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Excecutive Summary

TreeBLOSSIM is an integrated tree and branch growth model for radiata pine. The branching functions were developed from destructively sampling a few radiata pine trees at a limited number of sites throughout New Zealand.

Given the limited database used to develop the branching functions in TreeBLOSSIM, it is important to determine the performance of the model for a wide range of sites thoughout New Zealand. To this end a non-destructive, ground-based photogrammetric method (PhotoMARVL / TreeD) is being used to provide data for comparison with TreeBLOSSIM predictions.

TreeD images were collected for 114 trees from 18 permanent sample plots in the Southland Growth Modelling region. Branching characteristics were measured on the images and compared with predictions from the integrated tree growth and branching model, TreeBLOSSIM.

Trees were assigned to a “defect class” based on the “desc-code” in the PSP system and examining the images.

TreeBLOSSIM performed very well for trees that were not in an obvious gap and with no sign of stem damage. TreeBLOSSIM did not perform so well for trees with stem damage and/ or trees in an obvious gap. TreeBLOSSIM did not predict the large branch diameters that occur in these situations.

Examining branch size characteristics in conjunction with “defect classes” suggested that if:

- maximum branch diameter visible on image (BDI_{max}) > 160 mm
- average branch diameter, from image measurements (BDI_{av}) > 100 mm
- BDI_{max} - BDI_{av} > 100 mm

then the tree is likely to have received stem damage / be on an edge / be in a gap.

TreeBLOSSIM was developed for the purpose of growing branching characteristics, that are measured during inventories, forward in time. The above results indicate that TreeBLOSSIM will be acceptable for growing inventory data forward in time, but will not accurately predict the results of any stem damage occurring following the inventory.

Branching Characteristics of Radiata Pine in Southland as measured by TreeD

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INTRODUCTION

TreeBLOSSIM is an integrated tree and branch growth model for radiata pine. The branching functions in Version 3 (see SGMC Report No. 125) are specifically for GF14 seedlots and were developed from destructively sampling a few radiata pine trees at a limited number of sites throughout New Zealand.

Given the limited database used to develop the branching functions in TreeBLOSSIM, it is important to determine the performance of the model for a wide range of sites thoughout New Zealand. To this end a non-destructive, ground-based photogrammetric method (PhotoMARVL / TreeD) is being used to provide data for comparison with TreeBLOSSIM predictions.

At the July 2005 meeting of the Stand Growth Modelling Cooperative (SGMC), a project was approved to collect TreeD data from forests in the Southland Growth Modelling Region in order to determine how well TreeBLOSSIM is performing in this region. SGMC Representatives with forests in Southland were asked to nominate PSPs that they would like used in this study. The main criteria for plot selection was that the trees are approximately 25 m or greater in height.

Tree and branch development is a complex biological process that is not fully understood. From previous PhotoMARVL / TreeD studies, it appears that when a tree is damaged (for example, through top-out), one response is for branches to grow larger than might otherwise be expected.

To further investigate this aspect of branching, an attempt was made to select PSPs from the same forest with varying numbers of damaged trees and also by including pairs of trees of a similar DBH where one has been noted as having a defect and the other has never been noted as having a defect.

METHODS

Permanent Sample Plots (PSPs) selected.

Permanent Sample Plots for this study consisted of:

- PSPs from the SGMC Genetic Gain Trial in Dean Forest (SD682)
- PSPs nominated by Steve Dowman (Ernslaw One Ltd.)
- PSPs nominated by Peter Oliver (City Forests Ltd.)
- PSPs nominated by Janes McEwan (Wenita Forest Products Ltd.)

For each of the nominated PSPs, the percentage of trees that had ever been assigned a description code (Desc_Code in PSP system) was calculated. This value (**percentdefect**), covers all trees in the plot at time of establishment, not just current trees in the plot; and was used in determining the selected PSPs (Table 1 to Table 4).

The SGMC trial, SD 682 (Dean) contained PSPs planted with GF7, GF8, GF14 and LI19 (GF8) seedlots, which received the same silvicultural treatment. PSPs with the GF14 seedlot were selected because the current version (V3) of TreeBLOSSIM was developed using data from GF14 seedlots. PSPs with the long internode seedlot were also selected to provide a contrast in branching pattern. The GF7 and GF8 seedlots were not considered as they were not considered to be representative of the resource to be harvested in the future. Three GF14 and two LI19 PSPs with varying values of **percentdefect** were selected (Table 1).

Table 1. Sample plots measured from SD682, SGMC trial in Dean Forest

PLOT_ID	trees	treeswithdefects	percentdefect	Seedlot
SD 682/ 0 5/51	29	6	20.7	GF14
SD 682/ 0 11/41	27	12	44.4	GF14
SD 682/ 0 14/31	28	3	10.7	GF14
SD 682/ 0 7/41	26	6	23.1	LI19
SD 682/ 0 16/31	24	15	62.5	LI19

Four PSPs, two from Conical Hill and two from Dusky were measured from the Ernslaw One Ltd. estate in Southland. For each pair there was a difference in altitude and **percentdefect,** but there was not a consistent relationship between the two variables (Table 2).

Table 2. Sample plots measured from Ernslaw One Ltd estate

Forest	PLOT_ID	trees	treeswithdefects	percentdefect	altitude (m)
Conical Hill	SD 801/ 0 1/ 0	22	3	13.6	200
Conical Hill	SD 801/ 0 2/ 0	23	6	26.1	169
Dusky	SD 801/ 0 3/ 0	33	7	21.2	530
Dusky	SD 801/ 0 4/ 0	29	3	10.3	326

Five PSPs from the City Forest Ltd estate were measured. This included one PSP from Waipori Forest, which is a higher altitude forest with a high value of percentdefect; and four PSPs from Tokoiti forest, which is a coastal forest typical for Otago. The range in stocking and **percentdefect** was not that large (Table 3).

Table 3. Sample plots measured from City Forests Ltd estate

Forest	PLOT_ID	trees	treeswithdefects	percentdefect	Current stocking
Waipori	SD 10/10 10/ 0	30	19	63.3	325
Tokoiti	SD 20/10 7/ 0	34	13	38.2	413
Tokoiti	SD 20/10 9/ 0	27	7	25.9	338
Tokoiti	SD 20/10 10/ 0	24	12	50.0	288
Tokoiti	SD 20/10 12/ 0	23	7	30.4	284

Four PSPs from the Wenita Forest Products Ltd estate with varying stocking were selected from the trial SD 669 in the Akatore block (Compartment 159) of Otago Coast Forest. The values of **percentdefect** were quite low (Table 4). Trees from plot 5 were selected in the field after it was discovered a previously selected plot had been clearfelled.

Table 4. Sample plots measured from Wenita Forest Products Ltd estate

PLOT_ID	trees	treeswithdefects	Percentdefect	Current stocking
SD 669/ 0 4/ 0	21	2	9.5	67
SD 669/ 0 5/ 0	24	2	8.3	70
SD 669/ 0 8/ 0	30	3	10.0	230
SD 669/ 0 9/ 0	24	1	4.2	150

Selection of sample trees

As in previous PhotoMARVL/ TreeD studies, all the trees in a given PSP were ranked according to DBH (at last measurement), i.e:

- if there are n trees in the plot, then the ranks are 1….n
- the percentage rank for j^{th} tree is $100 \times j/n$

The number of trees sampled and the percentage ranks selected has varied between studies. Trees were selected on both percentage rank and whether the tree had ever been assigned a defect code.

Six trees were selected, in the office, from all forests, except Dean. These were trees whose percentage rank was closest to:

- 10%, 30%, 50%, 70%, 90%, 100%

In order to increase the number of PSPs sampled in Dean, five trees were selected, in the office, from each of the 5 PSPs. These were trees whose percentage rank was closest to:

- 10%, 30%, 50%, 70%, 90%

In addition, an attempt was made to choose trees that had never been assigned a defect code within the PSP system. In the field, a selected sample tree was occasionally replaced if the tree was badly damaged. In PSP: SD 20/10 12/0, 3 pairs of trees were measured where the DBH was similar and one tree had been assigned at least one "desc code" while the other tree had never been assigned a "desc code". The sample trees selected from each plot are listed in Appendix 1, Table 10 to Table 13. A selection of images is shown in Appendix 2, Figure 5 and Figure 6.

Image analysis

The following measurements were extracted from the images:

- stem diameter below the cluster,
- height to base and top of the cluster,
- diameter of the largest branch in the cluster that was visible on the photograph (*BDI)*.

TreeBLOSSIM runs

For each PSP, the latest re-measurement data was imported into TreeBLOSSIM (Version 3.1). The growth modelling region selected was Southland. The silvicultural history was input on the site sheet. Any change in stocking due to mortality etc. was input as a thinning and the tree mortality was set to zero. This approach allowed the stand conditions to be mimicked as close as possible. The stand was then, if necessary, grown forward (between 1 and 3 years) to the tree age when the TreeD images were collected (see Appendix 1, Table 14).

Comparisons

For each tree, the TreeBLOSSIM branching pattern for the section of stem measured by TreeD was extracted. The position of each cluster and the diameter of the largest branch in that cluster (*BDTB)* were retained.

The data for each tree was then summarised to give:

BDI_{max}: the maximum branch diameter measured on the TreeD image (i.e. maximum value of *BDI* for the tree)

$BDTB_{max}$: the maximum branch diameter predicted by TreeBLOSSIM for the relevant stem section (i.e. the maximum value of *BDTB* for the stem section)

BDI_{av}: the mean branch diameter measured by TreeD (i.e. average value of *BDI* for the tree)

$BDTB_{av}$: the mean branch diameter predicted by TreeBLOSSIM for the relevant stem section (i.e. average value of *BDTB* for the stem section)

CLI: number of branch clusters on the stem section measured by TreeD

CLTB: number of branch clusters on the same stem section in the TreeBLOSSIM prediction

zonelength: height to base of highest cluster – height to base of lowest cluster, both measured from the image

The following differences were then calculated for each tree:

$$DIFF_{max} = BDI_{max} - BDTB_{max}$$

$$DIFF_{av} = BDI_{av} - BDTB_{av}$$

$$DIFF_{CL} = (CLI - CLTB) / zonelength$$

These differences were then plotted against the relative position of the tree in the DBH distribution (equivalent to percentage rank) for each plot.

RESULTS

Determining what is an acceptable performance for a complex model, like TreeBLOSSIM, is a matter of judgement. In this study the model is considered to have performed well for predicting branch diameters on an individual tree if the absolute values of $DIFF_{max}$ and $DIFF_{av}$ are less than or equal to 20 mm. This was based on the fact that there is error in measuring branch diameters from TreeD (measured values are assumed to be within 10 mm of the true value); and that a model prediction within 10 mm of the true value would be reasonable.

Individual tree values of $DIFF_{max}$, $DIFF_{av}$, and $DIFF_{CL}$ from running TreeBLOSSIM V3.1 are shown in (Figure 1 to Figure 3). The graphs for $DIFF_{max}$ and $DIFF_{av}$ include horizontal lines illustrating errors of ± 20 mm. Many trees are within / close to these error bounds. There were large values of $DIFF_{max}$, and $DIFF_{av}$ for some trees in PSPs at low stockings in experiment SD669, Otago Coast Forest. There were also some large values of $DIFF_{max}$ for trees in SD 20/10 12/0, Tokoiti Forest (Figure 1). In this PSP, 3 pairs of trees were measured where the DBH was similar and one tree had been assigned at least one "desc code" while the other tree had never been assigned a "desc code". The first pair of trees had a relative position between 10 and 20, and $DIFF_{max}$ was less than 20 mm for both trees. The second pair of trees had a relative position between 50 and 60. $DIFF_{max}$ was large for the tree with stem damage and close to 20 mm for the tree without stem damage. The third pair of trees had a relative position around 70. $DIFF_{max}$ was greater than 20 mm for both trees. However the tree that was supposed to be undamaged, actually showed signs of damage on the image.

The correlation between the relative position of the tree in the DBH distribution and either $DIFF_{max}$, $DIFF_{av}$, or $DIFF_{CL}$ was calculated for each plot. Only 3 correlations were slightly significant (significant $p<0.05$, not significant $p<0.01$).
The SAS procedure PROC GLM was used to calculate least square mean values at a plot level (Table 5 to Table 8). "Plot Number" was set as a class variable and relative position in the DBH distribution set as a continuous variable. All trees, including those with obvious stem defects that have affected the tree's branching pattern, were included.
For the whole dataset, $DIFF_{max}$ and $DIFF_{av}$ were not influenced by the relative position of the tree in the DBH distribution. $DIFF_{CL}$ was slightly influenced by the relative position of the tree in the DBH distribution ($p=0.04$).

In Experiment 682 (Table 5), the least square mean values of $DIFF_{av}$ were not significantly different ($p=0.05$) between the long internode and GF14 seedlots. The least square mean values of $DIFF_{CL}$ were significantly different ($p \leq 0.06$) between the two seedlots with TreeBLOSSIM predicting more clusters than observed for the long internode seedlot. This is to be expected since long internode seedlots are bred to have less branch clusters.
TreeBLOSSIM predictions were very good for most of the Ernslaw One Ltd PSPs (Table 6) and City Forests Ltd PSPs (Table 7) with $DIFF_{max}$ and $DIFF_{av}$ being between ±20 mm. The larger values of $DIFF_{max}$ are considered to be related to stem damage.
TreeBLOSSIM predictions were poorest for the low stocked PSPs in Experiment SD669 (Table 8).

In order to access the impact of stem damage and low stocking, trees were classified into "defect classes":

0: no record of stem defects in PSP system and no obvious damage visible in image
1: record of stem damage in PSP system
2: stem damage visible on image
3: image indicates tree is either an edge tree or in a large gap.

The mean values of $DIFF_{max}$ and $DIFF_{av}$ were calculated for each "defect class" (Table 9), and clearly illustrate that TreeBLOSSIM is performing well for undamaged trees but less well for trees with damage / edge trees.

As an attempt to quantify what trees are likely to be damaged, bar charts were produced for the following variables with "defect class" as a sub-group (Figure 4):

- maximum branch diameter visible on image (BDI_{max})
- $DIFF_{max}$
- average branch diameter (BDI_{av})
- $DIFF_{av}$
- BDI_{max} - BDI_{av}

From examining the bar charts it is suggested that if:

- maximum branch diameter visible on image (BDI_{max}) > 160 mm
- average branch diameter (BDI_{av}) > 100 mm
- BDI_{max} - BDI_{av} > 100 mm

then the tree is likely to have received stem damage / be on an edge / be in a gap.

DISCUSSION

TreeD images were collected for 114 trees from 18 PSPs in the Southland Growth Modelling region. Branching characteristics were measured on the images and compared with predictions from the integrated tree growth and branching model, TreeBLOSSIM. The branching characteristics compared were:

$DIFF_{max} = BDI_{max} - BDTB_{max}$

$DIFF_{av} = BDI_{av} - BDTB_{av}$

$DIFF_{CL} = (CLI - CLTB) / zonelength$

TreeBLOSSIM performed well for many trees, but the main factor influencing the performance for branch size characteristics was stem damage and edge effects (Table 9 and Figure 4).

For trees with no signs of stem damage (defect class 0): the mean value of $DIFF_{max}$ was 5 mm, and the mean value of $DIFF_{av}$ was -0.6 mm. These results are well within the proposed acceptable limits of ± 20 mm. The mean values for trees with stem damage / influenced by edge effects the differences were much larger.

From examining the bar charts (Figure 4) it is suggested that if:

- maximum branch diameter visible on image (BDI_{max}) > 160 mm
- average branch diameter (BDI_{av}) > 100 mm
- $BDI_{max} - BDI_{av}$ > 100 mm

then the tree is likely to have received stem damage / be on an edge / in a gap.

The least square mean values at a plot level for $DIFF_{max}$ and $DIFF_{av}$ (Table 5 to Table 8) are influenced by the number of trees imaged that have stem damage / are influenced by edge effects. This is particularly true for the low stocked plots SD669/0 4/0 and 5/0 where all the trees were classified as either 2 or 3.

The least square mean values of $DIFF_{CL}$ were generally small and not influenced by "defect class". The least square means values of $DIFF_{CL}$ were influenced by seedlot in Experiment SD682, indicating that the number clusters in an annual shoot is influence by seedlot.

While the PSPs were selected on the basis of the number of trees recorded as having stem damage in the PSP system, additional trees were observed to have stem damage from the images, consequently comparisons based on the percentage of damaged trees in the plot are not valid.

TreeBLOSSIM was developed for the purpose of growing forward in time, branching characteristics measured during inventories. The above results indicate that TreeBLOSSIM will be acceptable for growing inventory data forward, but will not accurately predict the results of any stem damage occurring following the inventory.

Table 5. **Least square mean values of $DIFF_{av}$, $DIFF_{max}$, and $DIFF_{CL}$ for PSPs from Experiment SD682, Dean**

PLOT_ID	Seedlot	$DIFF_{av}$ (mm)	$DIFF_{max}$ (mm)	$DIFF_{CL}$
SD 682/ 0 5/51	GF14	-3	6	0.46
SD 682/ 0 11/41	GF14	1	25	0.41
SD 682/ 0 14/31	GF14	6	14	0.33
SD 682/ 0 7/41	LI19	8	21	-0.15
SD 682/ 0 16/31	LI19	8	28	-0.45

Table 6. **Least square mean values of $DIFF_{av}$, $DIFF_{max}$, and $DIFF_{CL}$ for PSPs from Ernslaw One Ltd estate**

Forest	PLOT_ID	altitude (m)	$DIFF_{av}$ (mm)	$DIFF_{max}$ (mm)	$DIFF_{CL}$
Conical Hill	SD 801/ 0 1/ 0	200	12	35	-0.01
Conical Hill	SD 801/ 0 2/ 0	169	-4	-2	-0.01
Dusky	SD 801/ 0 3/ 0	530	-8	-6	0.11
Dusky	SD 801/ 0 4/ 0	326	-13	-16	-0.07

Table 7. **Least square mean values of $DIFF_{av}$, $DIFF_{max}$, and $DIFF_{CL}$ for PSPs from City Forests Ltd estate**

Forest	PLOT_ID	Current stocking	$DIFF_{av}$ (mm)	$DIFF_{max}$ (mm)	$DIFF_{CL}$
Waipori	SD 10/10 10/ 0	325	13	24	0.09
Tokoiti	SD 20/10 7/ 0	413	-1	14	-0.02
Tokoiti	SD 20/10 9/ 0	338	3	17	-0.02
Tokoiti	SD 20/10 10/ 0	288	4	9	-0.04
Tokoiti	SD 20/10 12/ 0	284	9	61	0.13

Table 8. **Least square mean values of $DIFF_{av}$, $DIFF_{max}$, and $DIFF_{CL}$ for PSPs in Experiment SD669, Otago Coast, Wenita Forest Products Ltd estate**

PLOT_ID	Current stocking	$DIFF_{av}$ (mm)	$DIFF_{max}$ (mm)	$DIFF_{CL}$
SD 669/ 0 4/ 0	67	66	119	-0.47
SD 669/ 0 5/ 0	70	41	54	-0.44
SD 669/ 0 8/ 0	230	3	3	-0.02
SD 669/ 0 9/ 0	150	16	35	-0.29

Table 9. **Mean values of $DIFF_{av}$ and $DIFF_{max}$ for different "defect classes"**

Defect class	$DIFF_{av}$ (mm)	$DIFF_{max}$ (mm)
0	-0.6	5
1	14	49
2	23	67
3	41	54

Figure 1. Individual tree values of $DIFF_{max}$

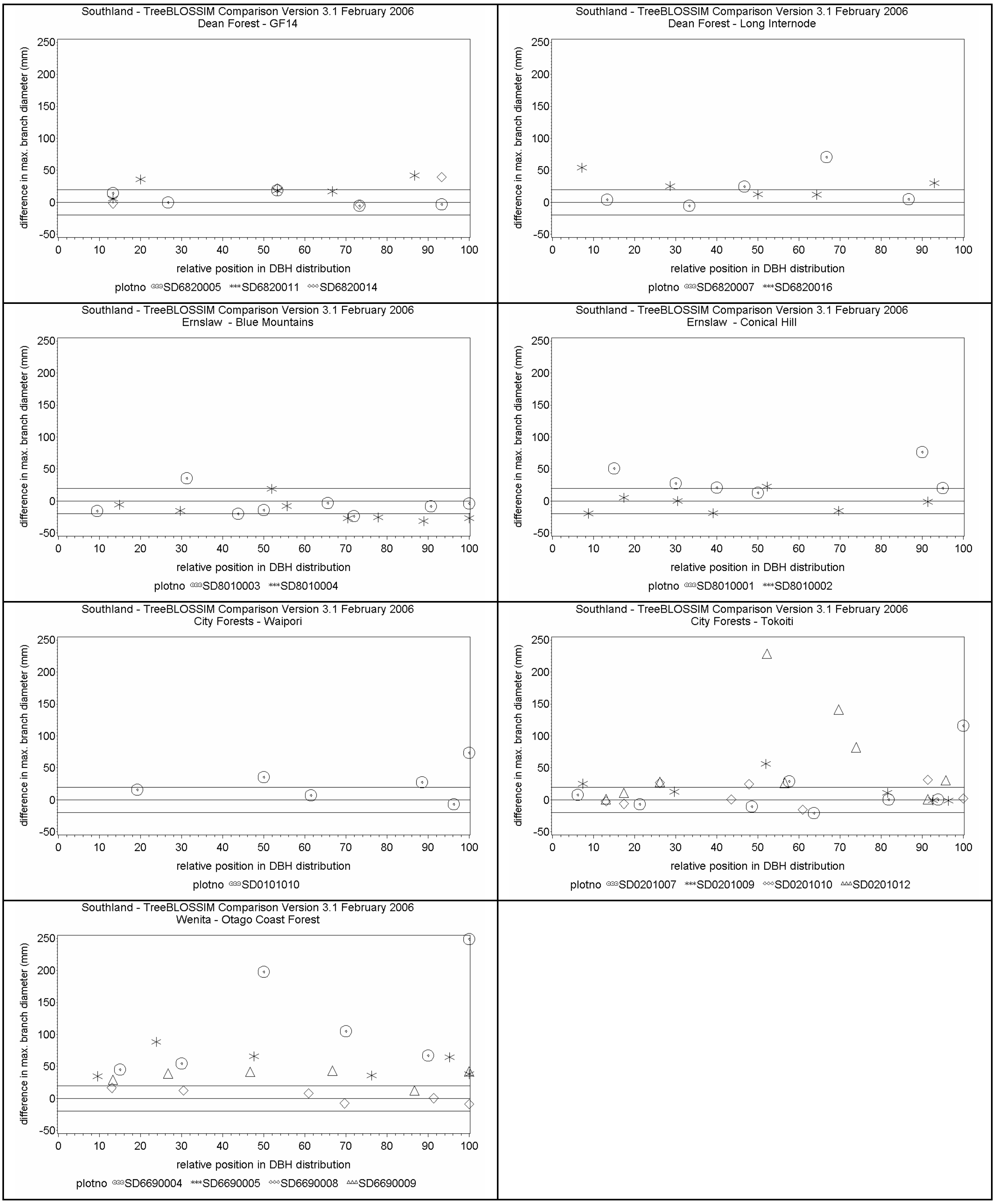


Figure 2. Individual tree values of *DIFF*$_{av}$

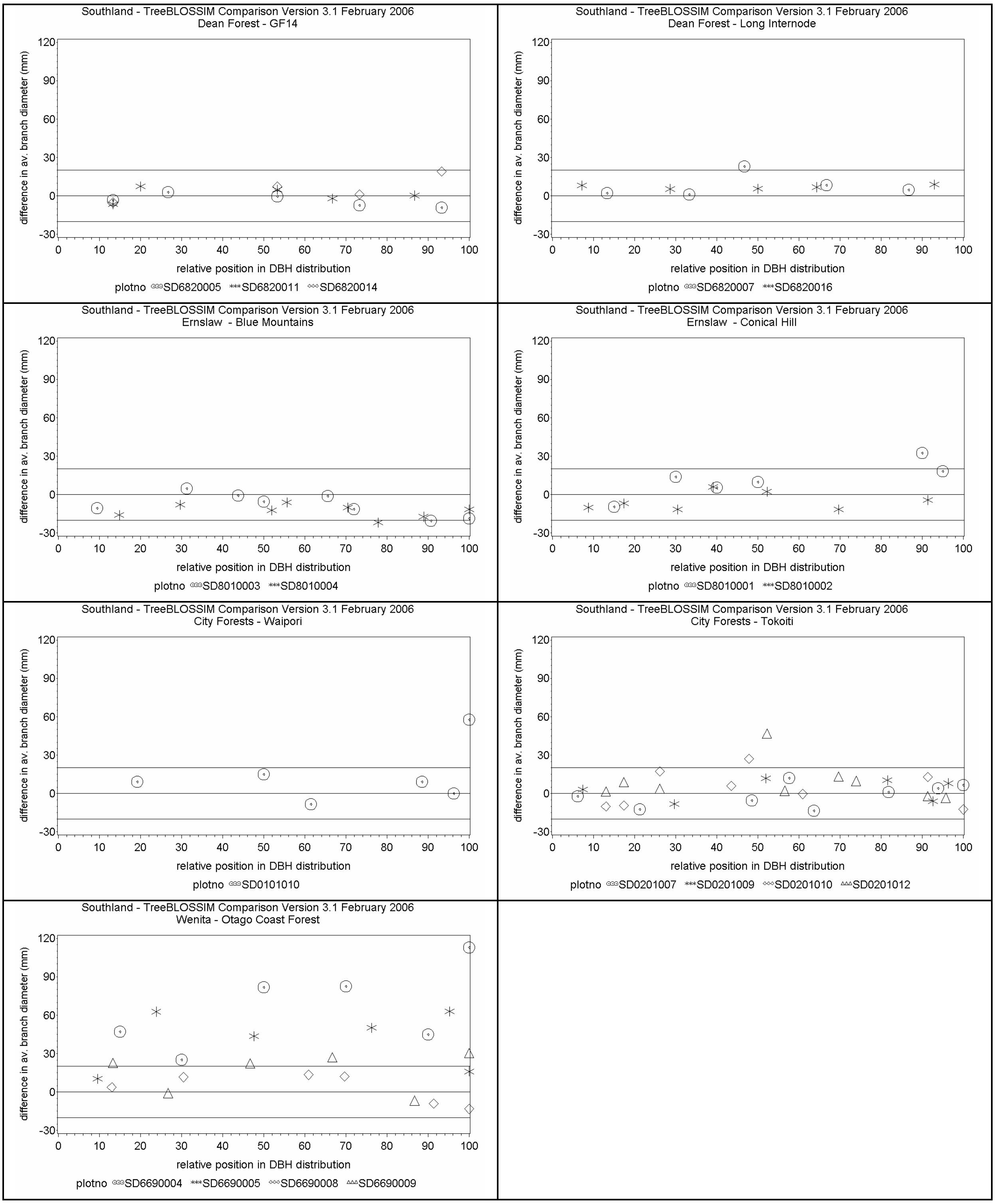


Figure 3. Individual tree values of $DIFF_{CL}$

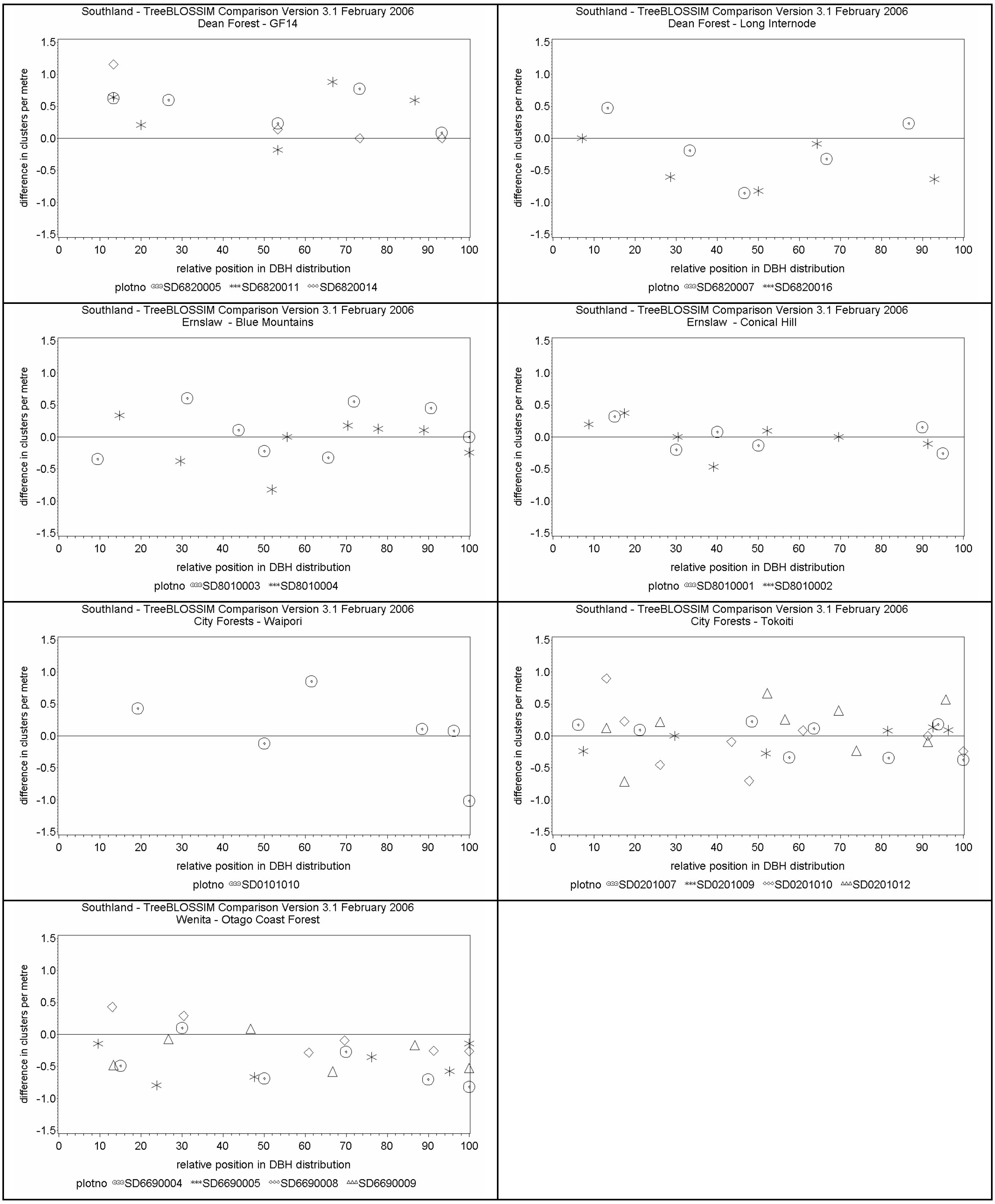
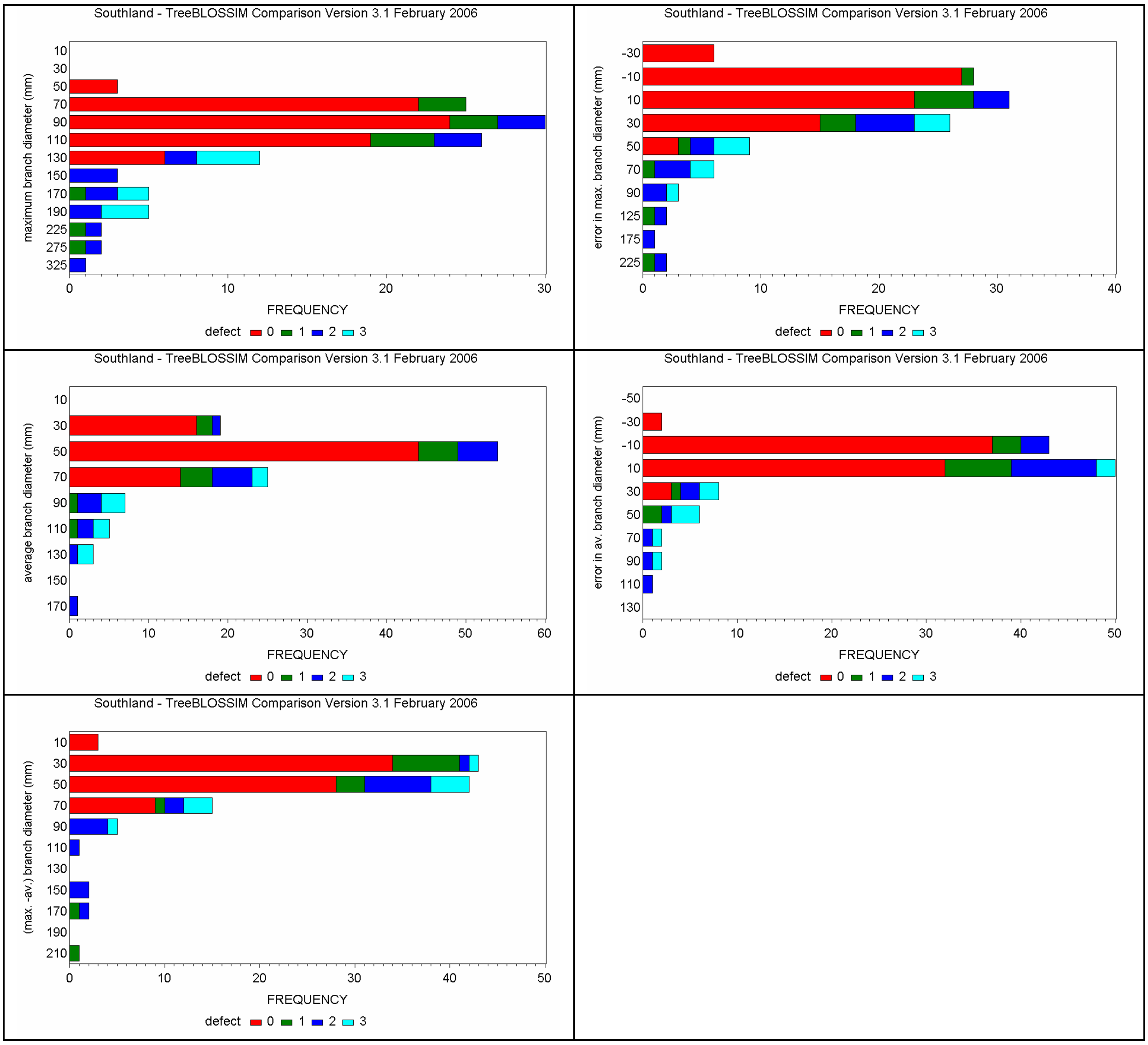


Figure 4. Bar charts showing how various branching characteristics vary with "defect class"



Appendix 1. Sample trees for Southland TreeD study.

Table 10. Sample trees from Experiment SD682, Dean Forest

Phim_no	Forest	Plotno	Treeno	Treekey	rel_pos	DBH
4118	DEAN	SD6820005	12	12	13.3	49.8
4126	DEAN	SD6820005	21	21	26.7	52.6
4122	DEAN	SD6820005	3	3	53.3	55.7
4124	DEAN	SD6820005	1	1	73.3	56.2
4120	DEAN	SD6820005	11	11	93.3	60.4
4112	DEAN	SD6820007	4	4	13.3	47.5
4110	DEAN	SD6820007	2	2	33.3	49.8
4108	DEAN	SD6820007	21	21	46.7	50.7
4114	DEAN	SD6820007	11	11	66.7	54.9
4116	DEAN	SD6820007	23	23	86.7	59.2
4130	DEAN	SD6820011	28	28	13.3	49.0
4138	DEAN	SD6820011	11	11	20.0	49.6
4132	DEAN	SD6820011	6	6	53.3	56.7
4136	DEAN	SD6820011	18	18	66.7	56.4
4128	DEAN	SD6820011	2	2	86.7	59.8
4144	DEAN	SD6820014	2	2	13.3	52.1
4142	DEAN	SD6820014	25	25	33.3	56.5
4146	DEAN	SD6820014	3	3	53.3	56.4
4140	DEAN	SD6820014	20	20	73.3	46.9
4148*	DEAN	SD6820014	8	8	93.3	63.1
4161	DEAN	SD6820016	2	2	7.1	38.9
4163	DEAN	SD6820016	3	3	28.6	52.5
4159	DEAN	SD6820016	5	5	50.0	52.1
4157	DEAN	SD6820016	10	10	64.3	56.5
4155*	DEAN	SD6820016	14	14	92.9	64.9

* Images shown in Figure 5.

Table 11. Sample trees from Ernslaw One Ltd estate

Phim_no	Forest	Plotno	Treeno	Treekey	rel_pos	DBH
4093	BLUE-C	SD8010001	12	13	15.0	41.3
4099	BLUE-C	SD8010001	13	14	30.0	57.7
4101	BLUE-C	SD8010001	14	15	40.0	49.0
4097	BLUE-C	SD8010001	6	7	50.0	54.9
4095	BLUE-C	SD8010001	8	9	90.0	64.8
4103	BLUE-C	SD8010001	17	18	95.0	70.6
4087	BLUE-C	SD8010002	19	20	8.7	43.8
4089	BLUE-C	SD8010002	11	12	17.4	45.4
4079	BLUE-C	SD8010002	1	2	30.4	49.1
4091	BLUE-C	SD8010002	17	18	39.1	48.7
4085	BLUE-C	SD8010002	10	11	52.2	49.5
4083	BLUE-C	SD8010002	8	9	69.6	53.9
4081	BLUE-C	SD8010002	4	5	91.3	60.1
4071	BLUE-D	SD8010003	30	31	9.4	36.8
4063	BLUE-D	SD8010003	3	4	31.3	42.4
4077	BLUE-D	SD8010003	24	25	43.8	42.3
4073	BLUE-D	SD8010003	33	34	50.0	43.1
4075	BLUE-D	SD8010003	23	24	65.6	47.3
4067	BLUE-D	SD8010003	22	23	71.9	47.4
4065	BLUE-D	SD8010003	19	20	90.7	55.8
4069	BLUE-D	SD8010003	29	30	100.0	54.9
4057	BLUE-D	SD8010004	1	2	14.8	35.8
4049	BLUE-D	SD8010004	10	11	29.6	38.6
4055	BLUE-D	SD8010004	25	26	51.9	41.7
4061	BLUE-D	SD8010004	6	7	55.6	40.4
4051	BLUE-D	SD8010004	17	18	70.4	43.6
4059	BLUE-D	SD8010004	4	5	77.8	40.9
4053	BLUE-D	SD8010004	22	23	88.9	47.5
4047	BLUE-D	SD8010004	3	4	100.0	52.6

Table 12. Sample trees from City Forest Ltd estate

Phim_no	Forest	Plotno	Treeno	Treekey	rel_pos	DBH
3977	WAPI	SD0101010	15	15	19.2	42.5
3975	WAPI	SD0101010	31	31	50.0	46.7
3979	WAPI	SD0101010	28	28	61.5	49.5
3973	WAPI	SD0101010	11	11	88.5	55.2
3971	WAPI	SD0101010	21	21	96.2	58.3
3981	WAPI	SD0101010	13	13	100.0	60.1
3997	TOIT	SD0201007	4	28	6.1	31.5
3995	TOIT	SD0201007	34	34	12.1	35.1
4005	TOIT	SD0201007	22	20	21.2	37.8
4011	TOIT	SD0201007	16	14	48.5	44.0
4003	TOIT	SD0201007	15	13	57.6	45.1
4001	TOIT	SD0201007	2	27	63.6	47.3
3999	TOIT	SD0201007	23	21	81.8	47.5
4007	TOIT	SD0201007	25	23	93.9	52.4
4009	TOIT	SD0201007	14	9	100.0	51.9
3993	TOIT	SD0201009	27	27	7.4	38.2
3989	TOIT	SD0201009	23	23	29.6	42.7
3983	TOIT	SD0201009	9	8	51.9	44.8
3985	TOIT	SD0201009	17	14	81.5	49.9
3991	TOIT	SD0201009	26	26	92.6	53.7
3987	TOIT	SD0201009	19	18	96.3	54.1
4025	TOIT	SD0201010	22	24	13.0	42.6
4027	TOIT	SD0201010	15	17	17.4	45.7
4021	TOIT	SD0201010	18	20	26.1	48.7
4015	TOIT	SD0201010	10	12	43.5	50.7
4017	TOIT	SD0201010	7	9	47.8	49.0
4019	TOIT	SD0201010	11	13	60.9	52.3
4013	TOIT	SD0201010	5	5	91.3	56.9
4023	TOIT	SD0201010	19	21	100.0	61.1
4043	TOIT	SD0201012	21	21	13.0	44.4
4039	TOIT	SD0201012	2	30	17.4	44.5
4041	TOIT	SD0201012	22	22	26.1	49.4
4035*	TOIT	SD0201012	15	16	52.2	51.2
4037*	TOIT	SD0201012	17	28	56.5	52.9
4029	TOIT	SD0201012	7	8	69.6	53.1
4031	TOIT	SD0201012	9	25	73.9	55.7
4045	TOIT	SD0201012	18	18	91.3	58.9
4033	TOIT	SD0201012	11	26	95.7	63.7

* images shown in Figure 6.

Table 13. Sample trees from Wenita Forest Products Ltd estate

Phim_no	Forest	Plotno	Treeno	Treekey	rel_pos	DBH
3939	OTCO	SD6690004	41	41	15.0	68.2
3935	OTCO	SD6690004	5	5	30.0	72.2
3937	OTCO	SD6690004	10	10	50.0	74.5
3941	OTCO	SD6690004	24	24	70.0	80.4
3933	OTCO	SD6690004	3	3	90.0	82.1
3943	OTCO	SD6690004	28	28	100.0	88.5
3947	OTCO	SD6690005	33	33	9.5	64.8
3953	OTCO	SD6690005	14	14	23.8	68.7
3949	OTCO	SD6690005	58	58	47.6	76.3
3955	OTCO	SD6690005	71	71	76.2	77.7
3945	OTCO	SD6690005	3	3	95.2	84.1
3951	OTCO	SD6690005	77	77	100.0	90.6
3929	OTCO	SD6690008	21	21	13.0	39.9
3924	OTCO	SD6690008	16	16	30.4	46.9
3931	OTCO	SD6690008	27	27	60.9	49.6
3922	OTCO	SD6690008	11	11	69.6	54.9
3927	OTCO	SD6690008	17	17	91.3	61.3
3920	OTCO	SD6690008	5	5	100.0	63.5
3961	OTCO	SD6690009	4	4	13.3	54.8
3967	OTCO	SD6690009	12	12	26.7	58.2
3957	OTCO	SD6690009	17	17	46.7	60.7
3963	OTCO	SD6690009	10	10	66.7	66.9
3959	OTCO	SD6690009	3	3	86.7	72.8
3965	OTCO	SD6690009	11	11	100.0	71.8

Table 14. Tree age for measurements imported into TreeBLOSSIM, and for measurements exported from TreeBLOSSIM

PLOT_ID	Tree age (years) of PSP measurement imported.	Tree age (years) PSP measurement grown forward to.
SD 10/10 10/0	22	25
SD 20/10 7/0	20	23
SD 20/10 9/0	21	24
SD 20/10 10/0	19	22
SD 20/10 12/0	24	26
SD 669/0 4/0	29	30
SD 669/0 5/0	29	30
SD 669/0 8/0	29	30
SD 669/0 9/0	29	30
SD 682/0 5/51	24	26
SD 682/0 7/41	24	26
SD 682/0 11/41	24	26
SD 682/0 14/31	24	26
SD 682/0 16/31	24	26
SD 801/0 1/0	24	27
SD 801/0 2/0	21	24
SD 801/0 3/0	20	23
SD 801/0 4/0	18	21

Appendix 2. Selected TreeD images.

Figure 5. **Images from SD682, Dean. Left hand image: GF 14 tree, right hand image: long internode tree**

Figure 6. Images from Tokoiti forest. Left hand image: no damage, right hand image: stem damage and large branches around damage