch to be considered in the estimation of branch index, the mean height of the whorl ((height to bottom of whorl + height to top of whorl)/2.0) had to be greater than or equal to 5.7 m and less than or equal to 11.2 m.

RESULTS

Branch indices for the second log were found to decrease with increasing site index and increasing stocking (Fig. 2). Calculation of the 95% confidence intervals (Table 2) indicates that these trends are significant and not an artifact of the sampling.

The estimates of branch index for 150 and 250 stems/ha at Matea are likely to be underestimates as there were whorls below 11.2 m where all the branches were still alive (i.e., had attached green foliage). For the other treatments, the mean height to the first whorl with all branches still alive was above 11.2 m.

Branch index for the 2nd log was estimated using the model of Inglis (1989). Fig. 3 shows that the error in estimating branch index (actual - predicted) increases with decreasing stocking and site index.

There was a significant increase in mean internode length with increasing site index, however there was no obvious trend with stocking (Table 3).

DISCUSSION

Fig. 3 shows that the model of Inglis (1989) underestimates 2nd log branch index at low site indices and low final crop stockings. One reason for the under prediction is that stocking, which clearly influences branch index (Fig. 2) is not an independent variable in the regression model.

Several studies have shown that branch size is related to stocking (e.g., Kilpatrick *et al.*, 1981; Ballard and Long, 1988) hence it was not surprising to find that final-crop stocking influenced branch index in the trials measured. However to be able to develop a more reliable model for predicting branch size one needs to understand why stocking should influence branch size. Below we outline a more mechanistic approach to developing a branch size predictor.

On examining forest stands, one notices that there is little overlap of individual tree crowns. If one makes the assumptions that:

branch diameter is a function of branch length
branches stop growing when they touch of another tree

one can show that branch diameter is a function of stocking at time of crown closure.

Possible explanations for site index influencing branch size are:

the relationship between branch length and branch diameter varies with site,
the more rapid height growth at high site indices causes branches to be shaded earlier and hence they cannot achieve the same growth as on a poorer site.

We have planned an experiment to investigate these alternatives, and the results together with our assumptions about spacing will form the basis of a revised branch size predictor.

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TABLE 1 - Site index and stems/ha for final crop stocking trials

Site	Site Index (m)	Year Planted	Initial Stems/ha	Predominant Mean Height at thinning	Final Stems/ ha
Matea	24	1967	3086	11.8 m	150 250 350
Goudies	29	1966	2315	12.5 m	117 250 390
Northern Boundary	33	1968	2315	11.3 m	150 250 350

TABLE 2 - 2nd log branch index and 95% confidence intervals for three final crop stocking trials in Kaingaroa

Site	Site Index (m)	Final Stems/ha	Branch index (cm)	95% confidence interval (cm)
Matea	24	150 250 350	8.0 6.6 5.7	7.4 - 8.5 6.0 - 7.1 5.2 - 6.3
Goudies	29	117 250 390	6.7 5.3 4.8	6.0 - 7.4 4.8 - 5.7 4.4 - 5.2
Northern Boundary	33	150 250 350	6.3 4.9 4.5	5.8 - 6.8 4.5 - 5.4 4.2 - 4.8

TABLE 3 - Mean internode length and 95% confidence intervals for three final crop stocking trials in Kaingaroa

Site	Site Index (m)	Final Stems/ha	Mean Internode Length (m)	95% confidence interval (cm)
Matea	24	150	0.34	0.30 - 0.37
		250	0.38	0.34 - 0.42
		350	0.34	0.31 - 0.37
Goudies	29	11	0.42	0.37 - 0.48
		250	0.37	0.33 - 0.41
		390	0.38	0.34 - 0.43
Northern Boundary	33	150	0.45	0.38 - 0.53
		250	0.46	0.40 - 0.51
		350	0.46	0.40 - 0.51

FIG. 1 - TRIAL LOCATIONS

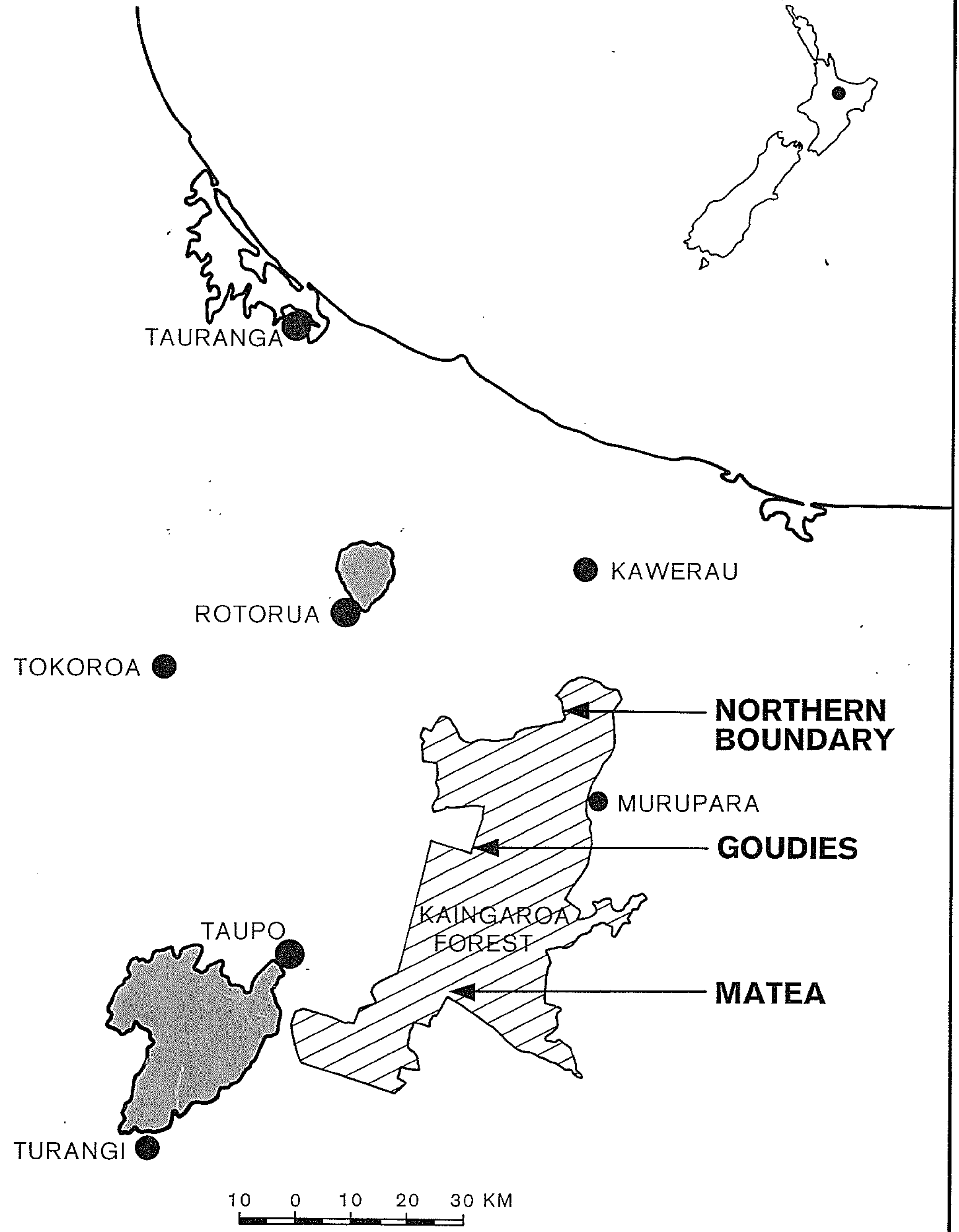

FIG 2 2nd LOG BRANCH INDEX

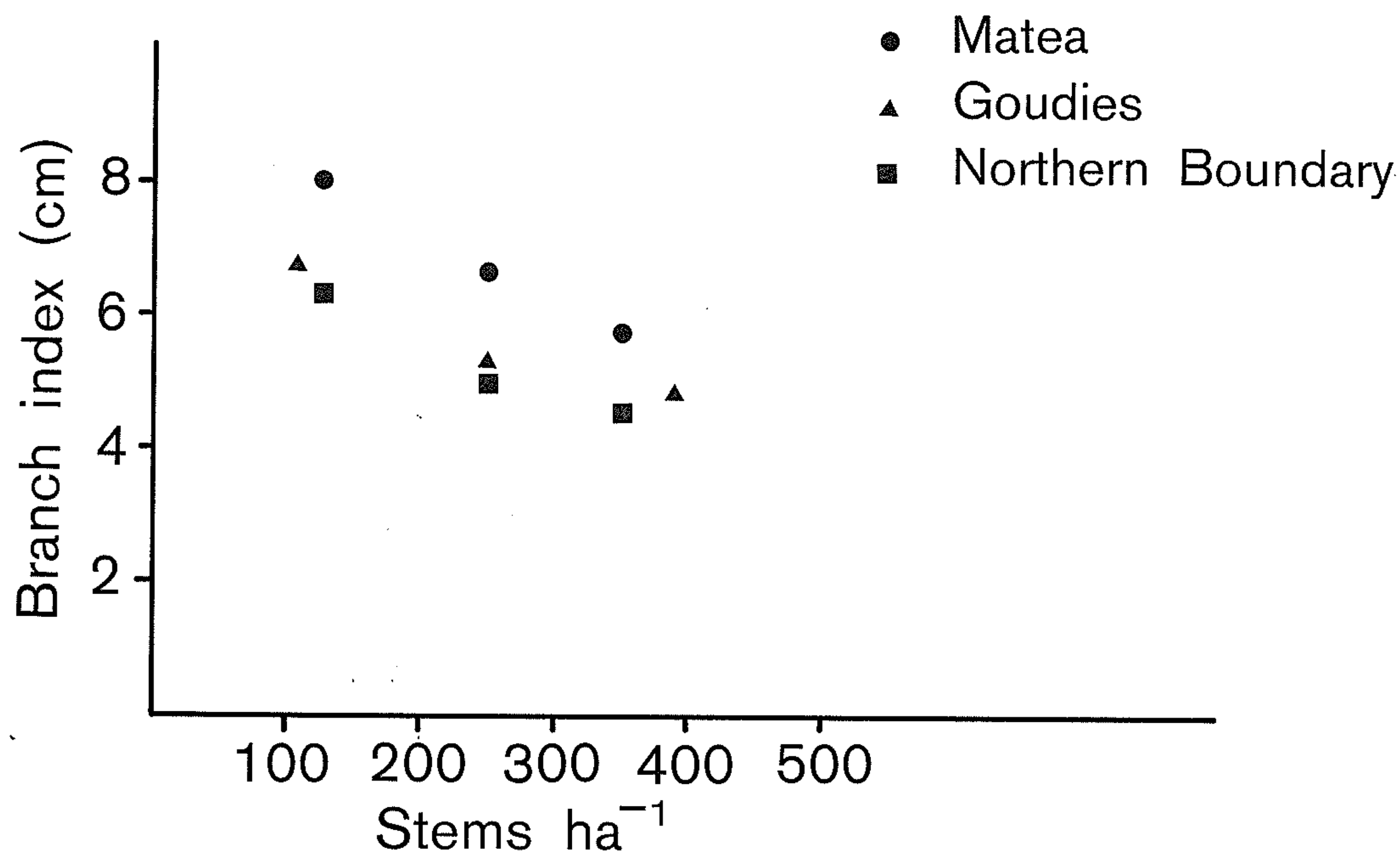

FIG. 3 Errors in predicting branch index