VALIDATION OF THE MODEL TO PREDICT BRANCH INDEX IN DIRECT SAWLOG REGIMES

M. Middlemiss & R.L. Knowles

Report No. 4 November 1994

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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Branch measurements from second logs in an independent data set of 34 stands were used to validate the model developed for radiata pine by Knowles and Kimberley (1993) for predicting branch index which is the mean of the four largest branches per 5.5m log length. Whilst the relative effects of the three main variables used to predict branch size (DBH @ 20 yrs, Height at thinning, and Site Index) are accurately modelled, the model was found to consistently over predict branch index across all combinations of inputs by an average of 7.3mm. There are several possible explanations for the cause of this bias; the most likely is that higher initial stocking levels in the validations data favoured the development of the crown disease *Dothistroma pini* which would have resulted in a reduced final branch size.

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Introduction

Branch size is a significant quality determining feature of radiate pine logs, especially where logs are sawn into timber for structural uses. Stand modelling systems such as STANDPAK incorporate functions to predict branch size, which depend on such variables as tree size, height at thinning, and log height class. The initial model was constructed by Inglis and Cleland(1982) and more recently a model has been produced by Kimberly and Knowles(1993) to predict branch size in the second log height class (5.8 - 11.3m). In both models, "branch size" is represented by "branch index" which is the mean of the four largest branches per 5.5m log length.

This project aims to use the data provided by Inglis and Cleland, to validate the more recent model. Table 1 shows the data set which was available.

Table 1. Stand means of Inglis Cleland data

Forest	Height thinned (m)	Site index	DBH age 20	Branch Index
Berwick	10.5	22	42.9	7.23
Berwick	10.5	23	40.25	5.55
Berwick	13.5	22	41.36	5.7
G. Downs	15	28	38.92	4
G. Downs	15	28	36.68	3.72
Gwavas	12.5	31	52.39	6.07
Gwavas	12.5	31	45.26	4.32
Kaingaroa	9.6	33	50.16	5.96
Kaingaroa	10.9	33	49.17	6.33
Kaingaroa	11.8	33	40.59	4.5
Ngaumu	13.5	27	46.71	5.41
Ngaumu	14.8	27	39.69	4.04
Tarawera	18.5	36	41.4	3.29
Tarawera	12	36	42.84	4.3
Tarawera	18	36	40.68	3.56
Tarawera	17	35	39.55	3.64
Tarawera	12.5	35	43.75	4.92
Tarawera	12.5	36	45	5.08
Tarawera	12.5	36	39.24	3.85
Tarawera	12.5	36	34.56	3.74
Whangapoua	14.5	30	50.7	4.96
Whangapoua	15	32	41.6	3.5
Whangapoua	18	31	40.92	2.91
Woodhill	12.5	25	36.25	3.8

KSF adv. shoot	7.6	33	48.4	5.7
Tawhai1	13.5	20	36.3	4.7
Mawhera	12.5	27	53.8	7.7
Tawhai4	13.4	20	34.5	5.3
Nemona	21.3	27	44.3	4.6
Granville	20	25	45.7	5.4
KSF N. bound	12.1	35	40.6	4.3
Matea	12.3	24	40	6.2
Tikitere	10.1	33	49.3	5.3
Waratah	12	31	50.22	5.8

The equation for the Kimberley and Knowles model is:

$$BIX = 3.0 + b * \ln(1 + \exp(0.985/b + 0.356/b\ DBH20 - 0.354/b\ SI - 0.212/b\ GF - 0.321/b\ HTTHIN))$$

with $b = 3.52$

For the validation data set, a Growth and Form (GF) factor of 7 was used. for all plots.

Results and Discussion

The Kimberly and Knowles model appears to consistently overpredict branch index for this data set by an average of 7.3 mm (Figs. 1 & 2).

Fig. 1.

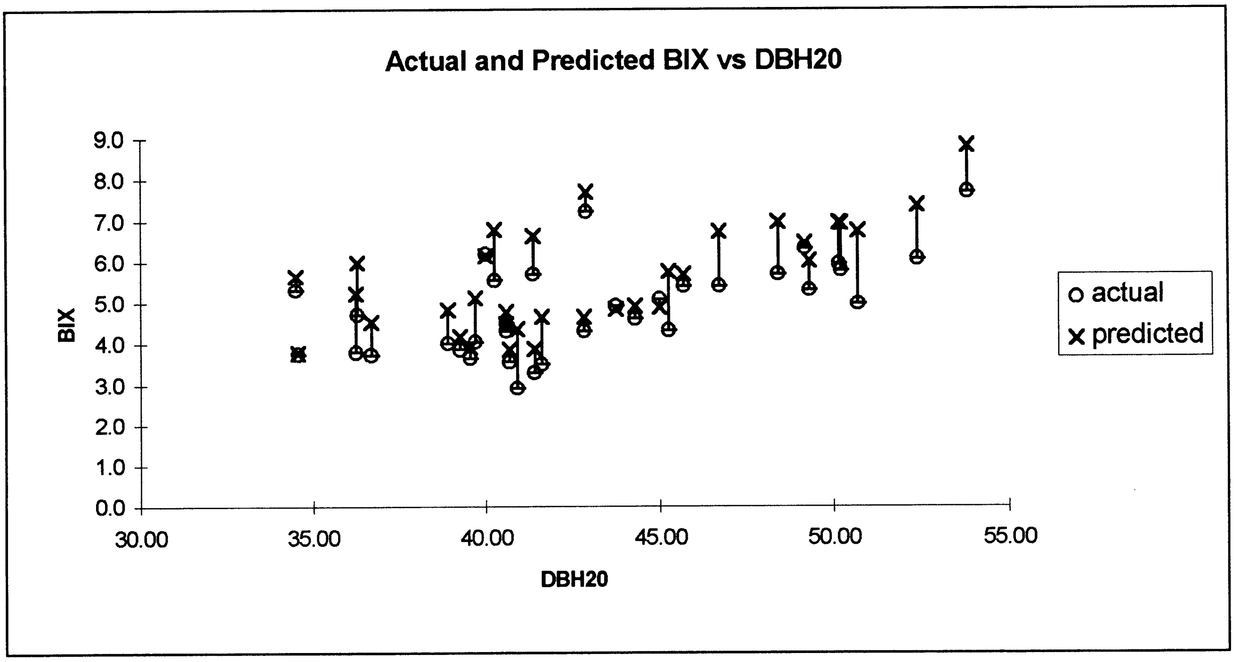
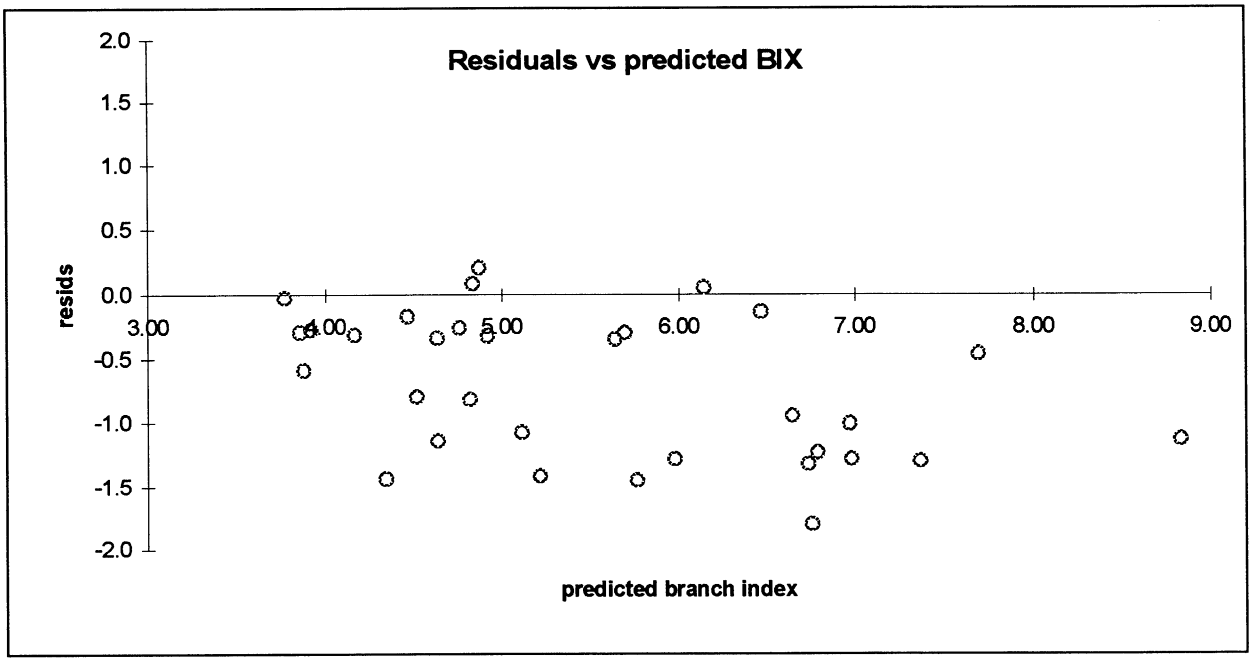


Fig. 2.



To examine the cause of the overprediction of BIX in greater detail, the model equation was fitted to the validation data set. The coefficients obtained are shown in Table 2, together with the original model coefficients. Note that no coefficient for GF was available from the validation data, which was assumed to have a constant GF of 7. The coefficients fitted to the validation data set are generally very close to the model values. These results indicate that the **relative** effects of the three variables: DBH at age 20yrs, Height at Thinning and Site Index, are accurately modelled. In other words, the bias in prediction for the validation data is consistent across all combinations of inputs.

Table 2. Model coefficients and coefficients derived from validation data

	Coefficients	
Variable	Model	Derived from validation data
DBH20	0.356	0.352
SI	-0.354	-0.371
HTTHIN	-0.321	-0.372
GF	-0.212	-

There are several possible explanations for the cause of this bias:

- The manner in which branches were measured differed in some way between the two data sets.
- The criteria for selecting trees for measurement differed.
- The adjustment used to obtain DBH at age 20yrs. was inaccurate.
- That measurements were taken by Inglis and cleland of branches which were still alive, and therefore capable of additional growth.
- The model overpredicts the effect of GF on branch size. The effect of GF could not be examined in isolation using the validation data.
- There is some common factor in the validation data not present in the model data, which has an effect on branch size not accounted for in the model. One possibility is initial stocking level which would have been much higher for the validation data. A further possibility is that levels of the crown disease Dothistroma pini could have been higher than in the later data sets collected by Knowles and Kimberly. Higher stockings tend to favour the development of this disease (L Bulman, pers com) and the effect of earlier onset of crown scenescence would have been a reduction in final branch size.

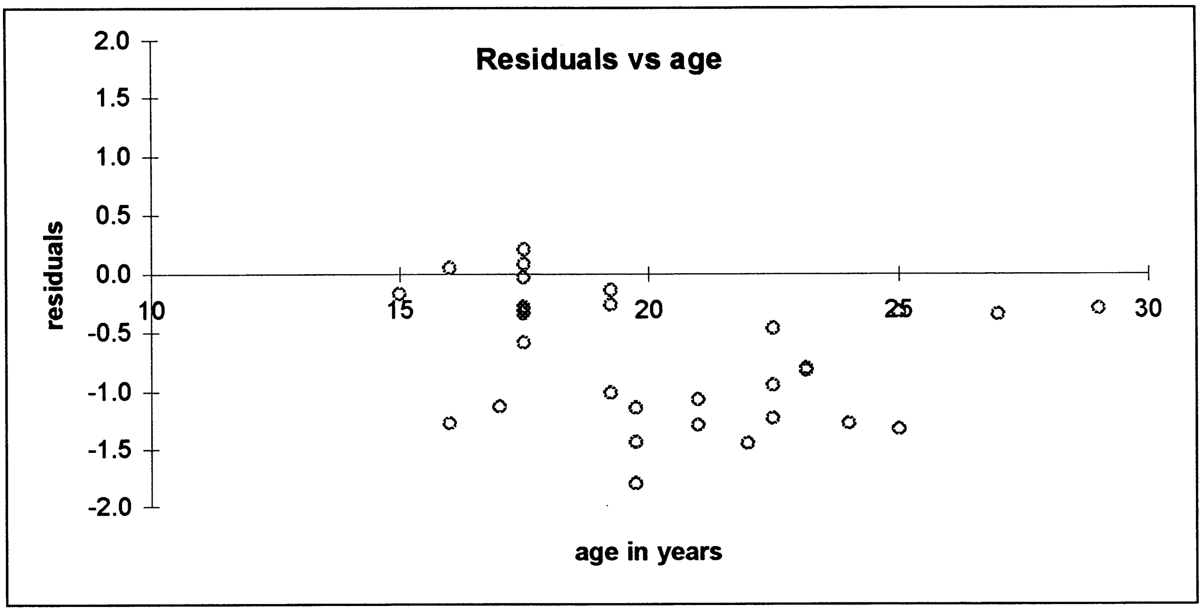
These possibilities are discussed in further detail.

1. Discussion with Mr C Inglis revealed that the methods and tools used for measuring branches were identical to those described by Kimberly and Knowles. This explanation can therefore be rejected.

2. Inglis and Cleland measured what they described as trees of "normal form". Trees which were malformed such as exhibiting heavy basket whorls were not measured whereas such trees were measured by Kimberly and Knowles. The difference in terms of mm of branch index that this would introduce is unknown, but it could be a significant factor.

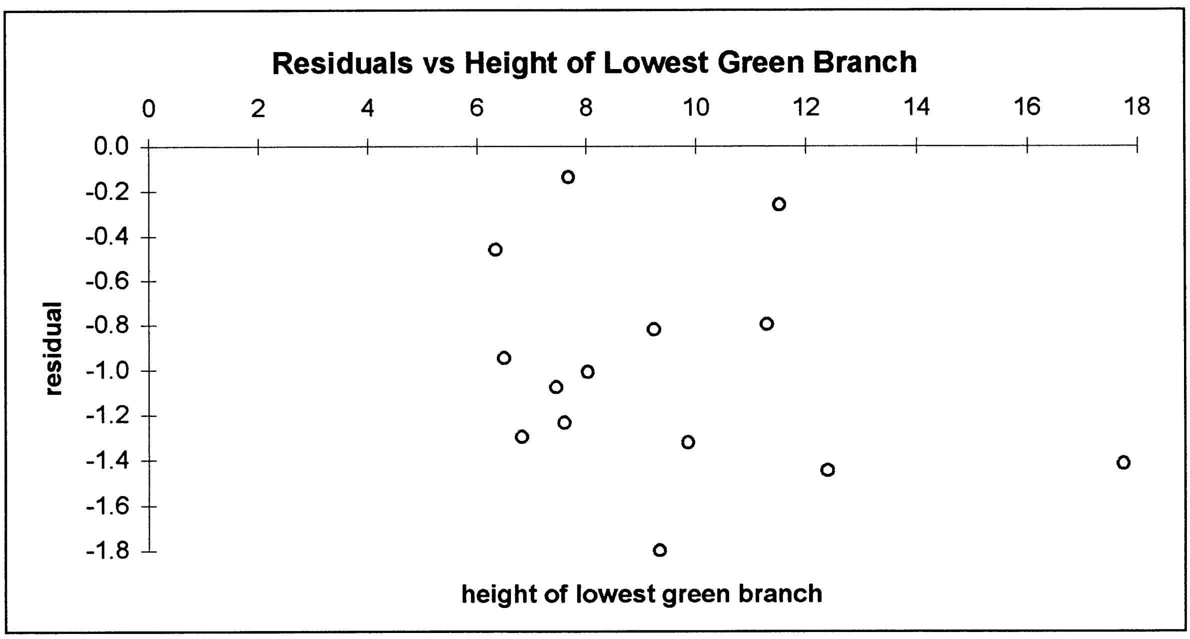
3. Inglis and Cleland measured stands aged between 17.5 and 37 years of age. Since DBH at age 20 years is a variable used to predict branch size, it was necessary to predict the DBH of the stand if it was measured at an age other than 20 years. Because regional growth models were not then generally available they used a simple method of adjusting the stand DBH, by assuming stands grew 1.66 m^2/ha of basal increment per metre of height increment. We now know that this is an oversimplification, but a graph of residuals against age shows no increased error with ages further away from 20. (Fig. 3)

Fig. 3.



4. To further test if measuring live branches gave smaller measurements the measurements for lowest green branch were obtained where possible. When residuals were plotted against these measurements there was no indication that lower green branches resulted in larger discrepancies between measured and predicted branch index.

Fig. 4.



5. The stands measured by Inglis and Clelend had a high initial stocking (majority was 2300, average 2444) and one possibility is that although a stand was thinned before some branches grew the trees retained the characteristics of high stocking, ie smaller branches. As mentioned earlier, the crown disease Dothistroma pini could also be implicated.

Conclusion

For stands which have been established at initial stockings of around 1500 stems/ha or less, and thinned to a final crop in a direct sawlog regime, the model to predict branch index derived by Knowles and Kimberly is the most appropriate. However, some caution in its application is justified until more validation data is available from stands incorporating new genetic material, established at relatively low initial stockings.

References

Kimberly and Knowles, 1993. A Model to Predict Branch Index in Radiata Pine Direct Sawlog Regimes. Forest and Farm Plantation Management Cooperative Report No. 1.

Inglis and Cleland 1982. Predicting Final Branch Size in Thinned Radiata Pine Stands, NZ Forest Service, FRI Bulletin No. 3.