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Comparison of TreeBLOSSIM predictions with inventory data: Hawkes Bay Forests

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EXECUTIVE SUMMARY

Data from 10 Permanent Sample Plots in the Hawkes Bay Region were used as initial starting values for TreeBLOSSIM. The data was projected forward to 2001 (a period of 13 or 14 years) and the model predictions compared with current inventory data.

Comparing inventory data with TreeBLOSSIM predictions at a plot level, TreeBLOSSIM predicted:

- less branches in the first cluster above prune height (between 1 and 3),
- a bigger diameter for the largest branch in the first cluster above prune height (between 1.1 and 4.2 cm),
- and up to 1 cluster more per metre.

An "Index of Fit" was derived to indicate the percentage of stem for with the model predictions for diameter of the largest branch in a cluster visually agreed with the inventory assessment. For an individual tree the "Index of Fit" varied between 0% and 100% (TreeBLOSSIM perfect). For a plot, the average "Index of Fit" varied between 36.7% and 59.2%.

It was considered that the approach of comparing TreeBLOSSIM predictions for Permanent Sample Plots with inventory data from the same plots was a promising approach for testing the accuracy of TreeBLOSSIM. It is suggested that the study is repeated for other forests to give a country-wide assessment of TreeBLOSSIM, and that an automatic procedure is written for deriving the "Index of Fit".

Comparison of TreeBLOSSIM predictions with inventory data: Hawkes Bay Forests

J. Grace

Introduction

The reason for the development of an integrated tree and branch growth model (TreeBLOSSIM) was to be able to input mid-rotation inventory data and hence predict rotation age stem dimensions, branching patterns and branch dimensions. The mathematical functions in the branch component of TreeBLOSSIM have been developed from detailed measurements on 66 destructively sampled trees from various regions within New Zealand. As the tree sample size is so small, it is anticipated that model may not give very good predictions for all stands within New Zealand. The problem is how to determine, in a cost-efficient manner and reasonable time-frame, where the model gives reasonable predictions and where there are problems.

Several methods are being/ have been considered for testing the sensitivity of TreeBLOSSIM:

- Grow mid-rotation inventory data forward in time (see SGMC Report No. 94). This report indicated that the concept was feasible, but as a current inventory was used it will be several years before the predictions can be compared with reality.
- Use stands where inventory data has been collected at least twice (several years apart) on the same trees (see SGMC Meeting Proceedings 14/2/2001). This study bought home the subjective nature of inventory data with 7 of the 21 trees examined exhibiting smaller branches at the 2nd inventory. The shortage of repeat inventory data is also a problem for this approach.
- Run TreeBLOSSIM for permanent sample plots that contained the destructively sampled trees (see SGMC Meeting Proceedings 14/2/2001). This approach will only cover a limited number of sites and trees.
- Run TreeBLOSSIM for permanent sample plots and compare model predictions with PhotoMARVL data. This approach is currently being examined for two thinning experiments (RO2098 and CY597). A disadvantage of this approach is that the collection of PhotoMARVL data is time-consuming.
- Run TreeBLOSSIM for permanent sample plots and compare model output with inventory data. Using inventory would allow a wide range of sites to be considered in a short time frame and pin-point major deficiencies in the model. By necessity it is necessary to assume that the inventory data is unbiased.

The last approach has recently been tested in Hawkes Bay in conjunction with Pan Pac Forest Products Ltd. The results are presented in this report.

Methods

Pan Pac Forest Products Ltd selected ten Permanent Sample Plots for the study. (Table 1).

Table 1. Permanent Sample Plots selected for the study.

Sample Plot Number	Site Index (m)	TreeBLOSSIM initialised with PSP measurement in Year:	Tree age at start of simulation	Final Crop Stocking
Mohaka Forest				
WN 1320/1 159/1	28.0	1988	9	220 (at age 8 years)
WN 1320/1 177/1	34.3	1987	7	220 (at age 7 years)
WN 1320/1 186/1	34.4	1987 and 1996	6 and 15	170 (at age 6 years)
WN 1320/1 211/1	32.9	1987	12	210 (at age 8 years)
Gwavas Forest				
WN 1100/1 39/3	31.3	1988	9	260 (at age 7 years)
WN 1100/1 48/2	30.7	1988	8	210 (at age 7 years)
Kaweka Forest				
WN 2100/1 125/1	23.9	1988	10	260 (at age 9 years)
WN 2100/1 126/1	27.2	1988	12	260 (at age 10 years)
WN 2100/1 138/1	30.5	1988	9	300 (at age 8 years)
WN 2100/1 138/2	25.3	1988	9	200 (at age 8 years)

Field Inventory Data

Each sample plot was visited and the following information recorded for each tree:

- diameter at breast height (DBH)
- height
- height to first branch cluster (equivalent to prune height), h_p
- number of branches in the first cluster
- diameter of the largest branch in the first cluster (using either a pentaprism or a fork-like instrument attached to the top of a height pole. In the latter case each prong on the fork represented 2 cm)
- height of the cluster nearest to 12 m, h_{12}
- number of branch clusters between h_p and h_{12} **including** the cluster at both end-points (see Figure 1)
- inventory-style assessment of branching for stem up to the height of any gross malformation, giving zones with different sized branches
- point where crown starts to taper inwards, i.e. height of actively growing crown

For some plots height to lowest live branch and lowest live cluster were recorded.

TreeBLOSSIM simulations

For each sample plot, the latest measurement on the Permanent sample Plot System at ***Forest Research*** in August 2001(see Table 1) was extracted and used as an input file to TreeBLOSSIM (June 2001 version). Extra measurements were added to the system at a later date. To determine whether starting age had a major impact on TreeBLOSSIM predictions, the age 15 year measurement for plot WN1320/1 186/1 was extracted and used as an input file to TreeBLOSSIM (June 2001 version).

The site file in TreeBLOSSIM was edited for each sample plot as follows:

- Breed was selected to be "850".
- Taper function was set to be 169. (TreeBLOSSIM would not run for plots that were initialised with a taper equation 134).
- The Past Thinning box was filled out as follows:
  Age Zero : Planting stocking
  Plot Establishment Age: Stocking recorded at this time
  Thinning Age: Stocking after thinning
- The mortality adjustment factor was kept at the default value of 0, implying no mortality. There was no mortality in 4 of the 10 plots and slight loss of trees in the other 6.

First the branching pattern at the age of the last PSP measurement was calculated. Then both stem and branches were grown forward to the plot age in winter 2001, a period of 13 or 14 years; except for plot WN1320/1 186/1 started at age 15 years when the period was 5 years.

The resulting file of branch data was exported from TreeBLOSSIM and imported into a SAS program that synthesised the data generated to the following variables for each tree:

- tree diameter at breast height (DBH)
- tree height
- the number of branches in the cluster immediately above the field prune height
- the diameter of the largest branch in the cluster immediately above field prune height
- the number of branch clusters between field prune height and field measurement of the cluster nearest 12 m (see Figure 1)
- cluster height and diameter of largest branch for each cluster

Comparisons

For each plot, model predictions were compared with the inventory assessment in the following ways:

- Difference between field-measured and predicted diameter at breast height (DBH) was calculated and plotted against predicted DBH.
- Difference between field-measured and predicted tree height was calculated and plotted against predicted tree height.
- The mean number of branches in the first cluster above the observed prune height was calculated for both the field data and the model prediction. The difference in number of branches for an individual tree was plotted against field DBH.
- The mean value for the diameter for the largest branch in the first cluster above the observed prune height was calculated for both the field data and the model prediction. The difference between the two diameters for an individual tree was plotted against field DBH.

- A field measure of number of cluster per metre was calculated as follows (see Figure 1):

$$n_c = \frac{c_f - 1}{h_{12} - h_p} \qquad (1)$$

where: n_c is the number of clusters per m
c_f is the field count of number of clusters
h_{12} is the height of the cluster nearest 12 m
h_p is the prune height

- A model estimate of number of cluster per m was calculated as follows:

$$n_{cm} = \frac{c_m - 1}{h_{m12} - h_{mp}}$$

where: n_{cm} is the predicted number of clusters per m
c_m is the model count of number of clusters between h_{m12} and h_{mp} including the clusters at the two end-points (see Figure 1)
h_{m12} is the predicted height of the cluster immediately below h_{12}
h_{mp} is the predicted height of the cluster immediately above h_p

- The difference between the two estimates of clusters per metre was calculated and plotted against field measurements of tree DBH and height.
- In order to assess the overall fit of the model, the model prediction for diameter of the largest branch in each cluster was plotted against the height to the base of the cluster for each tree. The inventory estimates of branch diameter were overlaid on these graphs (see Figure 2). Given the subjective nature of the inventory assessment of branch diameter, and the fact that it represents an upper level for branch diameter in that zone, a subjective assessment of the fit was considered the most appropriate approach. For each zone in the inventory data, the model predictions were classified into one of five classes:

  - 0: Model prediction of branch diameter realistic – The larger predicted branch diameters fell within the inventory branch zone. This class was also used if just a few predicted branch diameters were less than 1 cm larger than the zone boundary and the prediction was otherwise reasonable.
  - 1: Model prediction of branch diameter too small due to a small zone of very large branches (it is assumed that these were spike knots, basket whorls or some other defect).
  - 2: Model prediction of branch diameter too small in a zone below a class 1 zone or noted damage. (In the field, we have observed larger than expected branches below a "top-out".
  - 3: Model predictions of branch diameter too small for no obvious reason.
  - 4: Model prediction of branch diameter too large for no obvious reason.

  An "Index of Fit" was calculated for each tree – the % of observed stem length falling in class 0. The index of fit was plotted against observed tree DBH. The plot mean value was calculated for the "Index of Fit" was calculated. For each plot the fraction of stems length falling into each class was calculated.

The data on the position of different crown zones (actively growing branches, all branches dead, mixture of live and dead branches) have yet to be analysed.

Results

Diameter at breast height and tree height

For each plot (apart from WN1320/1 186/1 at age 15) there was a negative correlation between:
- "field DBH – predicted DBH" and predicted DBH for each plot.
- "field tree height – predicted tree height" and predicted tree height for each plot.

The maximum and minimum values for the DBH and height residuals are shown in Table 2. The range of residual values was much reduced when starting plot WN1320/1 186/ 1 with the age 15 measurement compared to the age 6 measurement. This suggests that one reason for the trends was that TreeBLOSSIM was started at too young an age. Another possible reason is that TreeBLOSSIM was started to soon after silviculture (Bob Shula pers. comm.).

Table 2. Differences between field measurements and TreeBLOSSIM predictions.

Sample Plot Number	Minimum dbh residual (cm)	Maximum dbh residual (cm)	Minimum height residual (m)	Maximum height residual (m)
Mohaka				
WN 1320/1 159/1	-23.2	16.3	-9.4	1.4
WN 1320/1 177/1	-24.5	10.3	-15.9	1.5
WN 1320/1 186/1 (6)	-42.2	13.6	-18.7	-2.3
WN1320/1 186/1 (15)	-8.2	2.1	-11.3	2.1
WN 1320/1 211/1	-21.1	17.9	-6.4	7.2
Gwavas				
WN 1100/1 39/3	-29.4	19.1	-4.7	2.9
WN 1100/1 48/2	-23.1	2.2	-8.0	2.6
Kaweka				
WN 2100/1 125/1	-24.6	24.2	-8.8	3.4
WN 2100/1 126/1	-13.6	14.8	-7.3	4.0
WN 2100/1 138/1	-27.6	19.1	-13.5	8.2
WN 2100/1 138/2	-20.6	19.2	-11.7	3.1

It was thought that the poor prediction for DBH would have minimal effect on branch diameter prediction since branch diameter growth is a function of relative tree DBH. The poor prediction of height might impact on the number of branch clusters in an annual shoot and the position of the actively growing portion of the growing crown.

Comparing the results for plot WN1320/1 186/1 from starting the model at age 15 years versus age 6 years (Tables 2, 3, and 4) confirms that the starting age has had minimal impact on the mean branching characteristics.

Number of branches in the lowest cluster

In TreeBLOSSIM, the predicted number of branches in a cluster is a random number from a Polya-Aeppli distribution (SGMC Report No. 68). The coefficients for the Hawkes Bay Region that were used in this analysis were derived using data from 3 trees in plot WN 235/0 31/0 in Esk Forest (SGMC Report No. 87). For these three trees, the mean number of branches in a cluster was 6.4, 3.6, and 5.7.

The plot mean values for the number of branches in the lowest cluster from the field count and from the model prediction are shown in Table 3. The difference was calculated on an individual tree basis and then the mean difference calculated. In some instances, the number of trees in the plot at the start of the simulation differed from the current number for some plots, due to tree mortality.

Table 3. Plot mean values of field count and model estimate of the number of branches in the first cluster above prune height.

Forest, Experiment and Sample Plot	Number of trees (field)	Field count of number of branches	Number of trees (model)	Model Prediction of number of branches	Number of common trees	Mean Difference
Mohaka WN1320/1						
159/1	20	8	22	6	20	2
177/1	21	7	22	5	21	2
186/1 (6)	17	7	17	5	17	2
186/1 (15)	17	7	17	6	17	2
211/1	21	7	21	5	21	2
Gwavas WN1100/1						
39/3	26	7	26	6	26	1
48/2	19	6	20	5	18	1
Kaweka WN2100/1						
125/1	25	8	26	5	25	2
126/1	23	8	26	5	23	3
138/1	27	7	30	6	27	1
138/2	20	8	20	5	20	3

On average the model predicted fewer branches (between 1 and 3) in the first cluster above prune height compared with the field data. Apart from the two plots in Gwavas, the difference was significant. Kaweka Forest tends to have slightly more branches in a cluster compared to Mohaka, which in turn tends to have slightly more branches than Gwavas.

It needs to be pointed out that the model function was based on data from only 3 trees, one of which appears to have a low number of branches per cluster (see above). This is a disadvantage of only sampling a few trees.

Apart from 1 plot, there was no significant correlation between the difference and tree DBH. This supports the model assumption that the number of branches in a cluster is not a function of tree size.

Diameter of the largest branch in the lowest cluster

Branch diameter development is determined by a series of potentials relating to the branch, cluster, tree, stocking, site, genetics, and thinning response (SGMC Report No. 108). Of these, the cluster potential is considered to have the largest impact on the variation in the diameter of the largest branch in a cluster. To date, we have not been able to relate "cluster size" to position in the annual shoot; consequently the cluster potential is a random observation from a known distribution. For these runs the distribution coefficients were derived from "850" trees in the Central North Island. These coefficients result in less variability between clusters compared to the other 3 sets of coefficients derived to date (SGMC Report No. 108).

The measured diameter of the largest branch in the lowest cluster is compared with the model prediction for the first cluster above prune height (Table 4).

Table 4. Plot mean values for diameter of the largest branch for the cluster immediately above prune height.

Forest, Experiment and Sample Plot	Number of trees (field)	Field - Branch Diameter (mm)	Number of trees (model)	Model - Branch Diameter (mm)	Number of common trees	Mean Difference (mm)
Mohaka WN1320/1						
159/1	20	66.4	22	42.0	20	25.0
177/1	21	60.4	22	45.0	21	15.4
186/1 (6)	17	84.1	17	42.4	17	41.7
186/1 (15)	17	84.1	17	45.8	17	38.2
211/1	21	59.7	21	40.9	21	18.8
Gwavas WN1100/1						
39/3	26	64.1	26	45.0	26	19.2
48/2	19	54.6	20	44.4	18	11.3
Kaweka WN2100/1						
125/1	25	79.4	26	45.9	25	34.2
126/1	23	76.8	26	39.2	23	36.8
138/1	26	69.2	30	44.6	26	23.7
138/2	20	83.4	20	52.2	20	31.1

The mean difference in branch diameter varied between 1.1 and 4.2 cm and was non-significant for only plot WN1100/1 48/2. The mean differences tended to be largest in Kaweka Forest and smallest in Gwavas forest. For all but 1 plot of the other plots it was significant at the 1% level.

As branch growth is the result of a series of potential, one or more of these could be contributing to the observed differences. Another point which may be influencing the result is that, the inventory data indicated that between 17% and 43% of the trees in any plot had a narrow zone of large branches immediately above the prune height. This may be the result of either people stopping pruning when they reach a cluster of large branches; or that after pruning, the cluster immediately above prune height grows more than would be expected if the tree had not been pruned.

For 8 of the plots there was no significant correlation between the difference and field dbh. For the other two plots the significant correlation was the result of two or three trees with excessively large branches in the first cluster. This suggests that the tree potential realistically accounts for differences in branch growth due to relative tree size.

Number of branch clusters

The model functions determining the number branch clusters on the stem are "the number of branch clusters in an annual shoot" and "their relative position in the annual shoot". In these runs the average number of clusters in the annual shoot was based on data from 3 trees in plot WN235/0 31/0 in Esk Forest. The average value was 3.9 cluster per annual shoot, which is the 2nd highest value obtained from the destructively sampled sites. Rather than estimate the annual shoot lengths for the field trees, it was decided to compare clusters per metre as this would be sufficient to highlight and differences between field counts and model predictions. The field measurements and predicted values are shown in Table 5.

Table 5. Field estimate and model prediction for number of clusters per metre.

Forest, Experiment, and Sample Plot	Number of trees (field)	Field number of clusters	Number of trees (model)	Model number of clusters	Number of common trees	Mean Difference
Mohaka WN1320/1						
159/1	17	1.7	17	1.9	17	-0.2
177/1	22	1.5	21	1.7	21	-0.2
186/1 (6)	14	1.5	14	1.6	14	-0.1
186/1 (15)	14	1.5	14	1.7	14	-0.2
211/1	20	1.4	20	1.8	20	-0.4
Gwavas WN1100/1						
39/3	27	1.6	26	1.8	26	-0.2
48/2	17	1.7	18	1.9	17	-0.2
Kaweka WN2100/1						
125/1	23	1.5	22	2.3	22	-0.8
126/1	21	1.6	21	2.1	21	-0.5
138/1	23	1.2	21	2.0	21	-0.5
138/2	15	1.5	15	2.1	15	-0.6

The difference was not significantly different from zero for Mohaka Plot 186/1 and Gwavas Plot 48/2 and was only just significant at 5% level for Gwavas Plot 39/3.

The differences were largest for Kaweka Forest (where the site index tended to be lower). The differences were similar for Gwavas and Mohaka Forest.

There was no trend in the difference with tree dbh. There was a significant correlation for between the difference and tree height for only one plot.

Together, these results suggest that the shape of the model function is realistic for the three forests, but that average number of clusters per annual shoots varies slightly between the forests.

Index of fit

The mean value for the "Index of Fit" (the % of observed stem length for which model predictions appeared realistic) varied between 36.7% and 59.2% (Table 6). On an individual tree basis the index varied between 0% and 100% in each plot and there was no obvious relationship between the index of fit and tree DBH. The two different starting ages, for plot WN1320/0 186/1, only had a small effect on the plot mean value for the "Index of Fit". However, for some trees the "Index of Fit" changed drastically. This is considered to be due to changes in the tree potential (tree DBH / plot mean DBH) (SGMC. Report No. 108). Two of the biggest changes in the "Index of Fit" were:

- from 0% (starting at age 6) to 100% (starting at age 15). At the end of the simulation periods, the difference in predicted DBH of the tree was less than 3 cm, but its position in the DBH distribution increased resulting in the larger branches being approximately 2 cm bigger.
- from 65% (starting at age 6) to 0% (starting at age 15). At the end of the simulation periods, the predicted DBH of the tree from starting at age 15 years was 34 cm smaller compared with starting at age 6 years. Consequently its position in the DBH distribution dropped resulting in the larger branches being approximately 2 cm smaller.

Table 6. Predicted "Index of Fit".

Sample Plot Number	Number of trees	Plot mean value for Index of Fit (%)	Minimum value for Index of Fit (%)	Maximum value for Index of Fit (%)
Mohaka Forest				
WN 1320/1 159/1	16	53.1	0	100
WN 1320/1 177/1	21	56.5	0	100
WN 1320/1 186/1 (6)	15	49.9	0	100
WN 1320/1 186/1 (15)	15	46.4	0	100
WN 1320/1 211/1	20	45.1	0	100
Gwavas Forest				
WN 1100/1 39/3	26	51.5	0	100
WN 1100/1 48/2	17	36.7	0	100
Kaweka Forest				
WN 2100/1 125/1	22	36.9	0	100
WN 2100/1 126/1	21	59.2	0	100
WN 2100/1 138/1	24	53.8	0	100
WN 2100/1 138/2	20	43.9	0	100

The fraction of stem length in each class is shown in Table 7. The proportion of stem in Class 1 and 2 (related to defects) was no more than 20% but generally less than 10%. The proportion of stem in Class 3 or 4 (predicted branch diameter too small or too large) was generally over 30%. It is difficult to see any other consistent patterns in these numbers.

Table 7. Fraction of stem length in each class.

Sample Plot Number	Stem Length (m)	Class 0	Class1	Class 2	Class 3	Class 4
Mohaka Forest WN 1320/1						
159/1	419.0	0.53	0.05	0.05	0.09	0.28
177/1	480.6	0.50	0.05	0.01	0.01	0.43
186/1 (6)	242.5	0.52	0.04	0.10	0.27	0.07
186/1 (15)	242.5	0.50	0.04	0.10	0.21	0.15
211/1	575.0	0.46	0.02	0.01	0.10	0.41
Gwavas Forest WN 1100/1						
39/3	550.9	0.56	0.02	0.04	0.21	0.17
48/2	325.5	0.36	0.03	0.07	0.09	0.45
Kaweka Forest WN 2100/1						
125/1	388.3	0.40	0.05	0.04	0.26	0.25
126/1	416.6	0.64	0.08	0.11	0.09	0.08
138/1	543.5	0.54	0.02	0.00	0.11	0.33
138/2	338.9	0.41	0.02	0.05	0.47	0.05

Discussion

TreeBLOSSIM was run for 10 permanent sample plots in Hawkes Bay Forests and the model predictions visually compared with inventory data.

For the original 10 simulations, when TreeBLOSSIM was started at a young age (12 years or less), the model predictions of tree DBH and height were poor. For 1 plot an extra simulation was run where TreeBLOSSIM was started at age 15 years. This resulted in much improved predictions of tree diameter and height. This suggests that the poor predictions were a consequence of starting TreeBLOSSIM at a young age. Another possibility is that TreeBLOSSIM was started too soon after silviculture had been completed. The poor prediction of height and diameter had minimal impact on predicted plot average of branching characteristics but, in the worst cases, could result in approximately 2 cm difference in the diameter of the larger branches on an individual tree.

On average, TreeBLOSSIM predicted fewer branches (between 1 and 3) in the first cluster above prune height compared with the field counts. The model was most accurate for Gwavas and least accurate for Kaweka. The difference is considered to be due to the model function predicting too few branches. Occasionally two branch clusters can be extremely close together or overlapping. These can be distinguished in the field by the fact that there are smaller branches above larger branches. This definition needs to be clearly specified if this study is repeated in other forests so that such clusters are recognised and counts of number of branches are only for 1 cluster.

On average, TreeBLOSSIM predicted that the largest branch in the first cluster above prune height was smaller (between 1.1 and 4.2 cm) compared with the field data. This could be the result of model formulation or the fact that cluster immediately above prune height is not representative of the tree. The inventory data indicated that between 17% and 43% of the trees in any plot had a narrow zone of large branches immediately above the prune height. Two reasons why the cluster immediately above prune height may not be representative. Firstly people stop pruning when they reach a cluster of large branches. Secondly after pruning, the cluster immediately above prune height grows more than would be expected if the tree had not been pruned. I can think of no logical reason why the first cluster above prune height should be any different from the norm. However the issue of the cluster immediately above prune height having larger branches has been raised several times in casual discussions at cooperative meetings. This issue needs to be resolved before we continue to use data from the cluster immediately above prune height in model validation.

On average TreeBLOSSIM predicted up to 1 cluster more per metre than observed in the field. The difference was greatest at Kaweka Forest.

The plot average value of the "Index of Fit", comparing model predictions of branch diameter with inventory data, varied between 36.7% and 59.2%. There are no obvious reasons for the variation between plots.

One point that stood out when comparing the inventory data with the model predictions, was the number of trees that had some form of damage. These anomalies in the branching pattern are not currently included in TreeBLOSSIM but will obviously have an impact on the value of the tree. This raises several issues about the use and future development of TreeBLOSSIM. It appears that we need to develop a function to predict the probability of damaged branch clusters. Also, with the current importance of wood quality, we need to develop functions to predict what section of the stem is affected by compression wood being formed as a result of this damage. For example if another branch took over as the leader, compression wood would be formed on the underside of the branch as it straightened to become the leader. If we carried out a comparison of model versus inventory data with such a function included then the comparison could possibly look worse because the heights of the damage would not necessarily match up due to the stochastic nature of the model. If the use of TreeBLOSSIM is to grow inventory data forward in time then the age/height at which the inventory is carried out could be an issue. It might be logical to wait until the stem is a certain height before carrying out the inventory. This would ensure that the most valuable portion of the stem had been formed and minimise the stem section for which the location of damage needed to be predicted.

Overall, the approach of testing TreeBLOSSIM against inventory data appears promising. One important point that made the comparison a success was the fact that the branch classes were only 2 cm wide.

It is suggested that the study should be repeated in other forests to give a country-wide assessment of TreeBLOSSIM. In these studies the branch classes would need to be 2 cm wide, and the data collection carried out by experienced personnel to minimise bias.

In this first study, it was advantageous to visually compare model predictions with the inventory data, in order to gain an impression of how the model was working. However for future studies, an automatic procedure for comparing the model prediction with the inventory data needs to be written. The first use of such a procedure should be for these plots but with TreeBLOSSIM started at a later age.

ACKNOWLEDGEMENTS

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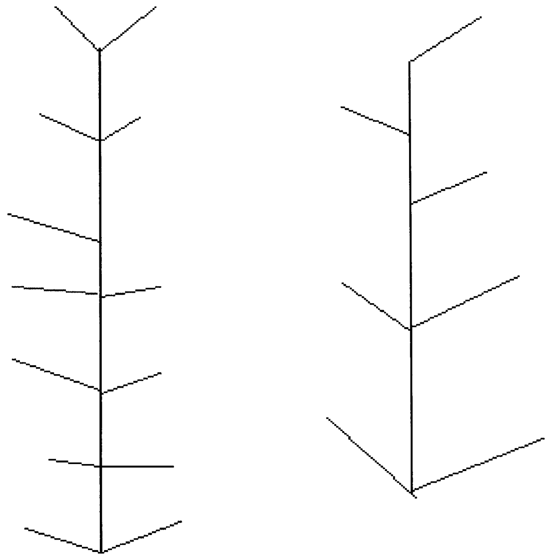
REFERENCES

Stand Growth Modelling Cooperative Reports:

No.	Year	Authors	Title
68	1999	M. Budianto	Modelling stem cone occurrence and number of branches within a cluster
87	In prep	J.C. Grace	Data collection and analysis: Hawkes Bay – WN235/0 31/0
94	2000	J.C. Grace	Expanding MARVL branch codes to provide a more complete description of the tree crown.
108	2001	J.C. Grace	Branch functions within TreeBLOSSIM – Version 1.1 (June 2001)

Figure 1. Diagram showing how clusters per metre was calculated.



Field Situation:
7 clusters between
prune height and cluster
nearest 12 m

Model Situation:
5 clusters between two
end heights. The end
heights being within field
measurements

Figure 2. Diagram showing TreeBLOSSIM prediction of largest branch in a cluster and the inventory assessment of branching. For this tree the "Index of Fit" was 77%. The blue points mark the model predictions and are joined together for clarity. The red line shows the inventory data. The classes assigned to the inventory data were, from bottom to top of tree: 1,0,1,0,3,0.