VALIDATION OF THE DIAMETER OVER STUBS PREDICTION FUNCTION FOR GENETICALLY IMPROVED RADIATA PINE

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FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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The series of improved silvicultural/breed trials established approximately five years ago provided the opportunity to collect first lift pruning data on diameter over stubs (DOS) and related variables for a range of breeds on seven sites. This study reports on the testing of the DOS prediction function using that data.

The DOS function appears to predict satisfactorily across a range of genetic improvement (GF5 to GF25) within the Growth & Form Breed. The Long internode breed and trees grown from cuttings also appear to be adequately predicted.

Considerable error in DOS prediction (1-1.5 cm) was found on two sites (Kaingaroa — low site index and Otago Coast) which appears to be linked to low site indices, high DBH/Ht ratios, or large maximum branch sizes. A further study is planned on this aspect using a more comprehensive data set.

VALIDATION OF THE DIAMETER OVER STUBS (DOS) PREDICTION FUNCTION FOR GENETICALLY IMPROVED RADIATA PINE

Introduction

Pruning of green branches for timber grade improvement is a common practice in New Zealand plantation forestry. The objective of pruning is to reduce degrade by knots and increase the yield of clear timber. Pruning forms a "defect core" within the tree which is made up of the size of the Diameter Over the pruned Stubs (DOS), the occlusion process, and sinuosity of the stem.
From numerous sawing studies DOS size has been found to be a critical variable in determining the value of a mature pruned log (Park, 1989).

The EARLY growth model was developed to allow forest growers to evaluate the trade-off between minimising the DOS size and maintaining tree growth while green crown pruning (West *et al* 1982). As part of that model, a DOS prediction function was developed for a wide range silvicultural regimes (Knowles *et al*, 1987). A single function was developed for all sites and validated with data from all regions of NZ. Special situations were also validated including the effect of tree breed. However this was limited to five plots of four different seedlots. The highest GF rating tested was approximately GF17.

The NZ FRI genetic tree improvement programme has resulted in the production of a wide range of new radiata pine breeds for plantation forestry. Each of these breeds have traits that have been emphasised in the selection process. Some of these traits are: long internodes, dothistroma resistance, growth and form. Generally all these breeds can be rated by a common index called GF (growth and form) rating. The higher the GF rating, he greater the expected improvement in growth rate and straightness.

To quantify the growth and yield gains from the new breeds a series of trials have been established throughout New Zealand over the last 7 years (Carson *et al* 1991, Skinner & Carson 1994). These trials test a range of seedlots (with various levels of improvement within breed) with a range of silvicultural treatments, involving a range of final crop stockings augmented by timing of thinning treatments. Pruning of these trials will only involve a first lift for access purposes.

The series of new breed trials described above provided the opportunity to collect data and test the performance at low pruning of the DOS prediction function for a range of breeds on numerous sites.
This study reports on the testing of the DOS prediction function for first lift pruning of new breeds on seven trial sites.

Method

Over the last two years trials of the new breeds series that were planted in 1987 and 1988, have become due for first lift pruning (usually at MCH 6.2m). All pruning has

been on a variable basis leaving 4m of green crown remaining. At this stage permanent sample plots (PSPs) have been established and the diameters and heights measured. In addition, measurements for DOS prediction were taken on a sample of 6 - 12 trees per plot. These trees are randomly selected across the diameter range ie the normal procedure for sampling height trees plus four trees (one in each quadrant) chosen as predominant mean height (PMH) trees. Measurements on these trees include: DBH, total height, pruned height, DOS, DOS height, and maximum branch.

The DOS data recorded for each trial has been entered into the PSP system. Details of the trials used to validate the DOS function are given in table 1.
Initially data from the Mamaranui trial - FR54, was also included in this analysis. Unfortunately this data could not be used because height measurements were not taken at the time of DOS measurement.

Table 1: Details of trials

Forest	PSP No.	Growth Model Region	Site category	Number of DOS measurements per plot	Tree age at measurement (years)
Woodhill	FR 7	Sands	Medium Site index	6	5.6
Kawerau	FR 84	Pumice Plateau	High basal area	12	4.5
Kaingaroa	FR 85	Pumice Plateau	Medium Site index	12	4.7
Kaingaroa	FR 9	Pumice Plateau	Low Site index	12	6.8
Tikokino	FR 57	Napier	High Site index	12	5.7
Blenheim	FR 11	Nelson	Low Site index	6	5.8
Otago Coast	FR 12	Southland	High basal area	12	6.9

Data for individual trees were extracted for the seven trials and entered into several EXCEL spreadsheets. DOS size was predicted using the Knowles *et al* (1987) formula and the error in DOS prediction calculated by: predicted - actual. Plot averages were then examined for trends of bias by tree breed.

Results

To first examine if the DOS prediction variables (or tree shape) varies with tree breed, measurements of DBH, Height, DOS height, maximum branch, and DOS have been summarised in the following six tables. This data represents means of only the sample of trees measured for DOS and have been averaged across a range of tree stocking treatments.

Table 2: Mean DBH (cm) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaroa-Med	Kaingaroa-Low	Tikokino	Blenheim	Otago Coast
5		13.41	9.89				
7	12.32			12.86		11.66	13.90
10+					12.71		
13*	11.83			13.02		12.07	14.48
14	12.85			13.48		11.88	15.26
16		14.07	11.00				
17#					11.99		
18			11.37				
19	12.77				13.86		
21	12.91			13.94		12.42	14.43
22#			11.22				
23			11.35				
25		14.60	11.61				
25#		14.63	12.53				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Table 3: Mean height (m) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaroa -Med	Kaingaroa -Low	Tikokino	Blenheim	Otago Coast
5		7.86	6.38				
7	6.96			6.65		6.57	6.53
10+					6.85		
13*	7.14			6.77		7.02	7.13
14	7.07			6.84		6.80	6.98
16		8.11	6.97				
17#					6.67		
18			7.31				
19	7.19				7.12		
21	6.96			7.01		6.75	6.80
22#			6.91				
23			7.35				
25		8.61	7.39				
25#		8.40	7.96				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Table 4: Mean DOS height (m) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaroa -Med	Kaingaroa-Low	Tikokino	Blenheim	Otago Coast
5		1.11	0.76				
7	0.77			0.52		0.67	0.69
10+					0.82		
13*	0.68			0.48		0.68	0.60
14	0.71			0.51		0.68	0.68
16		0.96	0.77				
17#					0.97		
18			0.85				
19	0.68				0.83		
21	0.84			0.48		0.70	0.72
22#			0.72				
23			0.83				
25		1.05	0.71				
25#		1.03	0.64				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Table 5: Mean Maximum branch (cm) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaro a-Med	Kaingaroa-Low	Tikokino	Blenheim	Otago Coast
5		3.59	2.26				
7	4.05			3.63		2.94	4.84
10+					3.71		
13*	4.74			4.42		3.67	5.08
14	3.92			3.39		2.81	4.35
16		3.08	2.53				
17#					3.49		
18			2.22				
19	3.44				3.51		
21	4.07			3.58		3.06	4.40
22#			2.28				
23			2.34				
25		3.31	2.38				
25#		3.26	2.83				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Table 6: Mean DOS (cm) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaroa-Med	Kaingaroa-Low	Tikokino	Blenheim	Otago Coast
5		18.29	13.72				
7	18.33			20.07		16.69	22.20
10+					18.16		
13*	18.21			20.68		18.04	23.25
14	18.75			20.54		16.58	22.74
16		18.20	15.23				
17#					16.41		
18			15.04				
19	18.10				19.18		
21	19.14			20.74		17.51	21.87
22#			15.79				
23			15.56				
25		18.63	16.05				
25#		18.70	17.06				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Table 7: Mean error in DOS prediction (cm) by GF rating for all trials.

GF rating	Woodhill	Kawerau	Kaingaroa-Med	Kaingaroa-Low	Tikokino	Blenheim	Otago Coast
5		-0.35	0.33				
7	-0.27			-1.07		0.09	-1.64
10+					-0.02		
13*	0.01			-0.91		-0.34	-1.88
14	-0.13			-1.11		0.24	-1.17
16		0.25	0.17				
17#					0.45		
18			0.20				
19	0.09				-0.12		
21	-0.61			-0.69		0.11	-1.16
22#			-0.29				
23			-0.16				
25		0.31	-0.17				
25#		0.25	0.11				

+ LI 15 - long Internode breed, * LI 28 - long Internode breed , # Cuttings

Effect of tree breed on DOS variables

The influence of tree breed on DBH and height is clearly evident in the tables above. Results of early growth in this trial series is given by Skinner *et al* (1994). The effect on tree shape can best be examined by the ratio DBH/Ht. Figure 1 gives the trend in DBH/Ht by GF rating. This shows clearly that tree shape is not changed at this age by the breeding programme but that it is influenced by site.

DOS height and maximum branch appear to be unaffected by tree breed. However differences between site are clearly evident. Also within the same forest, Kaingaroa , there are differences between the low and medium sites. This may be due to weed competition suppressing lower branch growth. Figures 2 and 3 give graphical results of DOS height and Maximum branch by tree breed. A consistent step trend in maximum branch (fig 3) on four sites results from the slightly larger branchs of a LI28 breed which has been given the equivalent rating of GF13. Overall there is a slight trend of maximum branch reducing with higher GF rating. However this trend is not statistically significant.

Figure 4 gives the effect of GF rating on DOS size and figure 5 gives error in DOS prediction by GF rating. No significant trends are indicated in DOS prediction error by GF rating. However two sites, Kaingaroa-L and Otago Coast show under prediction of 1 - 1.5 cm.

Effect of Initial stocking on DOS prediction

Five of the trials measured for DOS included a range of initial stocking treatments. This allowed the effect of initial tree stocking to be examined on a range of tree variables and on the error in DOS prediction.
Table 8 gives a summary of these results and figure 6 gives the trends in DOS prediction error by initial stocking. Mean values have been calculated across the range of GF values and have been derived from six to eight plots (ie two replicates of each level of GF or seedlot).

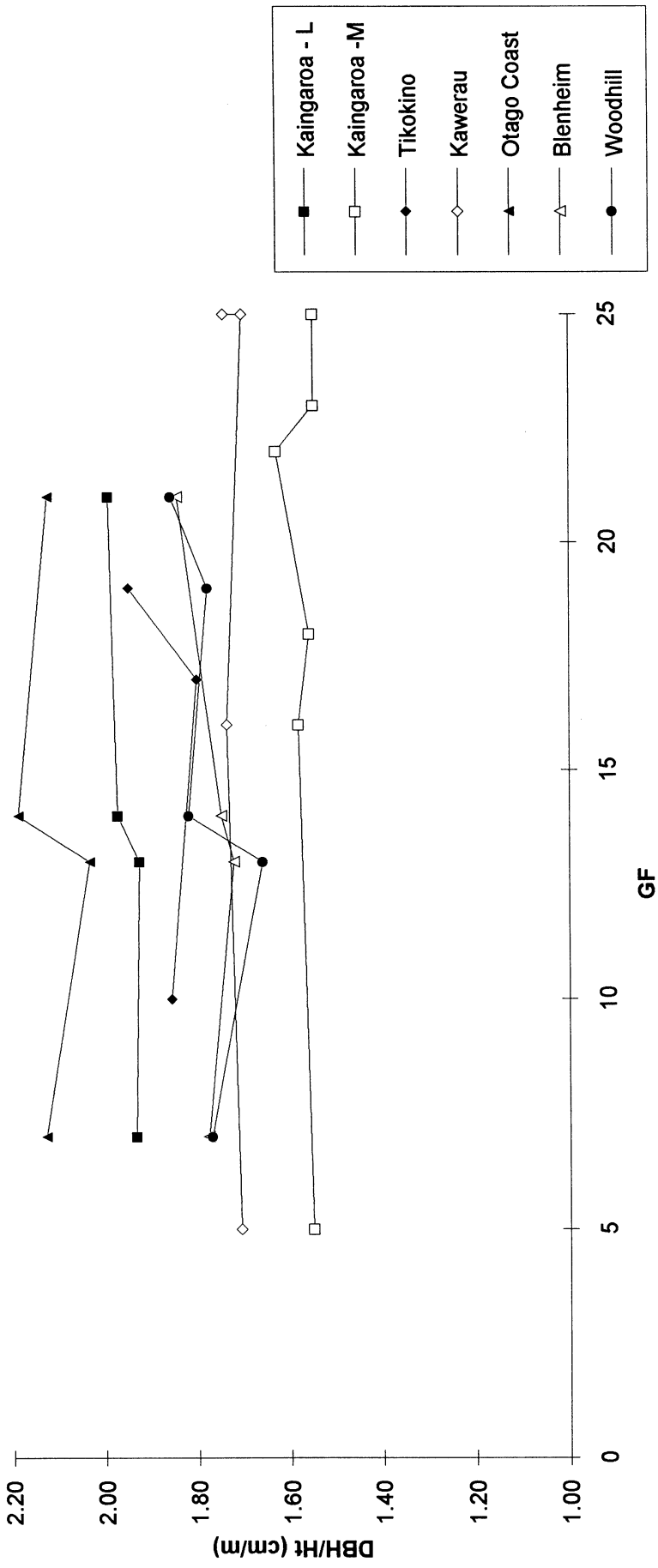
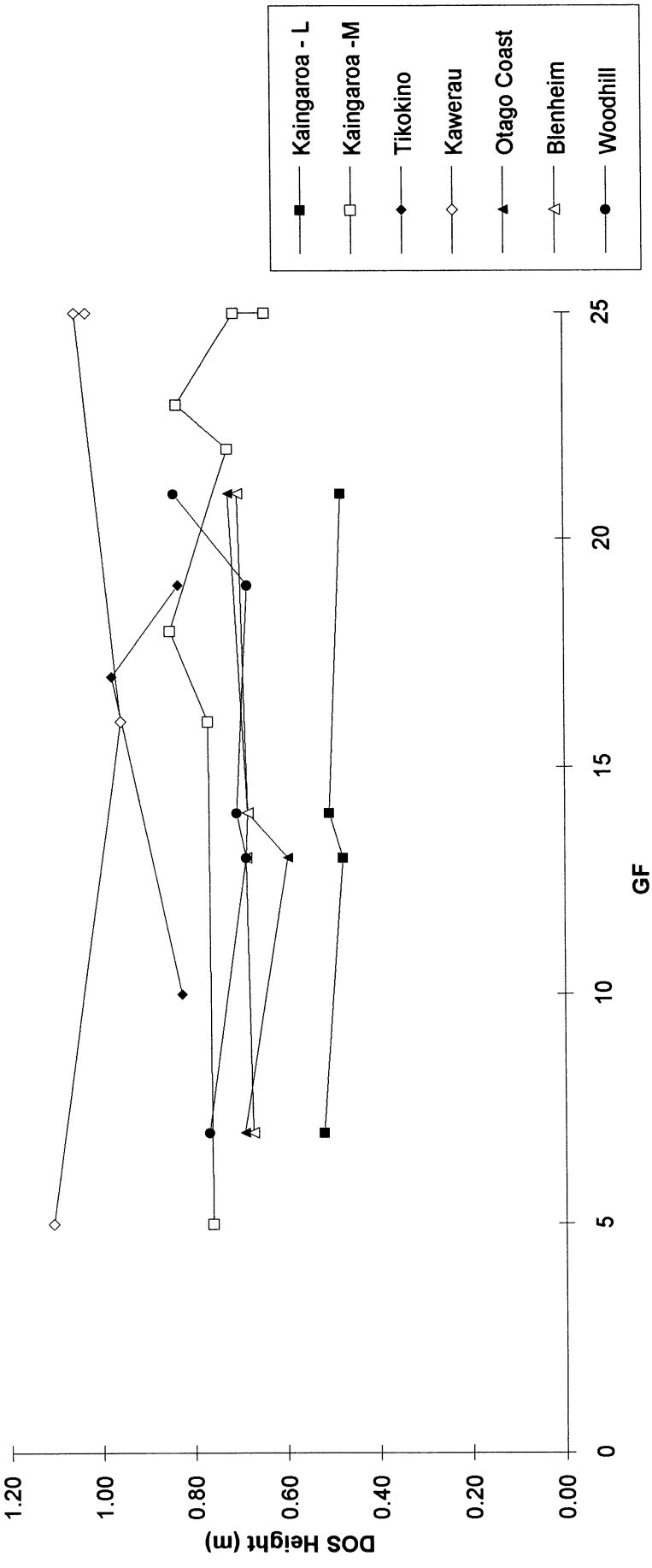


Figure 1: Effect of GF rating on DBH/Ht

Figure 2: DOS height for first lift pruning by GF rating



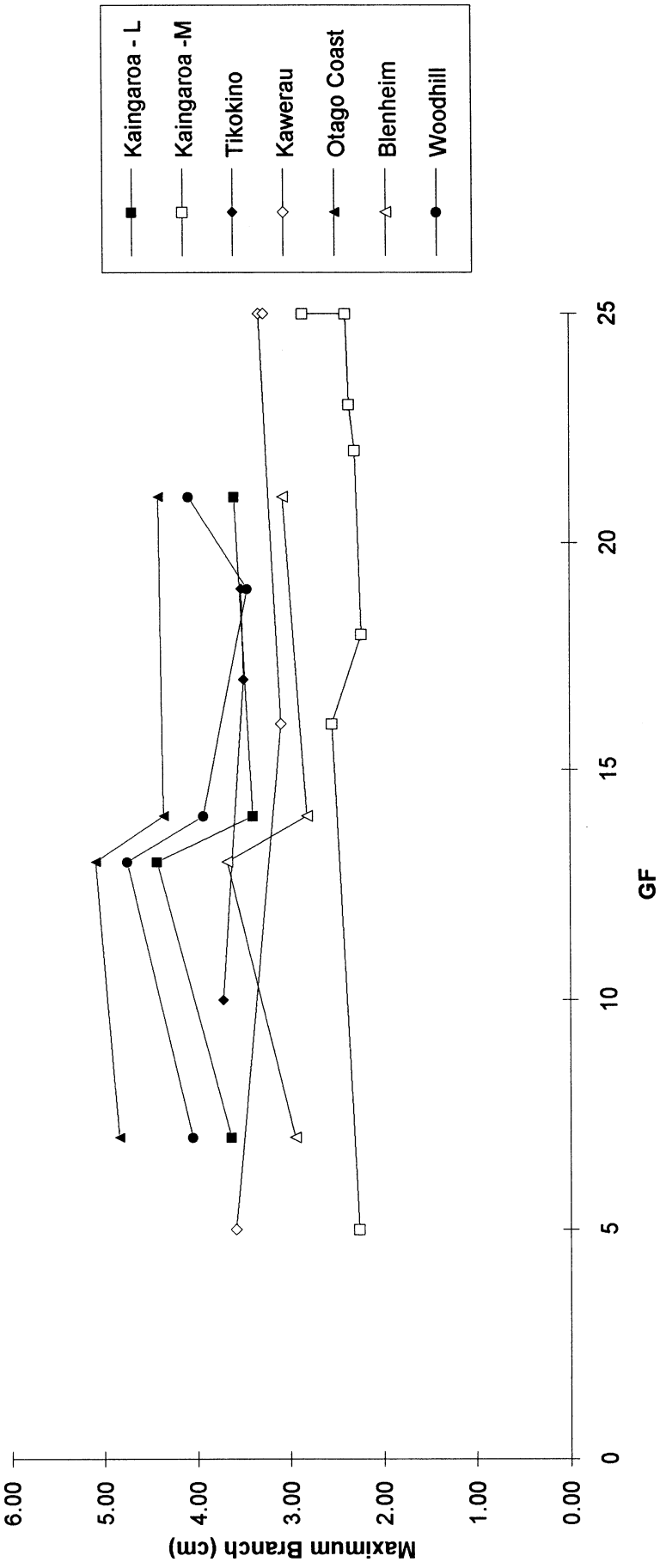


Figure 3: Maximum Branch measured at first lift pruning by GF rating

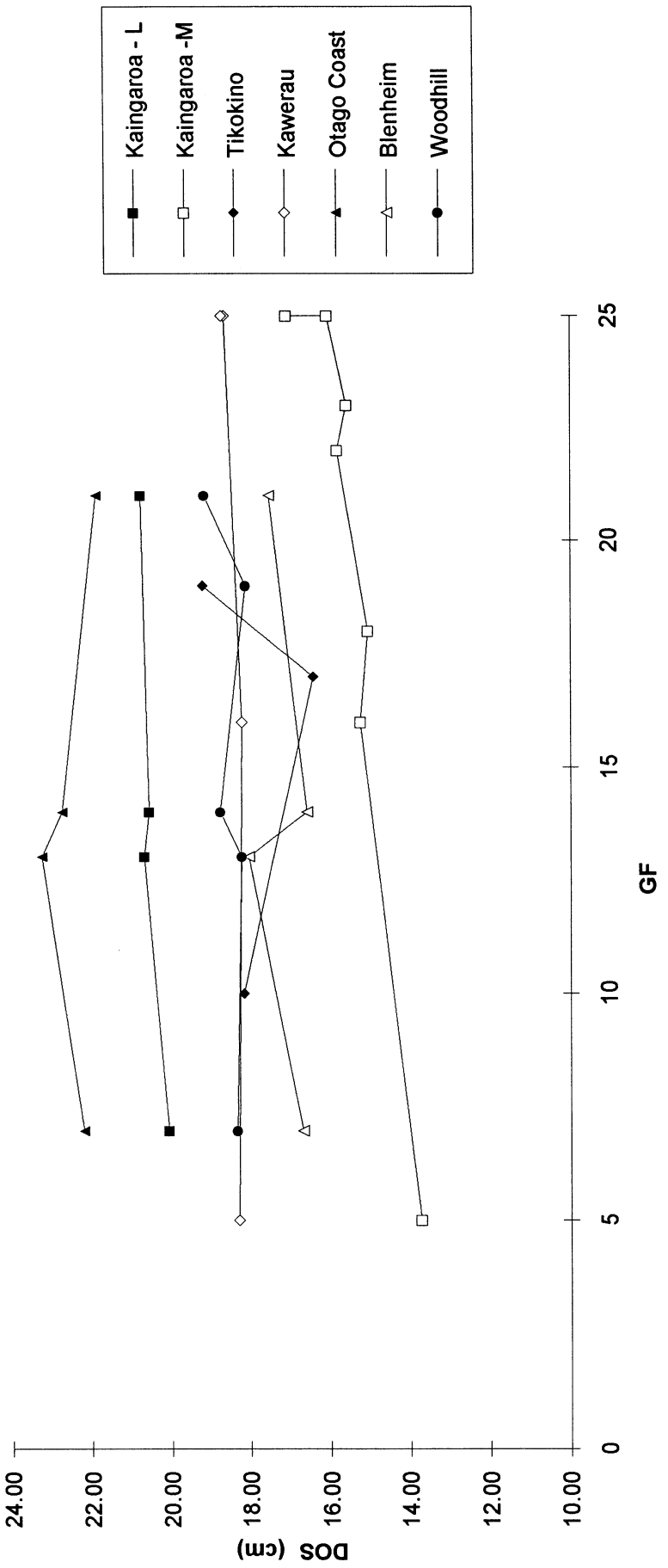


Figure 4 : DOS size measured at first lift pruning by GF rating

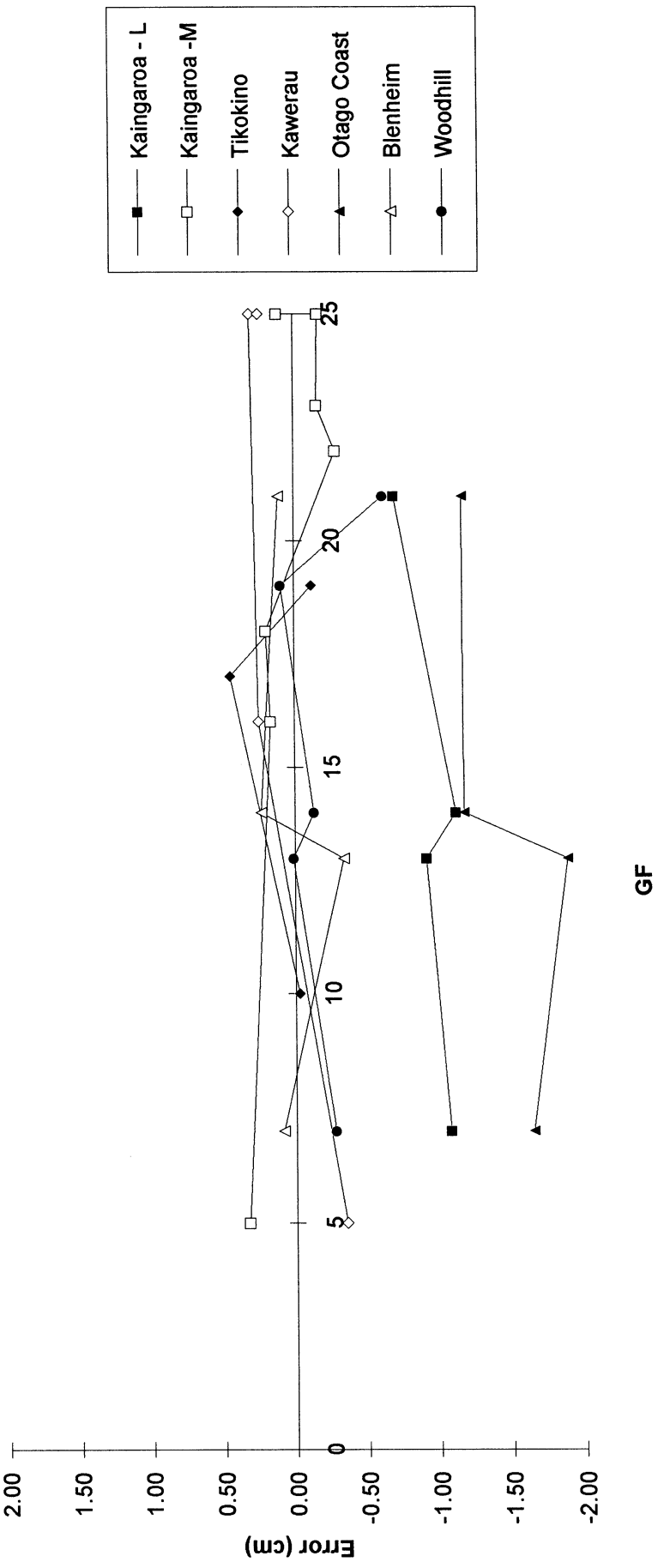


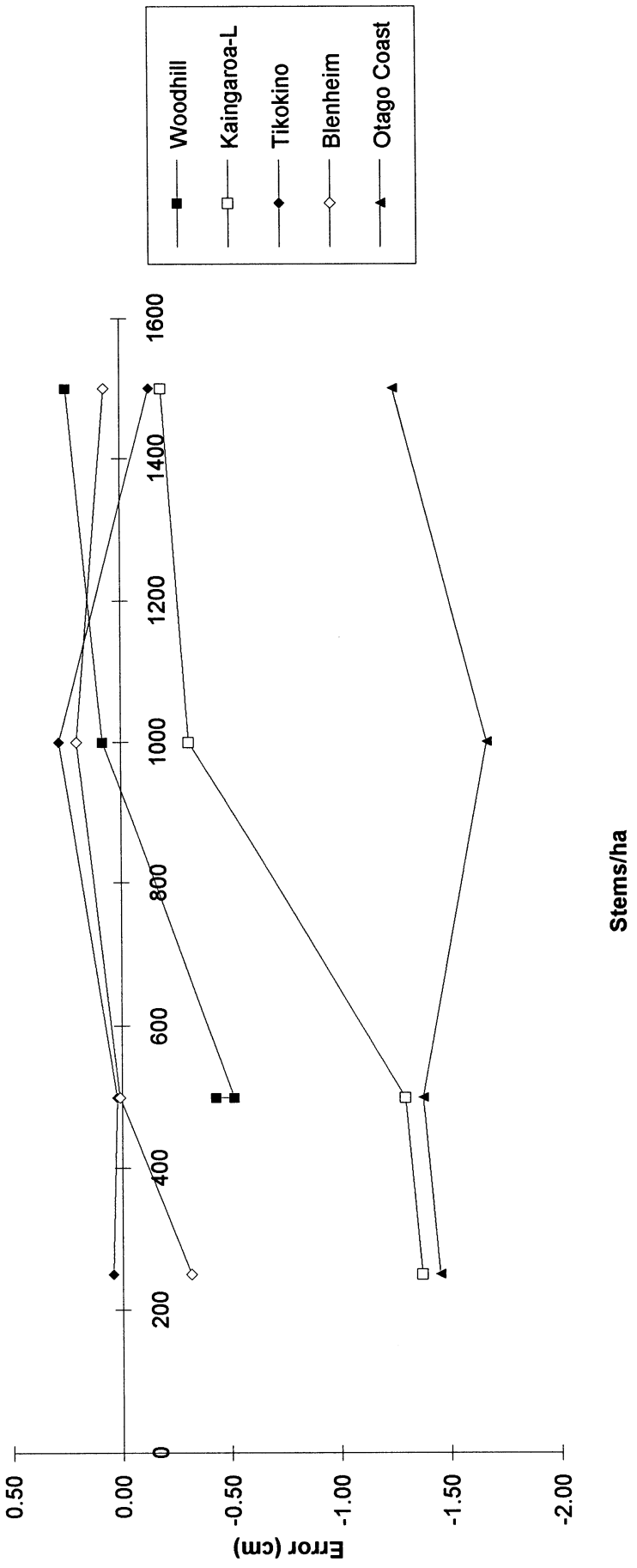
Figure 5: Error in DOS prediction for first lift pruning by GF rating

Table 8: Effect of initial stocking on tree variables and DOS prediction at first lift pruning

Forest	Initial stocking (stems/ha)	DBH (cm)	Height (m)	DOS (cm)	DOS Height (m)	Maximum branch (cm)	Error (cm)
Woodhill	500	13.25	7.06	19.90	0.68	4.38	-0.43
Woodhill	500	12.76	6.76	19.72	0.71	4.79	-0.51
Woodhill	1000	12.49	7.30	17.87	0.76	3.81	0.08
Woodhill	1500	11.82	7.19	16.70	0.79	3.39	0.25
Kaingaroa-L	250	14.03	6.52	22.48	0.43	4.39	-1.37
Kaingaroa-L	500	13.93	6.86	21.91	0.51	4.26	-1.30
Kaingaroa-L	1000	12.44	6.78	18.48	0.47	3.12	-0.31
Kaingaroa-L	1500	12.53	7.10	17.94	0.51	2.79	-0.19
Tikokino	250	12.95	6.62	18.36	0.78	3.53	0.04
Tikokino	500	13.03	6.84	18.33	0.84	3.64	0.02
Tikokino	1000	12.69	6.96	17.47	0.89	3.55	0.28
Tikokino	1500	11.90	7.06	16.62	1.00	3.24	-0.14
Blenheim	250	12.04	6.44	18.27	0.65	3.71	-0.31
Blenheim	500	12.06	6.49	17.48	0.70	3.27	0.01
Blenheim	1000	12.01	6.99	16.76	0.77	3.09	0.20
Blenheim	1500	12.24	7.40	16.70	0.68	2.50	0.07
Otago Coast	250	14.58	6.40	23.12	0.66	5.17	-1.45
Otago Coast	500	14.71	6.66	23.01	0.69	5.11	-1.37
Otago Coast	1000	14.72	7.16	22.54	0.74	4.54	-1.67
Otago Coast	1500	14.19	7.23	21.15	0.63	3.56	-1.25

For some sites (Woodhill and Kaingaroa-L) error in DOS prediction appears to decrease with increasing stocking rate, ie greatest error is at the lower stockings. However the trend is not consistent across all sites.

Figure 6: Effect of initial stocking on DOS prediction error in the first lift



Conclusions

The DOS function appears to prediction satisfactorily across a wide range of tree breeds, from GF 5 to GF 25. Specialised breeds such as the Long Internode breed and trees growth from cuttings also appear to be adequately predicted.

Considerable error in DOS prediction (1-1.5cm) was found on two sites (Kaingaroa - Low and Otago Coast) and appears to be linked to low site indices, high DBH/Ht ratios, or large maximum branchs. A further study on DOS validation is planned on this using more comprehensive data.

The influence of initial stocking was not consistent but does not appear to be implicated directly with error in DOS prediction.

References

Carson, S D, Carson, M J, Wilcox, P L , Kimberly M. 1991: Trials designed to quantify growth and yield gains from genetically improved radiata pine. Stand Growth Modelling Cooperative Report No. 24.

Skinner J. A. ; Carson S. D. 1994: Trials designed to quantify growth and yield gains from genetically improved radiata pine - an update. Stand Growth Modelling Coop Report No. 24a

Skinner J. A. ; Dunlop, J. D., Carson S. D. 1994: Establishment report for the 1987 silviculture/breed trials. Stand Growth Modelling Coop Report No. 32

Knowles, R.L.; West, G.G.; Koehler, A.R. 1987: Predicting "diameter over stubs" in pruned stands of radiata pine. Ministry of Forestry, FRI Bulletin No.12.

Park, J.C. 1989: Pruned log index. New Zealand Journal of Forestry Science 19(1): 41-53

West, G.G.; Knowles, R.L.; Koehler,A.R. 1982: Model to predict the effects of pruning and early thinning on the growth of radiata pine. New Zealand Forest Service, FRI Bulletin No.5.