

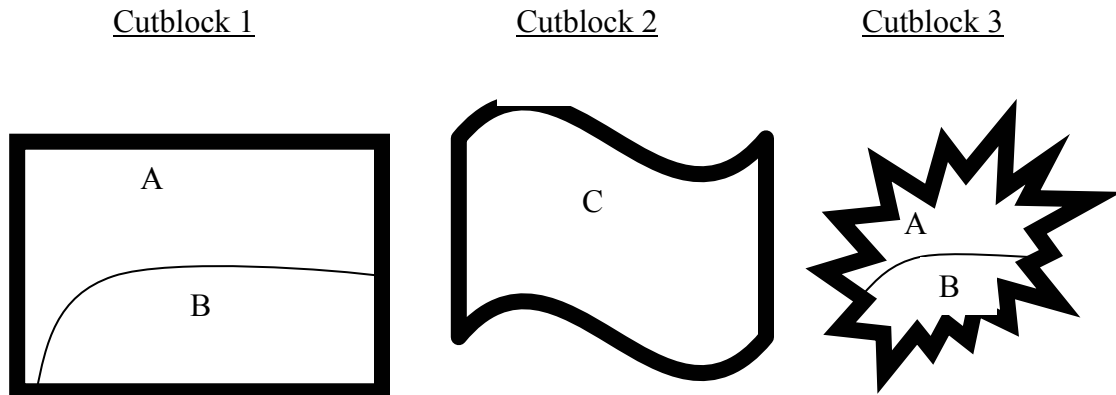
Sample design for the 2002 pilot of Riverside's new approach to silviculture obligations

To successfully pilot Riverside's proposed approach to regulating silviculture obligations on the TFL 49 Results-based Code Pilot area, a sample design is required. There are many feasible sampling designs. This document provides the sample design that will be used for the pilot of the system in the fall of 2002.

1.0 Definitions

The term "a stratum within a cutblock" refers to areas such as Area A within Cutblock 1, Area B within Cutblock 3, etc. "Stratum A" refers to the total area of A in the population. In this case, stratum A includes Area A in Cutblock 1 plus Area A in Cutblock 3.

PMV is predicted merchantable volume at age 80, from the tables in Eleanor's report.



2.0 The details

The survey employs stratified random sampling to estimate mean target PMV and mean achieved PMV for the population.

2.1 Objectives of the survey

The three objectives of the survey, addressed with this design, are:

1. Identify areas requiring (or with an opportunity for) treatment;
2. Estimate average target and achieved volume/ha over the entire population; and
3. Efficiently update the estimates of achieved volume/ha in the ledger after treatments are done.

Other objectives (such as providing future volume estimates to support timber supply analysis, establishing monitoring plots for re-measurement, generating inventory labels, and estimating future log size distribution) are not addressed here.

2.2 Population

The population is all of the NAR (net area to be reforested) in all cutblocks that were harvested by clear-cutting in a given year - 10 years ago.

2.3 Stratification

Three factors are used to stratify: species composition, density, and target stocking level:

- a) Three species classes are recognized: Pl, Sx, and Pl-Sx mixes.
- b) Two density classes are recognised (<700/ha and >=700/ha) based on well spaced trees of preferred and acceptable species that are healthy and not overtopped with brush.
- c) Target stocking standard (TSS). The target stocking standard varies by ecosystem. The most common TSS level is 1200/ha, but other levels also occur including 1000/ha, 800/ha, 600/ha, and 400/ha.

Thus, each plot is assigned to a species class, density class, and a target stocking standard class.

2.4 Plot intensity

Every cutblock in the population is surveyed. Plots are established on a 100 x 100 m grid. "Enhanced" plots are established at the 200 x 200 m grid intersections and "standard" plots are established at all of the remaining grid intersections.

2.5 Plot measurements

Refer to Appendix 1 for the specific field procedures. Data are obtained from a combination of field observation and measurement, SIBEC tables, and the Silviculture Prescription.

For each enhanced plot, the following data are recorded:

- a) Stratum: species class (Pl, Sx, Pl-Sx), density class (<700, >=700), and target stocking standard (e.g., 1200, 1000, etc).
- b) For the height sample tree: species (Pl or Sx), total height, and (if the tree is also a suitable GI sample tree) breast height age.
- c) BEC classification: zone/subzone/variant/site series.
- d) Stocked quadrants: tally of stocked quadrants (0, 1, 2, 3, or 4).
- e) Potentially stocked quadrants: Tally of quadrants (0, 1, 2, 3, or 4) that would be tallied as stocked following treatment (typically brushing).
- f) Well-spaced trees/plot, free growing trees/plot, total trees/plot, and total conifers/plot.
- g) UTM's

For each standard plot, the following data are recorded:

- a) Stratum.
- b) Stocked quadrants.
- c) Potentially stocked quadrants.
- d) UTM's

2.6 Map and treatment options

After a cutblock is surveyed, the surveyor prepares a map that shows the location of the plots and the mapped stratum boundaries (density class and TSS level). Also, the surveyor describes and identifies the approximate location of any treatment opportunities.

2.7 Target PMVs

Target PMVs and the method used to develop them are provided in Appendix 2.

2.8 Entering data in the ledger

The ledger contains two tables (or “worksheets”): one for the plot data and one for the stratum totals. The plot data table contains one record for each plot. For each plot, the following are entered: cutblock number, plot number, UTM, stratum (species class, density class, target stocking standard), stocked quadrant tally, and potentially stocked quadrants. For enhanced plots, the following are also recorded: height sample tree species, height, and bh age (if suitable GI sample tree); BEC classification; well-spaced trees/plot; free growing trees/plot; total trees/plot; and total conifers/plot.

After the entire population is sampled and each plot is entered in the plot data table, locally-calibrated SIBEC tables are applied to translate the observed site series to estimates of site index (Appendix 3). Then, for each height sample tree, effective age is estimated from site index and height using Eleanor’s tables.

Next, all of the plots in the same stratum (density/species/target stocking class) are pooled. From the pooled data, MSQ (mean stocked quadrant) for the stratum is calculated. In addition, mean site index and mean effective age for the stratum are calculated. From these values, for each stratum, achieved PMV is calculated using Eleanor’s tables and target PMV is calculated using the procedure described in Appendix 2. A count of the number of plots in the stratum (standard plus enhanced) provides the estimate of stratum area (ha). Stratum area is multiplied by the PMVs to obtain stratum totals. The PMV totals (achieved and target) from each stratum are summed and compared.

2.9 Updating after treatment

If a portion of a cutblock is treated after the surveys are completed, the treated area is drawn onto the cutblock map of the stratum boundaries and plot locations. This identifies the plots that fell in the area that is now treated. These plots are then identified in the plot data table, their plot numbers are retained, but the rest of their data is cleared. The treated area is stratified and plots are put into the new strata at an intensity of 1/ha. Data are collected and entered into the plot data table in the rows that have been reserved for them. The entire plot data table is re-sorted by strata, strata means are re-calculated, and new stratum totals are obtained.

3.0 Example

Sample design for the 2002 pilot

Here is a small worked example for a population with 3 cutblocks. The cutblock areas are 15, 5, and 5 hectares for cutblocks 1, 2, and 3, respectively. Note that in Cutblock 3 there are two distinct target stocking standards – thus two strata.

After sampling, the plot data were entered into the ledger (as below).

Cut-block No.	Plot No.	Species Class	Stratification		Stocked Quadrant Tally	Plot Type	Plot measurements					
			Density Class	Target Stocking (#/ha)			BEC	Site Indx (m)	SI Spp	Top Height (m)	Eff Age (yr)	
1	1-1	Pl	<700	1200	0	S						
1	1-2	Pl	<700	1200	4	S						
1	1-3	Pl	<700	1200	1	S						
1	1-4	Pl	<700	1200	3	E	MSdm2/01	19	Pl	2.9	11	
1	1-5	Pl	<700	1200	2	S						
1	1-6	Pl	>=700	1200	0	S						
1	1-7	Pl	>=700	1200	4	S						
1	1-8	Pl	>=700	1200	4	E	MSdm2/01	19	Pl	3.4	12	
1	1-9	Pl	>=700	1200	3	S						
1	1-10	Pl	>=700	1200	2	S						
1	1-11	Pl	>=700	1200	3	S						
1	1-12	Pl	>=700	1200	4	E	MSdm2/01	19	Pl	2.5	10	
1	1-13	Pl	>=700	1200	4	S						
1	1-14	Pl	>=700	1200	3	S						
1	1-15	Pl	>=700	1200	2	S						
2	2-1	Sx	>=700	1200	3	E	ESSFdc2/01	16	Sx	0.9	9	
2	2-2	Sx	>=700	1200	2	S						
2	2-3	Sx	>=700	1200	3	S						
2	2-4	Sx	>=700	1200	4	S						
2	2-5	Sx	>=700	1200	3	E	ESSFdc2/06	18	Sx	1.0	9	
3	3-1	Sx	>=700	1200	2	S						
3	3-2	Sx	>=700	1200	3	S						
3	3-3	Sx	>=700	600	4	S						
3	3-4	Sx	>=700	600	3	E	ESSFdc2/06	18	Sx	1.7	13	
3	3-5	Sx	>=700	600	2	S						

The plot data were sorted to group all plots in the same stratum. Stratum average values for site index, effective age, and MSQ were computed. Achieved and target PMV were calculated and totals computed (as below).

Strata			Mean values				PMV (per ha)			PMV (total)		
Species Class	Density Class	Target Stocking Level	Site Index (m)	Stocked Quadrant	Effective Age (year)	Site Index Multiplier	SI=20 Achieved (m3/ha)	SI=Actual Achieved (m3/ha)	SI=Actual Target (m3/ha)	Total Area (ha)	Achieved (m3)	Target (m3)
PI	<700	1200	19	2.0	11	0.9	301	271	354	5	1355	1770
PI	>=700	1200	19	2.9	11	0.9	383	345	354	10	3450	3540
Sx	>=700	1200	17	2.9	9	0.7	405	284	297	7	1988	2079
Sx	>=700	600	18	3.0	13	0.8	436	349	296	3	1047	888
Total:										25	7840	8277
Average:											314	331

Achieved PMV is less than target – so treatments must be conducted. An assessment of treatment options, indicates that brushing cutblock 1 will greatly increase stocked quadrant counts – and thus, achieved PMV. The data for plots 1-1 to 1-15 are cleared from the plot data table, and re-entered when the treatment is completed and the area is re-surveyed. Stratum totals are recomputed.

Appendix 1 – Field procedures for the 2002 pilot of Riverside’s new approach to assessing silviculture obligations

September 16, 2002

Scope of this document

This document describes only the requirements for the reforestation compliance aspect of the survey. To meet other needs, such as delineating and labelling inventory polygons, additional data will have to be collected during the survey. Additions to this survey must not result in changes to the survey procedures required to assess reforestation compliance.

1. Transfer TSS boundary from SP onto the survey map

Before the survey, obtain the currently approved SP. Transfer the SU boundaries onto the survey map. SU’s can be combined if they have a) the same TSS and b) the same preferred and acceptable (p+a) species. Record the TSS and the p+a species for each unit because this information will be required during the survey.

2. Plot locations on 100 m grid

Generate plot locations on 100 m grid for the cutblock.

3. Choose between “old” and “new” methods of assessing brush competition

At the block, before starting the survey, determine whether old or new “free from brush” rules will be applied. The old rules use a standard (usually 125%) conifer/brush height ratio, and for this survey a 30 cm minimum height. The new rules use the free-growing minimum heights, overtopped quadrant assessments and an allowance for some tall deciduous. Apply the same rule to every plot in the cutblock.

4. Plot falls outside NAR

When the surveyor gets to the plot and the plot center has landed outside the NAR, then the plot is a null plot. Do not collect data. Do not off-set the plot into the NAR. Do not record any plot information. Go on to the next plot.

5. Data collection at a standard plot

A standard plot is one where the last three digits of either or both of the UTM easting and northing are 100, 300, 500, 700, or 900. At a standard plot, the following is done:

a) Record species class.

Assess species composition in an area approximately 5.64 m around plot center.

Based on a rough ocular estimate, assign the area to 1 of 3 species groups: >=

- 80% Pl, \geq 80% Sx, or mix. For this purpose i) Fd, Lw, and Py will be treated as Pl and ii) Bl will be treated as Sx. Record species class for the plot.
- b) Record TSS class
Based on the SU boundaries that were transferred onto the survey map, record the TSS that applies to the area in which the plot fell.
- c) Count stocked quadrants
Record the number of quadrants that contain at least one acceptable tree. An acceptable tree is:
- i) Preferred or acceptable species (as listed in the SP for the SU)
 - ii) Healthy (Meets forest health standards)
 - iii) Acceptable advance regeneration (meets adv. regen. standards)
 - iv) Free from brush and taller than a minimum height (as assessed with either the old % conifer/brush ratio standard or the new FG standards).
- When a quadrant contains one or more live or dead trees with root disease, that quadrant is tallied as not stocked.
- d) Count potential stocked quadrants after brushing
Record the number of quadrants that would contain at least one acceptable tree following a brushing treatment.
- e) Record UTM coordinates
Record the UTM coordinates of the plot.

6. Data collection at an enhanced plot

An enhanced plot is one where the last three digits of both the UTM easting and northing are 000, 200, 400, 600, or 800. At an enhanced plot, collect all of the above data plus the following:

- a) Record BEC
Assess site series in an area approximately 5.64 m around plot center. Based on a rough ocular estimate, assign the area to the dominant site series. Record BEC zone/subzone/variant/site series.
- b) Pl or Sx height measure tree
In a 5.64 m radius plot, make a rough ocular estimate of whether Pl or Sx is more common. Locate the tallest tree of this species that is live and not a residual. Measure and record total height and species code. If this tree is also a suitable growth intercept sample tree (healthy, undamaged and unsuppressed), record breast height age.
- c) In a 3.99 m plot, collect WS tree count, FG tree count, total tree count, and total conifer count.

7. Map areas of low stocking (<700 ws/ha)

If during the survey, a mappable patch (1 ha or larger) of low stocking was found, transfer its boundaries onto the survey map. Map patches that a rough ocular estimate suggests have < 700 well spaced trees/ha, preferred and acceptable species, free from brush and healthy.

8. Add density class (<700 , >= 700) to each plot

After the boundaries of any <700 ws/ha area are delineated on the survey map, assign each plot to the >700 or < 700 ws/ha density class.

9. Mapping and identify treatment units

After a cutblock is surveyed, a map is prepared that shows:

- a) the location of the plots, and
- b) the boundaries of the mapped strata (density class and TSS level).

If the cutblock contains a viable treatment unit, add to the map the approximate location of treatment units and describe the treatment opportunity.

10. Provide data to MoF

In an ASCII or excel format file provide the following:

For each plot:

1. Cutblock identity (e.g., CP838 Block 1A)
2. Plot identity (e.g., plot # 1)
3. UTM coordinates of the plot (e.g., 307200; 5639200)
4. Stratum identity (e.g., species class, density class, target stocking class)
5. Stocked quadrant tally (e.g., 0, 1, 2, 3, or 4)
6. Potential stocked quadrant tally following a brushing treatment (e.g., 0, 1, 2, 3, or 4)
7. Plot type (S=standard plot, E=enhanced plot)

In addition to the above, for each enhanced plot:

8. Height sample tree species (e.g., Pl or Sx)
9. Sample tree height (e.g., 2.5 m)
10. If height sample tree is suitable GI tree, record breast height age (e.g., 4 years)
11. BEC classification (zone/subzone/variant/site series) (e.g., MSdm2 01)
12. Well spaced tree count (e.g., 5)
13. Free growing tree count (e.g., 4)
14. Total tree count (e.g., 25)
15. Total conifer count (e.g., 21)

Here is an example of what this data looks like.

		Stratum identity					Plot measurements												
						Target	Potential		BEC				Breast	Well	Free				
						Stocking	Stocked	Stocked	Zone		BEC	Height	Total	Height	Spaced	Growing	Total	Total	
Cutblock	Plot	UTM - easting	UTM - northng	Spp Class ¹	Density Class	Standard (#/ha)	Quadrant Tally	Quadrant Tally	Plot Type	Subzone Variant	Site Series	Sample Species	Height (m)	Age (yr)	Tree Count	Tree Count	Tree Count	Conifer Count	
CP838 Block 1A	1	307100	5639100	Pl	<700	1200	0	1	S										
CP838 Block 1A	2	307100	5639200	Pl	<700	1200	4	4	S										
CP838 Block 1A	3	307100	5639300	Mix	<700	1200	1	2	S										
CP838 Block 1A	4	307200	5639200	Sx	<700	1200	3	3	E	MSdm2	01	Sx	2.6	4	6	5	25	22	
CP838 Block 1A	5	307200	5639100	Pl	<700	1200	2	2	S										
CP838 Block 1A	6	307200	5639300	Mix	>=700	1200	0	0	S										
CP838 Block 1A	7	307300	5639500	Sx	>=700	1200	4	4	S										
CP838 Block 1A	8	307400	5639200	Pl	>=700	1200	4	4	E	MSdm2	02	Pl	2.8	3	5	5	14	14	
CP838 Block 1A	9	307400	5639100	Mix	>=700	1200	3	4	S										
CP838 Block 1A	10	307500	5639200	Pl	>=700	800	2	4	S										
CP838 Block 1A	11	307500	5639300	Mix	>=700	800	3	4	S										
CP838 Block 1A	12	307600	5639000	Mix	>=700	800	4	4	E	MSdm2	04	Pl	2.8	5	4	2	17	16	

¹ For species stratification a) Fd, Lw, and Py will be treated as Pl and b) Bl will be treated as Sx.

Appendix 2 - Target PMVs

To implement the system, target PMVs are required. This appendix describes the method that was used to develop the target PMVs and provides them in tabular format for some common combinations of species class, target stocking level, and site index.

The target PMVs are intended to represent 90% of the maximum PMV that could be attained with a very aggressive reforestation regime. This approach to setting targets replaces the previous approach in which target PMVs were based on 90% of the target stocking standard (plus a two year regeneration delay and 2% genetic gain). To avoid introducing bias into the comparison of target and achieved PMVs, Eleanor's tables are used to calculate both.

The following model was developed to predict target PMV:

$$PMV_{Target} = 0.9 \times PMV_{Max1200} \times TSS_{Adjustment} \times SI_{Adjustment}$$

where

PMV_{Target} is the target PMV,

$PMV_{Max1200}$ is the maximum PMV on sites where the TSS is 1200/ha,

$TSS_{Adjustment}$ is the adjustment to $PMV_{Max1200}$ for areas where TSS < 1200/ha, $SI_{Adjustment}$ is the site index adjustment factor.

The model to predict target PMV was developed in four steps:

1. A percentage of maximum PMV was selected to establish the target;
2. Maximum PMVs were chosen for each species group for those areas where the target stocking standard (TSS) is 1200/ha;
3. Adjustments to maximum PMVs were developed for areas where TSS is below 1200/ha;
4. The adjustment factors were combined to produce an equation to predict target PMV for any TSS and site index level, by species group

Target set at 90% of maximum PMV

Based on input from the Chief Forester on a related issue, target PMVs were set at 90% of the maximum PMV that could be attained with a very aggressive reforestation regime.

Maximum PMVs at a TSS level of 1200/ha

Where the TSS is 1200/ha, maximum PMV was assumed to occur at an MSQ of 4. To select a corresponding effective age, an aggressive, but feasible, reforestation regime was envisioned (see the table below). With late winter logging and spring planting 1 year old stock, seedlings are 12 years from seed at the time of a survey in the fall 10 calendar years after harvest. Thus, for a given species group, where TSS is 1200/ha, the target PMV is 90% of the PMV given by an MSQ of 4 and an effective age of 12 years, adjusted for site index. Where TSS is 1200/ha, the maximum PMVs are 437 m³/ha, 472

m³/ha, and 451 m³/ha on site index 20 m for pure Pl, pure Sx, and Pl-Sx mixes, respectively.

Calendar year	Regime and tree age in the fall
0	Late winter harvest. Spring plant 1 year old stock. Trees are two years from seed in the fall.
1	Trees are three years from seed in the fall.
...	...
10	Trees are 12 years from seed in the fall.

Adjustment for areas with TSS below 1200

On areas where the TSS is below 1200/ha, the “maximum” PMV must be reduced. On these areas, it is inappropriate to assume that an MSQ of 4 represents an attainable maximum. To reduce maximum PMV, a relationship between free growing trees/ha and mean stocked quadrants (MSQ) was used. This relationship was developed by Wendy when she re-analyzed the TASS simulations that Eleanor used to develop the PMV tables. For each Pl stem map, both MSQ (with no minimum height) and mean well spaced trees/plot (with no “M” value and a 1.5 m minimum height) were estimated. The resulting relationship for Pl between MSQ and mean well spaced trees per plot (wsp) is presented in Figure A-1 below.

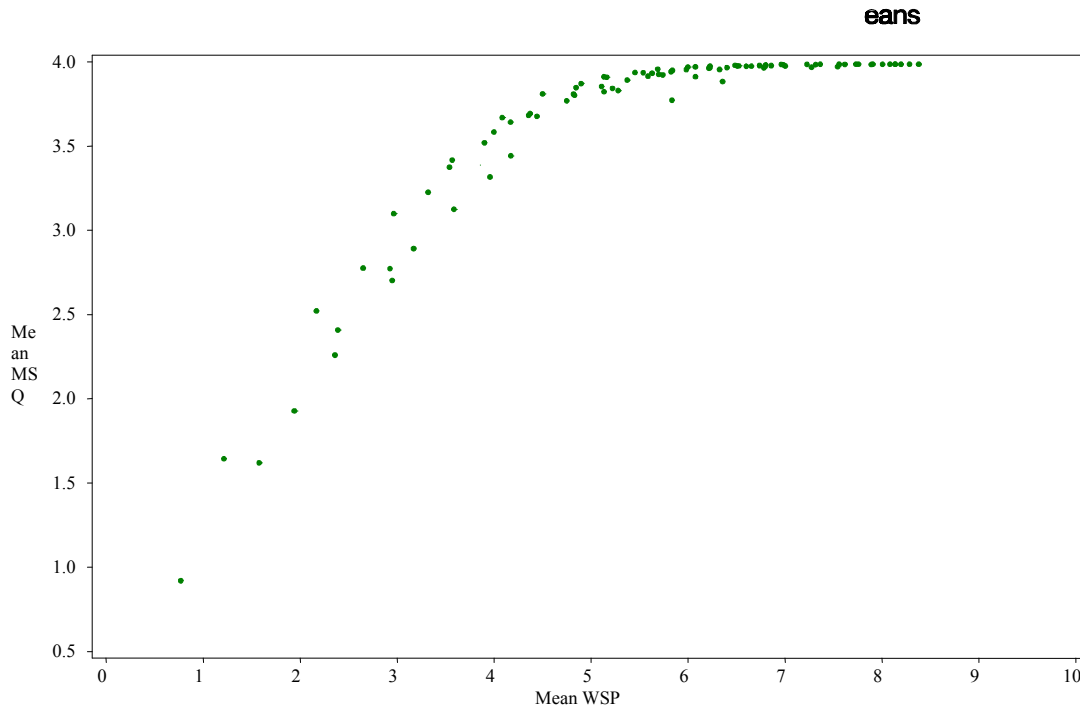


Figure A-1. Mean relationship for lodgepole pine between MSQ (with no minimum height) and well spaced trees/plot (wsp, with no M and a minimum height of 1.5 m).

A curve was hand-drawn on Figure A-1 and used to generate data points to which an equation relating MSQ to wsp was fit:

$$MSQ = 1.024 \times (1.1118wsp - 0.0564wsp^2 - 0.0034wsp^3)$$

where MSQ is mean stocked quadrants with no minimum height and wsp is mean well spaced trees per plot with a 1.5 m minimum height and no M.

Though developed for pure Pl, this relationship was applied to all 3 species groups. With the MSQ-wsp relationship, the MSQs that correspond to various levels of TSS were determined. For the pure Pl species group on site index 20 m, the PMVs given by these MSQs with an effective age of 12 are provided in the table below. Last, the PMVs are expressed as a proportion of maximum PMV (437 m3/ha).

TSS (#/ha)	MSQ corresponding to TSS	PMV with effective age of 12 years	PMV as proportion of maximum (437 m3/ha)
400	2.0	305	0.70
600	2.8	380	0.87
800	3.4	417	0.95
1000	3.8	432	0.99
1200	4.0	437	1.00

The relationship between TSS and PMV as a proportion of maximum (437 m3/ha) was modelled to develop the TSS adjustment factor:

$$TSS_{Adjustment} = 1 - \exp(-5.265 \times (TSS / 1200)^{1.3612})$$

The observed values and the fitted model are shown in Figure A-2.

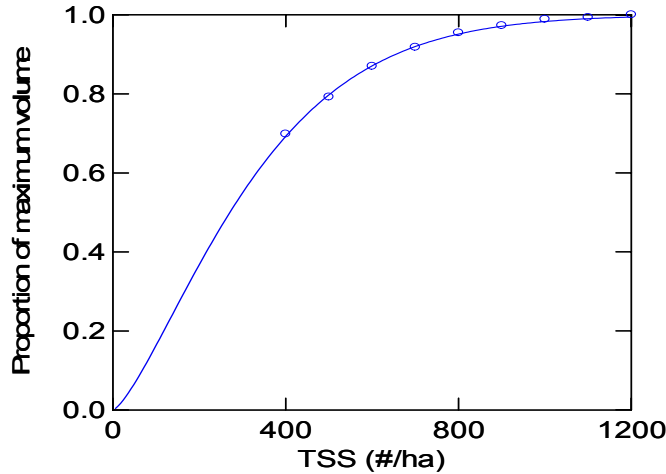


Figure A-2. Observed (circles) and fitted values (line) for the relationship between TSS and the proportion of maximum volume.

Equation to predict target PMVs

The equation for predicting target PMV for any TSS and site index, by species group is:

$$PMV_{Target} = 0.9 \times PMV_{Max1200} \times TSS_{adjustment} \times SI_{Adjustment}$$

where:

PMV_{Target} is the target PMV.

$PMV_{Max1200}$ is the maximum PMV on sites where the TSS is 1200/ha. 437 m3/ha for the Pl species group, 472 m3/ha for the Sx species group, and 451 m3/ha for the Pl-Sx species group on site index 20 m.

$TSS_{Adjustment}$ is the adjustment to $PMV_{Max1200}$ to account for areas where TSS < 1200/ha.

$SI_{Adjustment}$ is the site index adjustment factor.

Some example calculations are summarised in the table below.

TSS	SI	Species Group	$PMV_{Max1200}$	$TSS_{Adjustment}$	$SI_{Adjustment}$	PMV_{Target}
1200	17	Pl	437	1	0.7	275
400	20	Sx	472	0.6928	1.0	294
1000	23	Pl-Sx	451	0.9836	1.3	519

PMV tables

The following tables provide the target PMVs for some combinations of site index and TSS by species group.

Sample design for the 2002 pilot

PMV on SI=20 with MSQ=4 and effective age=12							
Species group	years (m3/ha)	TSS (#/ha)	TSS adjustment	SI (m)	SI adjustment	Target PMV (m3/ha)	
PI	437	400	0.69	16	0.6	163	
				17	0.7	191	
				18	0.8	218	
				19	0.9	245	
				20	1	272	
				21	1.1	300	
				22	1.2	327	
				23	1.3	354	
	600		600	0.87	16	0.6	206
					17	0.7	240
					18	0.8	274
					19	0.9	308
					20	1	343
					21	1.1	377
					22	1.2	411
					23	1.3	445
	800		800	0.95	16	0.6	225
					17	0.7	262
					18	0.8	299
					19	0.9	337
					20	1	374
					21	1.1	412
					22	1.2	449
					23	1.3	487
1000		1000	0.98	16	0.6	232	
				17	0.7	271	
				18	0.8	309	
				19	0.9	348	
				20	1	387	
				21	1.1	426	
				22	1.2	464	
				23	1.3	503	
1200		1200	1.00	16	0.6	236	
				17	0.7	275	
				18	0.8	315	
				19	0.9	354	
				20	1	393	
				21	1.1	433	
				22	1.2	472	
				23	1.3	511	
				24	1.4	551	

Sample design for the 2002 pilot

PMV on SI=20 with MSQ=4 and effective age=12							
Species group	years (m3/ha)	TSS (#/ha)	TSS adjustment	SI (m)	SI adjustment	Target PMV (m3/ha)	
Sx	472	400	0.69	16	0.6	177	
				17	0.7	206	
				18	0.8	235	
				19	0.9	265	
				20	1	294	
				21	1.1	324	
				22	1.2	353	
				23	1.3	383	
	600	0.87	600	0.87	24	1.4	412
					16	0.6	222
					17	0.7	259
					18	0.8	296
					19	0.9	333
					20	1	370
					21	1.1	407
					22	1.2	444
	800	0.95	800	0.95	23	1.3	481
					24	1.4	518
					16	0.6	243
					17	0.7	283
					18	0.8	323
					19	0.9	364
					20	1	404
					21	1.1	445
1000	0.98	1000	0.98	22	1.2	485	
				23	1.3	526	
				24	1.4	566	
				16	0.6	251	
				17	0.7	292	
				18	0.8	334	
				19	0.9	376	
				20	1	418	
1200	1.00	1200	1.00	21	1.1	460	
				22	1.2	501	
				23	1.3	543	
				24	1.4	585	
				16	0.6	255	
				17	0.7	297	
				18	0.8	340	
				19	0.9	382	
20	1	425					
21	1.1	467					
22	1.2	510					
23	1.3	552					
24	1.4	595					

Sample design for the 2002 pilot

PMV on SI=20 with MSQ=4 and effective age=12						
Species group	years (m3/ha)	TSS (#/ha)	TSS adjustment	SI (m)	SI adjustment	Target PMV (m3/ha)
Pl-Sx	451	400	0.69	16	0.6	169
				17	0.7	197
				18	0.8	225
				19	0.9	253
				20	1	281
				21	1.1	309
				22	1.2	337
				23	1.3	366
	600		0.87	16	0.6	212
				17	0.7	248
				18	0.8	283
				19	0.9	318
				20	1	354
				21	1.1	389
				22	1.2	424
				23	1.3	460
	800		0.95	16	0.6	232
				17	0.7	270
				18	0.8	309
				19	0.9	348
				20	1	386
				21	1.1	425
				22	1.2	464
				23	1.3	502
1000		0.98	16	0.6	240	
			17	0.7	279	
			18	0.8	319	
			19	0.9	359	
			20	1	399	
			21	1.1	439	
			22	1.2	479	
			23	1.3	519	
1200		1.00	16	0.6	244	
			17	0.7	284	
			18	0.8	325	
			19	0.9	365	
			20	1	406	
			21	1.1	446	
			22	1.2	487	
			23	1.3	528	
			24	1.4	568	

Discussion

For some combinations of species group, TSS, site index and effective age, the approximate MSQ required to equal the target PMV is provided in the table below. In the 10 blocks sampled in 2001, MSQ ranged from 3.3 to 4.0 with a mean of 3.7. If these MSQs are typical, it appears that the target PMVs are achievable and reflect a minimum standard.

Species Group	TSS (#/ha)	Site Index (m)	Target PMV (m3/ha)	Effective Age (yr)	MSQ Required To equal target PMV
Pl	1200	20	393	8	3.3
				12	3.0
Sx	1200	23	552	8	3.4
				12	3.0
Pl-Sx	600	20	354	8	2.6
				12	2.4
Pl-Sx	600	17	248	8	2.6
				12	2.4

Many factors are excluded for the target PMV calculation including genetic gain, the yield impact of retained trees, and so on. At this point, the plan is that if these factors are to be incorporated into the system it will be through post-hoc adjustments applied to the yield predictions. Generally, both the achieved and the target yields will need to be adjusted in any post-hoc adjustment process.

Appendix 3 – SIBEC values for TFL 49’s results-based silviculture project

The following site index estimates for Pl and Sx by BEC classification will be used in this project. SIBEC values provided by Timberline, June 2002.

BEC unit (zone/subzone/variant)	Site series	Species	Site index (m)
ESSFdc2	1	Pl	17.38
ESSFdc2	3	Pl	17.41
ESSFdc2	4	Pl	14.64
ESSFdc2	5	Pl	14.64
ESSFdc2	6	Pl	19.48
ESSFxc	1	Pl	19.15
ESSFxc	5	Pl	14.64
ESSFxc	6	Pl	16.99
ICHmk1	1	Pl	18.98
ICHmk1	4	Pl	17.30
IDFdk1	1	Pl	18.98
IDFdk1	4	Pl	15.00
IDFdk1	5	Pl	21.00
IDFdk2	1	Pl	20.91
IDFmw1	1	Pl	18.98
IDFxb2	1	Pl	16.19
MSdm2	1	Pl	18.63
MSdm2	3	Pl	16.46
MSdm2	4	Pl	17.90
MSdm2	5	Pl	20.17
MSdm2	6	Pl	22.19
ESSFdc2	1	Sx	15.53
ESSFdc2	6	Sx	18.41
ESSFdc2	7	Sx	17.21
ESSFxc	6	Sx	15.56
ICHmk1	5	Sx	22.18
IDFdk1	5	Sx	20.44
IDFdk2	5	Sx	21.12
IDFxb1	5	Sx	23.03
MSdm2	1	Sx	18.98
MSdm2	4	Sx	15.00
MSdm2	5	Sx	22.18
MSdm2	6	Sx	22.18

Appendix 4: Rationale for the sample design

Every sample design is the result of a series of choices, and often tradeoffs, made by the developers. Here are some of the choices that we made.

To ensure that treatment opportunities could be identified in the field, we chose a design that sampled every cutblock, plot locations on a grid and a sample intensity adequate to find treatable areas. So that the plot data could easily provide means and totals for various sub-divisions of the population, we chose to use a sample intensity that was constant over the entire population. Thus, we chose a sampling intensity of 1 plot/ha on a grid, constant over the entire population. Subsequent developments may result in relaxing this restriction.

We felt that it was desirable to minimize the amount of stratification required. Thus, we chose a design that does not stratify by site index. Instead, as it has a linear relationship with PMV, site index is averaged when the data are compiled without biasing the predicted volume. The stratification that is used is driven by administrative reasons and the requirements of Eleanor's tables – not by the desire to reduce variance by identifying areas homogeneous in terms of PMV. To address the curvilinear relationship between density and PMV, and to link to the current survey system with which we are familiar, we chose the break-point for the density strata at the 700/ha threshold defined in terms of well spaced trees of preferred and acceptable species that are healthy and free from brush.

To reduce field work, we chose to sub-sample for height and site index – though this complicates data compilation. We chose to not design for accurate estimates of PMV for individual cutblocks, strata within cutblocks, or treatment units.