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DENSITY EVALUATION OF LODGEPOLE PINE  
PARENT TREES

by

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### **SUMMARY**

A total of 117 lodgepole pine trees were analyzed for extracted relative density. Analysis was done separately on the inner and outer half of pith-to-bark radial strips cut from breast-height discs. The relative density of the inner-half samples was lower than that of the corresponding outer-half. This is due to the high proportion of juvenile wood in the inner-half sample. Juvenile wood has lower relative density than mature wood. The large variation in relative density among trees provides a potential for achieving genetic gain in wood density through intensive selection in tree improvement programs.

## TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	iii
1.0 OBJECTIVES	1
2.0 INTRODUCTION	1
3.0 STAFF	1
4.0 MATERIALS AND METHODS	2
5.0 RESULTS AND DISCUSSION	2
6.0 CONCLUSION	3
7.0 REFERENCES	4

#### LIST OF TABLES

- Table 1      Relative Density of the Outer- and Inner-Half Samples  
              Arranged in Increasing Order of the Average Relative Density  
              of the Outer-Half Samples
- Table 2      Relative Density of the Outer- and Inner-Half Samples  
              Arranged in Increasing Order of the Average Relative Density  
              of the Inner-Half Samples
- Table 3      Relative Density of the Outer- and Inner-Half Samples  
              Arranged in Sequential Order of the Tree Local Numbers
- Table 4      Mean Relative Density and Related Statistics of the Outer-  
              and Inner-Half Samples Based on 117 Trees

## 1.0 OBJECTIVES

To assess the relative density of lodgepole pine parent trees selected and sampled by the B.C. Ministry of Forests in a tree improvement program, so as to provide the tree improvement councils with a basis for ranking the trees according to wood quality.

## 2.0 INTRODUCTION

Wood quality includes a spectrum of wood properties which assume varying degrees of importance depending on the desired end-product use. The most important property of clear wood that affects its suitability as a structural and pulping material is density (Kellogg and Gonzalez, 1976; Van Buijtenen, 1964). No other wood property has been as widely studied as relative density and its effect on other important properties. A small change in wood density can have a substantial impact on pulp and lumber values (Kellogg, 1982). Moreover, it is a heritable trait in the coniferous species that have been studied (McKimmy, 1966; Zobel, 1971).

Forintek recommended the use of relative density as a wood quality index in tree improvement programs. In 1981, the tree improvement councils of British Columbia stipulated that relative density be assessed on all selected parent trees. As a service to tree improvement programs, Forintek assesses the relative density of parent trees selected through the coordination of provincial Ministry of Forests.

This report presents the relative density of lodgepole pine parent trees selected in 1986.

## 3.0 STAFF

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#### 4.0 MATERIALS AND METHODS

Discs which had been taken at breast height from lodgepole pine parent trees were received from the Ministry of Forests and immediately processed. Two radial strips (from pith to bark) measuring approximately 5.0 mm wide and 5.0 mm deep were cut from each disc. Whenever possible, the strips were taken at 180 degrees interval. This was often not possible because of knots, compression wood, checks, or other defects.

Each strip was cut in half, forming an inner-half: from the pith to half the total length (radius) of the strip, and an outer-half: from half the length of the strip to the bark. The inner- and outer-half samples were each analyzed for relative density using the maximum-moisture-content method (Smith, 1954).

The samples were extracted with solvents before they were analyzed for relative density. They were treated sequentially with ethanol-benzene (1:2 by volume), ethanol, and hot water, for 96 hours, 48 hours, and 24 hours, respectively.

All samples were examined for defects such as knots, compression wood, and spiral grain, which contribute to the relative density of the material. Such defects, when noted, were indicated in the tabulated results and excluded from the average for the tree.

#### 5.0 RESULTS AND DISCUSSION

The relative density of the outer-half sample was analyzed separately from that of the inner half. This approach was based on the results of a previous study in which it was found that the relative density of the outer half of breast-height increment cores in Virginia pine was a better estimator of the merchantable tree density than that of the entire core (Smith and Wahlgren, 1971). The inner-half sample was analyzed to obtain an estimate of the juvenile wood relative density.

A preliminary examination of lodgepole pine materials showed that the extractive content was significantly higher in the inner-half than in the outer-half samples. Since the relative density of the inner- and outer-half samples will be compared, and since extractives contribute to relative density (Keith, 1969), it was decided to assess relative density on extracted samples.

Tables 1 and 2 present in increasing order the average relative density of the outer- and inner-half samples, respectively, for each disc. Table 3 presents the same data in sequential order of the tree local

numbers. Samples with compression wood are marked with an asterisk (\*) and excluded from the average for the disc.

The inner-half samples ranged in relative density from 0.299 to 0.421; the outer-half ranged from 0.329 to 0.496. The inner-half generally gave a lower relative density than the corresponding outer half, reflecting the lower relative density of lodgepole pine juvenile wood than mature wood at breast height. The mean relative density of the inner-half samples for the 117 discs was 0.360 compared to 0.401 for the outer-half samples (Table 4). The variation in the relative density among discs was high.

## 6.0 CONCLUSION

The juvenile wood in the lodgepole pine discs analyzed in this report showed a lower relative density than mature wood at breast height. Future short-rotation harvests are expected to contain a high proportion of juvenile wood. Thus the concern of tree improvement councils for continuing to select parent trees for better wood quality is merited.

The large variability in the relative density of the trees permits opportunities for genetic gain in wood density through tree improvement programs.



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TABLE 1

RELATIVE DENSITY OF THE OUTER AND INNER-HALF SAMPLES ARRANGED IN  
INCREASING ORDER OF THE AVERAGE RELATIVE DENSITY  
OF THE OUTER-HALF SAMPLES

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE. OUT	INN 1	INN 2	AVE INN
PL 22	0.320	0.338	0.329	0.297	0.301	0.299
PL 11	0.324	0.336	0.330	0.338	0.341	0.339
PL 36	0.338	0.340	0.339	0.357	0.357	0.357
PL 1836	0.344	0.336	0.340	0.356	0.384	0.370
PL 26	0.355	0.333	0.344	0.331	0.333	0.332
PL 1835	0.378*	0.345	0.345	0.313	0.312	0.312
PL 42	0.436*	0.346	0.346	0.336	0.330	0.333
PL 104	0.351	0.400*	0.351	0.337	0.339	0.338
PL 9	0.365	0.345	0.355	0.352	0.358	0.355
PL 33	0.364	0.349	0.357	0.317	0.321	0.319
PL 2	0.359	0.453*	0.359	0.340	0.335	0.338
PL 102A	0.349	0.371	0.360	0.309	0.306	0.308
PL 78	0.344	0.376	0.360	0.330	0.318	0.324
PL 1837	0.353	0.367	0.360	0.350	0.355	0.353
PL 109	0.346	0.379	0.363	0.342	0.348	0.345
PL K98	0.369	0.469*	0.369	0.317	0.335	0.326
PL 101A	0.374	0.365	0.369	0.313	0.323	0.318
PL 62	0.374	0.365	0.370	0.312	0.314	0.313
PL 120	0.368	0.372	0.370	0.354	0.352	0.353
PL 8	0.373	0.368	0.370	0.337	0.338	0.337
PL 32	0.384	0.362	0.373	0.324	0.314	0.319
PL 51	0.374	0.426*	0.374	0.345	0.362	0.353
PL 17	0.375	0.373	0.374	0.333	0.337	0.335
PL 57	0.377	0.372	0.375	0.320	0.324	0.322
PL 94	0.370	0.381	0.375	0.315	0.325	0.320
PL 98	0.379	0.375	0.377	0.357	0.355	0.356
PL 34	0.363	0.392	0.377	0.348	0.359	0.353
PL 20	0.396	0.359	0.378	0.353	0.358	0.356
PL 4	0.395	0.361	0.378	0.331	0.322	0.327
PL 37	0.441*	0.379	0.379	0.353	0.336	0.344
PL 10	0.359	0.399	0.379	0.350	0.373	0.362
PL 1680	0.376	0.385	0.380	0.360	0.378	0.369
PL 64	0.394	0.365	0.380	0.390	0.376	0.383
PL 1647	0.376	0.385	0.381	0.360	0.357	0.359
PL 1838	0.372	0.393	0.382	0.345	0.353	0.349
PL 12	0.384	0.385	0.384	0.342	0.339	0.340
PL 46	0.423*	0.384	0.384	0.349	0.355	0.352

\* Compression wood present; excluded from average.

TABLE 1, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE. OUT	INN 1	INN 2	AVE INN
PL 61	0.430*	0.384	0.384	0.378	0.373	0.376
PL 66	0.400	0.370	0.385	0.347	0.334	0.340
PL 30	0.389	0.380	0.385	0.310	0.308	0.309
PL 21	0.434*	0.386	0.386	0.349	0.354	0.352
PL 65	0.392	0.382	0.387	0.394	0.398	0.396
PL 69	0.387	0.387	0.387	0.376	0.391	0.383
PL 39	0.471*	0.389	0.389	0.367	0.354	0.360
PL 68	0.385	0.394	0.389	0.343	0.343	0.343
PL K99	0.381	0.396	0.389	0.388	0.441*	0.388
PL 1681	0.435*	0.390	0.390	0.360	0.351	0.356
PL 91	0.386	0.394	0.390	0.353	0.345	0.349
PL K107	0.401	0.381	0.391	0.381	0.371	0.376
PL 73	0.405	0.377	0.391	0.352	0.356	0.354
PL 97	0.390	0.393	0.391	0.369	0.371	0.370
PL 23	0.404	0.378	0.391	0.371*	0.338	0.338
PL 56	0.407	0.380	0.393	0.339	0.335	0.337
PL 47	0.394	0.392	0.393	0.357	0.355	0.356
PL K155	0.486*	0.394	0.394	0.429*	0.366	0.366
PL 119	0.403	0.387	0.395	0.363	0.351	0.357
PL K154	0.386	0.404	0.395	0.390	0.407	0.399
PL 1653	0.392	0.399	0.396	0.343	0.348	0.345
PL 113	0.403	0.389	0.396	0.340	0.352	0.346
PL 35	0.407	0.388	0.397	0.354	0.352	0.353
PL 1	0.381	0.414	0.398	0.343	0.335	0.339
PL 52	0.403	0.393	0.398	0.359	0.372	0.366
PL 81	0.405	0.394	0.400	0.338	0.347	0.343
PL 82	0.469*	0.400	0.400	0.349	0.363	0.356
PL 40	0.400	0.400	0.400	0.352	0.359	0.356
PL 60	0.393	0.410	0.401	0.354	0.363	0.358
PL 76	0.419	0.388	0.404	0.345	0.329	0.337
PL 92	0.402	0.405	0.404	0.375*	0.343	0.343
PL 28	0.414	0.396	0.405	0.339	0.357	0.348
PL K156	0.417	0.395	0.406	0.388	0.377	0.383
PL 71	0.420	0.393	0.407	0.345	0.356	0.350
PL 18	0.393	0.423	0.408	0.356	0.360	0.358
PL 15	0.408	0.414	0.411	0.359	0.357	0.358
PL 31	0.402	0.419	0.411	0.348	0.372	0.360
PL 25	0.399	0.426	0.412	0.363	0.388	0.375
PL 59	0.426	0.399	0.412	0.356	0.343	0.350
PL 14	0.419	0.406	0.413	0.416	0.388	0.402
PL 79	0.403	0.424	0.413	0.365	0.362	0.364
PL 100	0.409	0.418	0.414	0.399	0.401	0.400

\* Compression wood present; excluded from average.

TABLE 1, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE. OUT	INN 1	INN 2	AVE INN
PL 43	0.416	0.418	0.417	0.380	0.430	0.405
PL 75A	0.428	0.408	0.418	0.428	0.401	0.414
PL 3	0.415	0.422	0.419	0.353	0.342	0.347
PL 93	0.433	0.407	0.420	0.334	0.346	0.340
PL 103	0.434	0.407	0.420	0.380	0.370	0.375
PL K90	0.410	0.431	0.420	0.423	0.420	0.421
PL 95	0.417	0.426	0.421	0.356	0.359	0.358
PL 99	0.415	0.427	0.421	0.369	0.368	0.368
PL 44	0.430	0.421	0.425	0.363	0.356	0.360
PL 58	0.440	0.411	0.426	0.352	0.350	0.351
PL 5	0.434	0.418	0.426	0.377	0.373	0.375
PL 45	0.436	0.417	0.427	0.364	0.240	0.302
PL 67	0.441	0.413	0.427	0.403	0.400	0.402
PL 80	0.439	0.419	0.429	0.375	0.359	0.367
PL 49	0.419	0.440	0.430	0.355	0.354	0.354
PL 101	0.424	0.438	0.431	0.372	0.367	0.370
PL 72	0.421	0.444	0.433	0.386	0.414	0.400
PL 48	0.423	0.443	0.433	0.377	0.394	0.386
PL 29	0.436	0.431	0.433	0.360	0.376	0.368
PL 19	0.419	0.448	0.433	0.366	0.370	0.368
PL 75	0.435	0.504*	0.435	0.384	0.402	0.393
PL 77	0.428	0.443	0.435	0.392	0.403	0.398
PL 53	0.437	0.432	0.435	0.378	0.393	0.386
PL 73A	0.432	0.443	0.437	0.392	0.379	0.385
PL 13	0.428	0.449	0.438	0.361	0.366	0.364
PL K157	0.441	0.540*	0.441	0.394	0.435*	0.394
PL 74	0.432	0.461	0.446	0.374	0.386	0.380
PL 50	0.434	0.460	0.447	0.388	0.398	0.393
PL 96	0.465	0.439	0.452	0.399	0.408	0.403
PL 41	0.453	0.452	0.452	0.375	0.380	0.378
PL 63	0.470	0.442	0.456	0.381	0.379	0.380
PL 55	0.476	0.436	0.456	0.361	0.361	0.361
PL 102	0.460	0.456	0.458	0.399	0.393	0.396
PL 16	0.456	0.463	0.459	0.393	0.398	0.395
PL 27	0.464	0.511*	0.464	0.390	0.413	0.402
PL 24	0.493	0.463	0.478	0.396	0.390	0.393
PL 70	0.499	0.466	0.483	0.417	0.394	0.406
PL 54	0.499	0.494	0.496	0.382	0.380	0.381

\* Compression wood present; excluded from average.

TABLE 2

RELATIVE DENSITY OF THE OUTER AND INNER-HALF SAMPLES ARRANGED IN  
INCREASING ORDER OF THE AVERAGE RELATIVE DENSITY  
OF THE INNER-HALF SAMPLES

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE.OUT	INN 1	INN 2	AVE INN
PL 22	0.320	0.338	0.329	0.297	0.301	0.299
PL 45	0.436	0.417	0.427	0.364	0.240	0.302
PL 102A	0.349	0.371	0.360	0.309	0.306	0.308
PL 30	0.389	0.380	0.385	0.310	0.308	0.309
PL 1835	0.378*	0.345	0.345	0.313	0.312	0.312
PL 62	0.374	0.365	0.370	0.312	0.314	0.313
PL 101A	0.374	0.365	0.369	0.313	0.323	0.318
PL 33	0.364	0.349	0.357	0.317	0.321	0.319
PL 32	0.384	0.362	0.373	0.324	0.314	0.319
PL 94	0.370	0.381	0.375	0.315	0.325	0.320
PL 57	0.377	0.372	0.375	0.320	0.324	0.322
PL 78	0.344	0.376	0.360	0.330	0.318	0.324
PL K98	0.369	0.469*	0.369	0.317	0.335	0.326
PL 4	0.395	0.361	0.378	0.331	0.322	0.327
PL 26	0.355	0.333	0.344	0.331	0.333	0.332
PL 42	0.436*	0.346	0.346	0.336	0.330	0.333
PL 17	0.375	0.373	0.374	0.333	0.337	0.335
PL 76	0.419	0.388	0.404	0.345	0.329	0.337
PL 8	0.373	0.368	0.370	0.337	0.338	0.337
PL 56	0.407	0.380	0.393	0.339	0.335	0.337
PL 104	0.351	0.400*	0.351	0.337	0.339	0.338
PL 2	0.359	0.453*	0.359	0.340	0.335	0.338
PL 23	0.404	0.378	0.391	0.371*	0.338	0.338
PL 11	0.324	0.336	0.330	0.338	0.341	0.339
PL 1	0.381	0.414	0.398	0.343	0.335	0.339
PL 93	0.433	0.407	0.420	0.334	0.346	0.340
PL 66	0.400	0.370	0.385	0.347	0.334	0.340
PL 12	0.384	0.385	0.384	0.342	0.339	0.340
PL 92	0.402	0.405	0.404	0.375*	0.343	0.343
PL 81	0.405	0.394	0.400	0.338	0.347	0.343
PL 68	0.385	0.394	0.389	0.343	0.343	0.343
PL 37	0.441*	0.379	0.379	0.353	0.336	0.344
PL 109	0.346	0.379	0.363	0.342	0.348	0.345
PL 1653	0.392	0.399	0.396	0.343	0.348	0.345
PL 113	0.403	0.389	0.396	0.340	0.352	0.346
PL 3	0.415	0.422	0.419	0.353	0.342	0.347
PL 28	0.414	0.396	0.405	0.339	0.357	0.348

\* Compression wood present; excluded from average.

TABLE 2, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE.OUT	INN 1	INN 2	AVE INN
PL 91	0.386	0.394	0.390	0.353	0.345	0.349
PL 1838	0.372	0.393	0.382	0.345	0.353	0.349
PL 71	0.420	0.393	0.407	0.345	0.356	0.350
PL 59	0.426	0.399	0.412	0.356	0.343	0.350
PL 58	0.440	0.411	0.426	0.352	0.350	0.351
PL 21	0.434*	0.386	0.386	0.349	0.354	0.352
PL 46	0.423*	0.384	0.384	0.349	0.355	0.352
PL 120	0.368	0.372	0.370	0.354	0.352	0.353
PL 1837	0.353	0.367	0.360	0.350	0.355	0.353
PL 35	0.407	0.388	0.397	0.354	0.352	0.353
PL 34	0.363	0.392	0.377	0.348	0.359	0.353
PL 51	0.374	0.426*	0.374	0.345	0.362	0.353
PL 49	0.419	0.440	0.430	0.355	0.354	0.354
PL 73	0.405	0.377	0.391	0.352	0.356	0.354
PL 9	0.365	0.345	0.355	0.352	0.358	0.355
PL 47	0.394	0.392	0.393	0.357	0.355	0.356
PL 98	0.379	0.375	0.377	0.357	0.355	0.356
PL 82	0.469*	0.400	0.400	0.349	0.363	0.356
PL 1681	0.435*	0.390	0.390	0.360	0.351	0.356
PL 20	0.396	0.359	0.378	0.353	0.358	0.356
PL 40	0.400	0.400	0.400	0.352	0.359	0.356
PL 119	0.403	0.387	0.395	0.363	0.351	0.357
PL 36	0.338	0.340	0.339	0.357	0.357	0.357
PL 95	0.417	0.426	0.421	0.356	0.359	0.358
PL 15	0.408	0.414	0.411	0.359	0.357	0.358
PL 18	0.393	0.423	0.408	0.356	0.360	0.358
PL 60	0.393	0.410	0.401	0.354	0.363	0.358
PL 1647	0.376	0.385	0.381	0.360	0.357	0.359
PL 44	0.430	0.421	0.425	0.363	0.356	0.360
PL 31	0.402	0.419	0.411	0.348	0.372	0.360
PL 39	0.471*	0.389	0.389	0.367	0.354	0.360
PL 55	0.476	0.436	0.456	0.361	0.361	0.361
PL 10	0.359	0.399	0.379	0.350	0.373	0.362
PL 79	0.403	0.424	0.413	0.365	0.362	0.364
PL 13	0.428	0.449	0.438	0.361	0.366	0.364
PL 52	0.403	0.393	0.398	0.359	0.372	0.366
PL K155	0.486*	0.394	0.394	0.429*	0.366	0.366
PL 80	0.439	0.419	0.429	0.375	0.359	0.367
PL 99	0.415	0.427	0.421	0.369	0.368	0.368
PL 19	0.419	0.448	0.433	0.366	0.370	0.368
PL 29	0.436	0.431	0.433	0.360	0.376	0.368
PL 1680	0.376	0.385	0.380	0.360	0.378	0.369

\* Compression wood present; excluded from average.

TABLE 2, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE. OUT	INN 1	INN 2	AVE INN
PL 1836	0.344	0.336	0.340	0.356	0.384	0.370
PL 97	0.390	0.393	0.391	0.369	0.371	0.370
PL 101	0.424	0.438	0.431	0.372	0.367	0.370
PL 25	0.399	0.426	0.412	0.363	0.388	0.375
PL 5	0.434	0.418	0.426	0.377	0.373	0.375
PL 103	0.434	0.407	0.420	0.380	0.370	0.375
PL K107	0.401	0.381	0.391	0.381	0.371	0.376
PL 61	0.430*	0.384	0.384	0.378	0.373	0.376
PL 41	0.453	0.452	0.452	0.375	0.380	0.378
PL 63	0.470	0.442	0.456	0.381	0.379	0.380
PL 74	0.432	0.461	0.446	0.374	0.386	0.380
PL 54	0.499	0.494	0.496	0.382	0.380	0.381
PL 64	0.394	0.365	0.380	0.390	0.376	0.383
PL 69	0.387	0.387	0.387	0.376	0.391	0.383
PL K156	0.417	0.395	0.406	0.388	0.377	0.383
PL 73A	0.432	0.443	0.437	0.392	0.379	0.385
PL 48	0.423	0.443	0.433	0.377	0.394	0.386
PL 53	0.437	0.432	0.435	0.378	0.393	0.386
PL K99	0.381	0.396	0.389	0.388	0.441*	0.388
PL 75	0.435	0.504*	0.435	0.384	0.402	0.393
PL 24	0.493	0.463	0.478	0.396	0.390	0.393
PL 50	0.434	0.460	0.447	0.388	0.398	0.393
PL K157	0.441	0.540*	0.441	0.394	0.435*	0.394
PL 16	0.456	0.463	0.459	0.393	0.398	0.395
PL 65	0.392	0.382	0.387	0.394	0.398	0.396
PL 102	0.460	0.456	0.458	0.399	0.393	0.396
PL 77	0.428	0.443	0.435	0.392	0.403	0.398
PL K154	0.386	0.404	0.395	0.390	0.407	0.399
PL 72	0.421	0.444	0.433	0.386	0.414	0.400
PL 100	0.409	0.418	0.414	0.399	0.401	0.400
PL 27	0.464	0.511*	0.464	0.390	0.413	0.402
PL 14	0.419	0.406	0.413	0.416	0.388	0.402
PL 67	0.441	0.413	0.427	0.403	0.400	0.402
PL 96	0.465	0.439	0.452	0.399	0.408	0.403
PL 43	0.416	0.418	0.417	0.380	0.430	0.405
PL 70	0.499	0.466	0.483	0.417	0.394	0.406
PL 75A	0.428	0.408	0.418	0.428	0.401	0.414
PL K90	0.410	0.431	0.420	0.423	0.420	0.421

\* Compression wood present; excluded from average.

TABLE 3

RELATIVE DENSITY OF THE OUTER AND INNER-HALF SAMPLES ARRANGED IN  
SEQUENTIAL ORDER OF THE TREE LOCAL NUMBERS

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE.OUT	INN 1	INN 2	AVE INN
PL 1	0.381	0.414	0.398	0.343	0.335	0.339
PL 2	0.359	0.453*	0.359	0.340	0.335	0.338
PL 3	0.415	0.422	0.419	0.353	0.342	0.347
PL 4	0.395	0.361	0.378	0.331	0.322	0.327
PL 5	0.434	0.418	0.426	0.377	0.373	0.375
PL 8	0.373	0.368	0.370	0.337	0.338	0.337
PL 9	0.365	0.345	0.355	0.352	0.358	0.355
PL 10	0.359	0.399	0.379	0.350	0.373	0.362
PL 11	0.324	0.336	0.330	0.338	0.341	0.339
PL 12	0.384	0.385	0.384	0.342	0.339	0.340
PL 13	0.428	0.449	0.438	0.361	0.366	0.364
PL 14	0.419	0.406	0.413	0.416	0.388	0.402
PL 15	0.408	0.414	0.411	0.359	0.357	0.358
PL 16	0.456	0.463	0.459	0.393	0.398	0.395
PL 17	0.375	0.373	0.374	0.333	0.337	0.335
PL 18	0.393	0.423	0.408	0.356	0.360	0.358
PL 19	0.419	0.448	0.433	0.366	0.370	0.368
PL 20	0.396	0.359	0.378	0.353	0.358	0.356
PL 21	0.434*	0.386	0.386	0.349	0.354	0.352
PL 22	0.320	0.338	0.329	0.297	0.301	0.299
PL 23	0.404	0.378	0.391	0.371*	0.338	0.338
PL 24	0.493	0.463	0.478	0.396	0.390	0.393
PL 25	0.399	0.426	0.412	0.363	0.388	0.375
PL 26	0.355	0.333	0.344	0.331	0.333	0.332
PL 27	0.464	0.511*	0.464	0.390	0.413	0.402
PL 28	0.414	0.396	0.405	0.339	0.357	0.348
PL 29	0.436	0.431	0.433	0.360	0.376	0.368
PL 30	0.389	0.380	0.385	0.310	0.308	0.309
PL 31	0.402	0.419	0.411	0.348	0.372	0.360
PL 32	0.384	0.362	0.373	0.324	0.314	0.319
PL 33	0.364	0.349	0.357	0.317	0.321	0.319
PL 34	0.363	0.392	0.377	0.348	0.359	0.353
PL 35	0.407	0.388	0.397	0.354	0.352	0.353
PL 36	0.338	0.340	0.339	0.357	0.357	0.357
PL 37	0.441*	0.379	0.379	0.353	0.336	0.344
PL 39	0.471*	0.389	0.389	0.367	0.354	0.360
PL 40	0.400	0.400	0.400	0.352	0.359	0.356

\* Compression wood present; excluded from average.



TABLE 3, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE. OUT	INN 1	INN 2	AVE INN
PL 41	0.453	0.452	0.452	0.375	0.380	0.378
PL 42	0.436*	0.346	0.346	0.336	0.330	0.333
PL 43	0.416	0.418	0.417	0.380	0.430	0.405
PL 44	0.430	0.421	0.425	0.363	0.356	0.360
PL 45	0.436	0.417	0.427	0.364	0.240	0.302
PL 46	0.423*	0.384	0.384	0.349	0.355	0.352
PL 47	0.394	0.392	0.393	0.357	0.355	0.356
PL 48	0.423	0.443	0.433	0.377	0.394	0.386
PL 49	0.419	0.440	0.430	0.355	0.354	0.354
PL 50	0.434	0.460	0.447	0.388	0.398	0.393
PL 51	0.374	0.426*	0.374	0.345	0.362	0.353
PL 52	0.403	0.393	0.398	0.359	0.372	0.366
PL 53	0.437	0.432	0.435	0.378	0.393	0.386
PL 54	0.499	0.494	0.496	0.382	0.380	0.381
PL 55	0.476	0.436	0.456	0.361	0.361	0.361
PL 56	0.407	0.380	0.393	0.339	0.335	0.337
PL 57	0.377	0.372	0.375	0.320	0.324	0.322
PL 58	0.440	0.411	0.426	0.352	0.350	0.351
PL 59	0.426	0.399	0.412	0.356	0.343	0.350
PL 60	0.393	0.410	0.401	0.354	0.363	0.358
PL 61	0.430*	0.384	0.384	0.378	0.373	0.376
PL 62	0.374	0.365	0.370	0.312	0.314	0.313
PL 63	0.470	0.442	0.456	0.381	0.379	0.380
PL 64	0.394	0.365	0.380	0.390	0.376	0.383
PL 65	0.392	0.382	0.387	0.394	0.398	0.396
PL 66	0.400	0.370	0.385	0.347	0.334	0.340
PL 67	0.441	0.413	0.427	0.403	0.400	0.402
PL 68	0.385	0.394	0.389	0.343	0.343	0.343
PL 69	0.387	0.387	0.387	0.376	0.391	0.383
PL 70	0.499	0.466	0.483	0.417	0.394	0.406
PL 71	0.420	0.393	0.407	0.345	0.356	0.350
PL 72	0.421	0.444	0.433	0.386	0.414	0.400
PL 73	0.405	0.377	0.391	0.352	0.356	0.354
PL 73A	0.432	0.443	0.437	0.392	0.379	0.385
PL 74	0.432	0.461	0.446	0.374	0.386	0.380
PL 75	0.435	0.504*	0.435	0.384	0.402	0.393
PL 76	0.419	0.388	0.404	0.345	0.329	0.337
PL 77	0.428	0.443	0.435	0.392	0.403	0.398
PL 78	0.344	0.376	0.360	0.330	0.318	0.324
PL 79	0.403	0.424	0.413	0.365	0.362	0.364
PL 80	0.439	0.419	0.429	0.375	0.359	0.367
PL 81	0.405	0.394	0.400	0.338	0.347	0.343

\* Compression wood present; excluded from average.

TABLE 3, CONTD.

TREE LOCAL NUMBER	OUT 1	OUT 2	AVE.OUT	INN 1	INN 2	AVE INN
PL 82	0.469*	0.400	0.400	0.349	0.363	0.356
PL 91	0.386	0.394	0.390	0.353	0.345	0.349
PL 92	0.402	0.405	0.404	0.375*	0.343	0.343
PL 93	0.433	0.407	0.420	0.334	0.346	0.340
PL 94	0.370	0.381	0.375	0.315	0.325	0.320
PL 95	0.417	0.426	0.421	0.356	0.359	0.358
PL 96	0.465	0.439	0.452	0.399	0.408	0.403
PL 97	0.390	0.393	0.391	0.369	0.371	0.370
PL 98	0.379	0.375	0.377	0.357	0.355	0.356
PL 99	0.415	0.427	0.421	0.369	0.368	0.368
PL 100	0.409	0.418	0.414	0.399	0.401	0.400
PL 101	0.424	0.438	0.431	0.372	0.367	0.370
PL 101A	0.374	0.365	0.369	0.313	0.323	0.318
PL 102	0.460	0.456	0.458	0.399	0.393	0.396
PL 102A	0.349	0.371	0.360	0.309	0.306	0.308
PL 103	0.434	0.407	0.420	0.380	0.370	0.375
PL 104	0.351	0.400*	0.351	0.337	0.339	0.338
PL 109	0.346	0.379	0.363	0.342	0.348	0.345
PL 113	0.403	0.389	0.396	0.340	0.352	0.346
PL 119	0.403	0.387	0.395	0.363	0.351	0.357
PL 120	0.368	0.372	0.370	0.354	0.352	0.353
PL 1647	0.376	0.385	0.381	0.360	0.357	0.359
PL 1653	0.392	0.399	0.396	0.343	0.348	0.345
PL 1680	0.376	0.385	0.380	0.360	0.378	0.369
PL 1681	0.435*	0.390	0.390	0.360	0.351	0.356
PL 1835	0.378*	0.345	0.345	0.313	0.312	0.312
PL 1836	0.344	0.336	0.340	0.356	0.384	0.370
PL 1837	0.353	0.367	0.360	0.350	0.355	0.353
PL 1838	0.372	0.393	0.382	0.345	0.353	0.349
PL 75A	0.428	0.408	0.418	0.428	0.401	0.414
PL K107	0.401	0.381	0.391	0.381	0.371	0.376
PL K154	0.386	0.404	0.395	0.390	0.407	0.399
PL K155	0.486*	0.394	0.394	0.429*	0.366	0.366
PL K156	0.417	0.395	0.406	0.388	0.377	0.383
PL K157	0.441	0.540*	0.441	0.394	0.435*	0.394
PL K90	0.410	0.431	0.420	0.423	0.420	0.421
PL K98	0.369	0.469*	0.369	0.317	0.335	0.326
PL K99	0.381	0.396	0.389	0.388	0.441*	0.388

\* Compression wood present; excluded from average.

TABLE 4

MEAN RELATIVE DENSITY AND RELATED STATISTICS OF THE  
OUTER- AND INNER-HALF SAMPLES BASED ON 117 TREES

VARIABLE	N	MEAN	STD DEV	RANGE	STD ERR OF MEAN	COEFF OF VAR. (%)
INNER	117	0.360	0.026	0.299 - 0.421	0.0024	7.3
OUTER	117	0.401	0.033	0.329 - 0.496	0.0031	8.3