



Squamish Forest District

Extension Note

Extension Note

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Plantation Performance Database for the Coast-Interior Transition Zone: 2002 Growth Curves

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Prepared for the
Transition Zone
Working Group

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INTRODUCTION

In 1997 the Transition Zone Working Group (TZWG)¹ initiated a study of plantation performance in the Coast-Interior Transition, which is in the Sub Maritime Seed Planning Zone on the south coast of British Columbia (BCMOE and BCMOF 1995). Free-growing survey data—supplemented by data from measurements of selected plantations—were gathered and analyzed. The study involved the creation of a plantation performance database containing information about stocking, growth, and vegetation. The database is described in Scagel et al. (2001) and Hunt (2002). The database has continued to expand, and emphasis on height growth has increased. The main objective of the database is to develop a tool for assessing plantation performance relative to similar plantations.

This Extension Note describes results of the database updates, presents examples of height/age and diameter/age curves, describes a downloadable charting tool *Normals02.xls*, and recommends steps for further development of the database.

2002 RESULTS

Since 2000, the database has grown by about 60% and now contains over 72 000 height measurements (Table 1). Additional data were obtained from operational free-growing surveys, compliance surveys, and targeted surveys funded by the Forest Investment Account. In general, trees were

measured as follows: 20 sample trees closest to plot center per strata, plus the tallest trees per plot. Three height increments were usually measured for each tree species of determinate growth. Originally, all the data came from Squamish Forest District, but since 2000, data from Chilliwack Forest District have been added.

Most of the sample trees are <10 years old (Figure 1), and variability increases considerably for sample trees >8 years old.

The majority of the measured trees are planted (72%), although Ba, Hw, Hm, and Pli are predominantly natural (Table 2).

The database consists of 70% sample trees and 30% tallest trees (Table 3). In some cases, the sample and tallest trees are the same. The dataset of tallest trees generally shows a level of high performance. However some site series have small, variable datasets of tallest trees. And, in a few instances, the mean heights of sample trees can be greater than the mean heights of the tallest trees.

CHARTING TOOL *NORMALS02.XLS*

A calculator Excel file, *Normals02.xls* for generating height/age and diameter/age charts is available from the Squamish Forest District website at: <http://www.for.gov.bc.ca/vancouver/district/squamish/Silviculture/SilvStart.htm>.

Users can plot data from sample plantations against the average height/age curves for selected site series and species. Some diameter/age curves are also included. This plantation assessment tool is a decision aid for determining if treatments may be required. It also has value as a due diligence step for confirming that a plantation is on track and does not require an intervention.

¹The Transition Zone Working Group is a collective of representatives from government and industry that was formed in 1990 to improve silviculture in the Coast-Interior Transition, exchange ideas and reports, and co-ordinate research trials and other co-operative efforts.



Table 1. Summary of sample sizes in the TZWG plantation performance database.

Biogeoclimatic subzone	Area (ha)	Strata (no.)	Trees (no.)	Height increments (no.)
CWHdm	555	76	1 820	5 672
CWHds1	2 131	215	4 406	13 286
CWHms1	6 109	435	9 175	27 070
CWHvm1	216	25	547	1 540
CWHvm2	625	52	1 369	4 455
CWHxm	260	18	479	956
ESSFmw	405	52	1 209	4 037
IDFww	771	101	2 251	7 969
MHmm1	472	27	825	2 998
MHmm2	1 075	57	1 466	4 311
Total	12 619	1 058	23 547	72 294

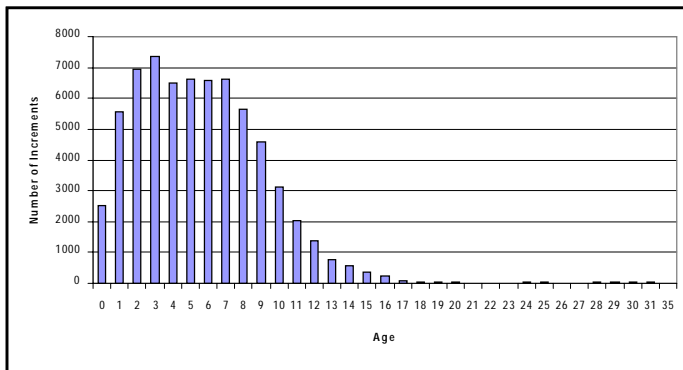


Figure 1. Age distribution of height increments.

An example showing a sample plantation plotted against the database average height is shown in Figure 2 where plantation 92G089-503 is growing near the lower standard deviation for Fdc in the CWHds1 01. The lower standard deviation of the database mean crosses just below 225 cm at Year 11. The plantation may achieve minimum height at late free growing. Further monitoring is likely required to ensure that the plantation continues on track. If there is a likelihood that problems exist, an intervention would be prudent.

Some example height/age and diameter/age curves modified from *Normals02.xls* are shown in Appendix A. Table 4 shows an overview of the curves in Appendix A, including sample sizes and calculations for the year at which minimum heights are obtained in relation to the *Vancouver Forest Region Establishment to Free Growing Guidebook* (BCMOF and BCMOE 2000).

Analysis of the database showed there are five site series/species combinations where minimum heights are reached after early free growing: Fdc in the CWHms1 01, ms1 04, and ms1 06; and Ba in the CWHvm2 04 and vm2 05. There are 38 combinations where minimum height is reached at or before early free growing. These calculations are based on average tree ages, with no allowance for regeneration delay (RD=0). *Normals02.xls* includes

Table 2. Distribution of planted and naturally regenerated trees.

Species	Planted (no.)	Natural (no.)	Advanced (no.)	Total (no.)
Ba	1 441	9 217	2 869	13 527
Bg	192	8		200
Bl		10	108	118
Cw	4 566	1 512	126	6 204
Dr	14			14
Fdc	26 773	2 028	162	28 963
Hm		272	58	330
Hw	243	1 849	278	2 370
Lw	2 205			2 205
Pli	151	709	60	920
Pw	44	20	4	68
Py	2 699	148		2 847
Ss	56			56
Sx	12 521	18	4	12 543
Yc	1 202	393	47	1 642
Total	52 394	16 184	3 716	72 294

an adjustment for regeneration delay which can move the entire curve over by the selected number of years.

Using a regeneration delay of one year, it is estimated that 16 out of 50 site series/species combinations will have a lower standard deviation that does not exceed the *Guidebook* minimum height at late free growing. It should be noted that in many cases, the 150% brush rule is more constraining than minimum heights in achieving free growing, but information on the height of surrounding brush is not included in the database.

The curves in *Normals02.xls* and Appendix A are not smooth and often have dips or bumps. These bumps are largely due to splicing data from different eras, different management regimes and natural variation among sites. To improve their look, the charts in Appendix A have been modified by editing out some of the later years that have small sample sizes and high variation.

Normals02.xls allows the user to select and compare the performance of sample trees and tallest trees. Planted and/or naturally regenerated trees can also be selected. The charts in Appendix A show sample planted trees for Cw, Fdc, and Sx, and sample natural trees for Ba.

DATABASE GAPS AND FURTHER SAMPLING

There has been considerable discussion about what constitutes a stable curve, and the suitability of average growth curves. Scagel et al. (2001) originally recommended 20 strata and 20 trees/strata for stable curves. Earlier versions of the TZWG height normals calculated the average of all trees pooled over all surveyed trees (e.g., sample and tallest trees) for each year (Scagel et al. 2001). There was some discussion in the group about combining sample and tallest trees as previously reported since this biases the average growth upwards.

Table 3. Distribution of sample trees and tallest trees.

Biogeoclimatic subzone	Site series	Sample trees (no.)	Tallest trees (no.)	Total trees (no.)
CWHdm	01	1 480	724	2 204
CWHdm	02	109		109
CWHdm	03	133	53	186
CWHdm	05	1 692	873	2 565
CWHdm	07	301	307	608
CWHds1	01	6 201	1 510	7 711
CWHds1	03	1 896	769	2 665
CWHds1	04	239	140	379
CWHds1	05	802	411	1 213
CWHds1	06	192	95	287
CWHds1	07	509	167	676
CWHds1	09	313	23	336
CWHds1	12	10	10	20
CWHms1	01	12 077	5 060	17 137
CWHms1	02	73	28	101
CWHms1	03	626	230	856
CWHms1	04	2 635	1 657	4 292
CWHms1	05	1 477	845	2 322
CWHms1	06	1 196	854	2 050
CWHms1	07	183	79	262
CWHms1	08	3	3	6
CWHms1	11	46	2	48
CWHvm1	01	411	421	832
CWHvm1	03	36	39	75
CWHvm1	05	261	139	400
CWHvm1	06	109	111	220
CWHvm1	14	7	6	13
CWHvm2	01	1 849	744	2 593
CWHvm2	03	240	122	362
CWHvm2	04	272	106	378
CWHvm2	05	308	286	594
CWHvm2	06	242	99	341
CWHvm2	07	88	41	129
CWHvm2	09	41	17	58
CWHxm	01	957		957
ESSFmw	01	2 147	1 087	3 234
ESSFmw	03	87	57	144
ESSFmw	04	60	60	120
ESSFmw	05	225	182	407
ESSFmw	06	120		120
ESSFmw	07	6	6	12
IDFww	01	3 686	1 113	4 799
IDFww	02	137	104	241
IDFww	03	1 420	675	2 095
IDFww	04	481	158	639
IDFww	05	77	72	149
IDFww	06	29	17	46
MHmm1	01	1 549	855	2 404
MHmm1	02	35	27	62
MHmm1	03	209	19	228
MHmm1	04	40	40	80
MHmm1	05	116	112	228
MHmm2	01	2354	1 077	3 431
MHmm2	02	50	50	100
MHmm2	03	46	37	83
MHmm2	04	415	87	502
MHmm2	06	30	30	60
MHmm2	08	100	35	135
Total		50 433	21 871	72 304

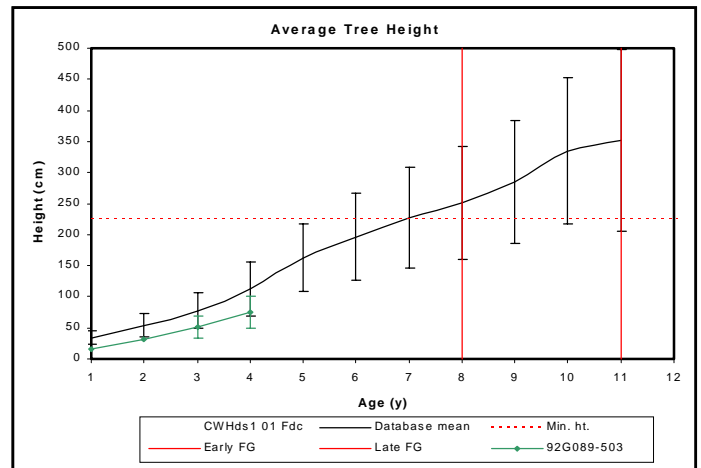


Figure 2. Example assessment of plantation 92G089-503.

To avoid inefficient use of resources, further additions to the database to fill gaps should be targeted to priority site series and species. Effort should be concentrated on sites series where there are existing large sample sizes with gaps, where significant harvesting has occurred, and where problems achieving free growing are anticipated.

It is recommended that any further development of the database should focus on the dataset of planted and sample trees.

Emphasis should be placed on site series/species combinations where the lower standard deviation of the mean is not expected to surpass minimum height at late free growing, given a regeneration delay of one year.

Emphasis should be placed on site series/species combinations where there are less than 20 strata, fewer than 400 increments, and preferably standard error of the mean is greater than 10. Currently there are 10 'stable' site series/species combinations that have greater than 20 strata and 400 increments with a standard error less than 10 up to age 8. One should consider that the database is the best available information, and the standard error criteria may not require heavy weighting in some cases.

CONCLUSIONS

This database is a very large compilation of tree growth data from the Coast-Interior Transition, which is in the Sub Maritime Seed Planning Zone on the south coast of British Columbia (BCMOE and BCMOF 2000). The main objective of the database is to provide a tool for assessing plantation performance relative to similar plantations. Users can download the charting tool *Normals02.xls* from the Squamish Forest District website and plot data from sample plantations against the average height/age or diameter/age curves for selected site series and species.

Example charts for the main site series/species combinations are shown in Appendix A. This plantation assessment tool is a decision aid for determining if treatments may be required. It also has value as a due diligence step for confirming that a plantation is on track and does not require an intervention.

Table 4. Summary of height/age and diameter/age charts in Appendix A.

Biogeoclimatic subzone	Site series	Species	Planted or natural ^a	Height			Calculated year @ min. height	Guidebook Standards		
				Strata (no.)	Increments (no.)	Diameter (no. trees)		EFG (y)	LFG (y)	Min. height (cm)
CWHdm	01	Fdc	P	24	1190	240	7	8	11	300
	05	Fdc	P	33	1344	327	8	8	11	400
	07	Fdc	P	8	153		8	8	11	400
CWHds1	01	Cw	P	43	294		5	8	11	150
		Fdc	P	80	3161	866	7	8	11	225
	03	Fdc	P	37	1209	397	6	8	11	150
CWHms1	01	Ba	N	118	1647		5	8	11	75
		Cw	P	126	617		6	8	11	150
		Fdc	P	160	3631	934	9	8	11	225
		Sx	P	103	3280	569	6	8	11	100
	04	Cw	P	17	347	154	8	8	11	200
		Fdc	P	19	622	181	11	8	11	300
	Sx	P	21	603		8	8	11	125	
CWHvm2	01	Ba	N	23	868		8	11	14	175
ESSFmw	01	Sx	P	36	1462	434	8	12	20	100
IDFww	01	Fdc	P	42	1819	385	6	9	15	150
	03	Fdc	P	21	554		7	8	15	150
MHmm1	01	Ba	N	19	1101		5	15	20	60
MHmm2	01	Ba	N	30	404		4	15	20	60
	01	Sx	P	28	1235		5	15	20	100

^a Height/ages of natural seedlings are less reliable than data for planted seedlings.

KEYWORDS

Plantation performance, growth curves, seedling survival, stocking density, tree height growth, tree diameter growth, seedling response, Coast-Interior Transition, British Columbia.

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**APPENDIX A.
HEIGHT/AGE AND DIAMETER/AGE GROWTH CURVES
FOR SAMPLE TREES OF SELECTED SUBZONES, SITES SERIES AND SPECIES**

