Documentation for the SORTIE-ND SBS Research Parameter File Version 1.0

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1. Introduction

This report documents the SORTIE-ND SBS Research Parameter File Version 1.0. This parameter file is the result of several years of intensive field measurements and model development. Several projects that provided parameters for the SBS Research Parameter File Version 1.0 are published, but several projects still await publication. Thus, prior to publicizing work based on the SBS Research Parameter File Version 1.0 it is requested that the Version 1.0 parameter file developers are contacted by email (research@bvcentre.ca). When work is published we request that this report in combination with (????) is cited.

Before use the SBS Research Parameter File Version 1.0 it is recommended that model users are familiar with this document. As for any model, SORTIE-ND in combination with the SBS Research Parameter File Version 1.0 has strengths, limitations and weaknesses. This document is designed to help users and new model developers: (1) understand the models capabilities or limitations, (2) understand which model features that causes given model behaviors, and (3) provide users with sufficient information let the user make an informed choice to weather or not to use SORTIE-ND in combination with the SBS Research Parameter File Version 1.0

SORTIE-ND is an individual tree, spatially explicit model of stand dynamics that originated from the small scale disturbance model SORTIE developed and tested in the mid 1990's for transitional oak-northern hardwood forests in the northeastern US (Pacala et al. 1996). SORTIE was designed to extrapolate fine-scale/short-term field measurements to large-scale, long-term forest dynamics (Pacala et al. 1996). In recent years SORTIE was parameterized for mixed forests in northwestern British Columbia and modified to be better suited for dealing with management issues (SORTIE/BC; Coates et al. 2004). SORTIE/BC has recently been restructured and reprogrammed in C++. The result is SORTIE-ND where ND signifies the model's focus on local neighbourhood dynamics. SORTIE-ND is freely available on web (www.sortie-nd.org).

Researchers from the BV Research Centre and the BC Ministry of Forests have played a leading role in the design and development of both SORTIE/BC and SORTIE-ND. Additionally, the BV Centre researchers have played a key role in the parameterization of SORTIE-ND for mixed forests in western British Columbia (e.g.

Kobe and Coates 1997; Wright et al. 1998, 2000; Canham et al. 1999; LePage et al. 2000; Coates et al. 2004; Canham et al. 2004; Astrup and Larson 2005; Astrup 2006).

In SORTIE-ND, each equation that affects a tree is called a behavior. Examples of behaviors are a growth behavior which determines the growth of an individual tree given its available resources or a mortality behavior which assigns a probability of mortality to an individual tree given its current growth rate. In SORTIE-ND the user has to specify which behaviors (processes) to apply to a population of trees. Each behavior can be specific for a combination of species and life-cycle stage (seed, seedling, saplings, adult trees, snags, woody debris). The number of available behaviors is large and SORTIE-ND can consequently be configured to do different types of simulations with very different objectives and outcomes. The C++ code structure allows for new behaviors to be incorporated into the model with relative ease.

In SORTIE-ND, a behavior is represented as an equation with a number of parameters. The parameters do not have default values and have to be specified by the user in a parameter file that can be accessed through the model's user interface. Thus, SORTIE-ND simulations performed by different users can be very different and are dependent on the model setup which is specified through the parameter file. Thus, to use SORTIE-ND a parameter file is required. A parameter file can be made with the models interface but will not contain default parameter estimates. To obtain parameter estimates, large amounts of field data and statistical analysis are required. Development of a new parameter file can consequently often require years of data collection and analysis.

2. Research and Management Parameter files

Researchers at the BV Centre have developed SORTIE-ND parameter files for several forests types in northwestern BC. The developed parameter files falls into two general categories: (1) Research Parameter Files and (2) Management Parameter Files.

The two types of parameter files differ in their appropriate applications and in the methods in which the individual parameters are estimated. The Research Parameter Files are mainly appropriate for research and silvicultural decision making. The parameters in the Research Parameter Files are generally estimated directly from short-term data from individual trees. In other terms, the parameter files have been parameterized but they have not been calibrated. In this terminology, parameterization is the process in which the parameters in an equation are fitted to a dataset. On the other hand, calibration is the processes in which the stand-level predictions from a model are compared with observations and afterwards one or more parameters in the model are changed to produce predictions that match the observations. Calibration is not appropriate for the Research Parameter Files as is does not necessarily allocate the changes to the correct processes. The Management Parameter Files are mainly developed for use in relation to timber supply analysis problems. For these types of problems, calibration is more appealing as it, for example, might reduce biases in volume predictions. The Management Parameter Files are constructed by calibrating selected parameters in the Research Parameter Files to long term permanent plot data.

2.1. SBS Research Parameter File Version 1.0

The SBS Research Parameter File Version 1.0 represents mesic sites with an approximate medium nutrient availability (site series 01) and is only appropriate for this site type. The parameter file is constructed to model conifer-dominated forests. The vast majority of the parameter estimates originate from the SBSmc2 around Smithers. When using the SBS Research Parameter File Model Version 1.0 in other parts of the SBS, users should be aware that there are some differences in growth rates between the different subzones of the SBS.

The SBS Research Parameter File Version 1.0 has five variants and each is designed for application to a general type of simulations. The differences between the five variants are in reality small but they may still result in quite different outcomes. The five parameter file variants, their differences, and their intended applications are outlined in **Table 1**. The model flow (applied behaviours) and the data sources for each parameter file variant are described in the Model Flow section. The actual function of each behavior is described in Section 4; Behaviors for the SBS Research Parameter File Version 1.0. The actual parameter estimates for each parameter file are included in Appendix A.

Table 1 The five variants of the SBS Research Parameter File Version 1.0

Version 1.0 Variant	Difference to the above variant	Typical application
Research Parameter File Version 1.0 SBS Planted Trees, No Regeneration, No Snags.xml	Only light, growth, mortality, and analysis behaviours are applied. Natural regeneration does not occur and snags do not exist.	Simulation of even aged stands or comparison to other growth models that do not predict natural regeneration.
Research Parameter File Version 1.0 SBS Planted Trees, Regeneration and Snags.xml	Same light, growth, and mortality behaviours. Natural regeneration and snags behaviours are added.	Simulation of stands where the main type of establishment is planting but natural regeneration also occurs.
Research Parameter File Version 1.0 SBS Natural Regeneration, Regeneration and Snags.xml	Same behaviours but juvenile trees have a higher associated mortality rate. The higher mortality rate reflects a higher level of mortality in natural regeneration compared to planted seedlings.	Simulation of stands where the main type of establishment is natural regeneration.
Research Parameter File Version 1.0 SBS MPB Natural Regeneration, Regeneration and Snags.xml	Same behavious but the proportion of pine that fall after mortality is reduced. The lower fall rate reflects that most MPB killed pine remains standing for several years.	Simulation of stands where pine has been affected by MPB and the main type of establishment is natural regeneration.
Research Parameter File Version 1.0 SBS MPB Planted Trees, Regeneration and Snags.xml	Same behaviours but the juvenile mortality rate is lower. The lower mortality rate reflects a lower mortality in planted trees compared to natural regeneration.	Simulation of stands where pine has been affected by MPB and the main type of establishment is planting (e.g. underplanting in MPB affected stands)

3. Model Flow

The model flow (behaviours) and the data sources for parameterization of the SBS Research Parameter File Version 1.0 are included in **Table 2**. For Research Parameter File Version 1.0 SBS Planted Trees, No Regeneration, No Snags.xml only applies light, growth, mortality, and analysis behaviours. The four other variants of the SBS Research Parameter File Version 1.0 apply all the behaviors in Table 2.

Table 2 Model behaviours applied to interior spruce, lodgepole pine, subalpine fir and trembling aspen in the SBS Research Parameter File Version 1.0

Life Stage	Behaviours	Data Source for parameterization
Seed	**All: interior spruce, lodgepole pine, subalpine fir and trembling aspen** • Substrate Dependent Seed Survival With Gap Status • Seed Establishment	
Seedling	**interior spruce and subalpine fir** • Quadrat-based GLI light • Logistic growth w/ size dependent asymptote - diam with auto height • BC Mortality • Juvenile Stochastic Mortality • Dead tree remover • Detailed Output **lodgepole pine** • Quadrat-based GLI light • Logistic growth - diam with auto height • BC Mortality • Juvenile Stochastic Mortality • Dead tree remover • Detailed Output **trembling aspen** • Quadrat-based GLI light • Logistic growth - diam with auto height • BC Mortality • Juvenile Stochastic Mortality • Density Self-Thinning Mortality • Dead tree remover • Detailed Output	
Sapling	**interior spruce and subalpine fir** • GLI light • Logistic growth w/ size dependent asymptote - diam with auto height • BC Mortality • Juvenile Stochastic Mortality • Substrate • Dead tree remover • Detailed Output **lodgepole pine** • GLI light • Logistic growth - diam with auto height • BC Mortality	

	• Juvenile Stochastic Mortality • Substrate • Dead tree remover • Detailed Output **trembling aspen** • GLI light • Logistic growth - diam with auto height • BC Mortality • Juvenile Stochastic Mortality • Density Self-Thinning Mortality • Substrate • Dead tree remover • Detailed Output	
Adult	**All: interior spruce, lodgepole pine, subalpine fir and trembling aspen** • Sail light • NCI growth – diam with auto height • Senescence • Adult Stochastic Mortality • Competition Mortality • Substrate • Dead tree remover • Non-spatial disperse • Gap spatial disperse • Tree Volume Calculator • Detailed Output	
Stump	**trembling aspen** • Gap spatial disperse **All others: interior spruce, lodgepole pine and subalpine fir** • n/a	
Snag	**All: interior spruce, lodgepole pine, subalpine fir and trembling aspen** • Weibull Snag Mortality • Substrate • Dead tree remover	
Woody Debris	**All: interior spruce, lodgepole pine, subalpine fir and trembling aspen** • No behaviours	

4. Behaviours for the SBS Research Parameter File

4.1. Behaviours

This section briefly describes the behaviours that are used in the SBS Research Parameter Files. The section builds on the SORTIE-ND help menu and more information for all behaviours can be found in the help menu.

4.2. Allomety

The allometry equations assign height and crown dimensions to each tree and updates these during a simulation. Seedling height is regressed from diameter at 10 cm above ground (diameter10) with equation [1A]. For seedlings and saplings diameter10 is converted to dbh with equation [2A]. Sapling and adult tree height is regressed with the equation [3A]. In SORTIE-ND sapling and adult tree crowns are represented as cylinders with a radius and a depth while seedlings do not have a crown. Crown radius is regressed with equation [4A] and crown depth is regressed with equation [5A].

[1A] $$Height = 0.1 + 30 \times \left[1 - e^{-a \times diameter_{10}}\right]$$

[2A] $$dbh = I + diameter10 \times R$$

[3A] $$Height = 1.35 + (MaxHeight - 1.35) \times \left[1 - e^{-b \times dbh}\right]$$

[4A] $$CrownRadius = C * dbh^{a}$$

[5A] $$CrownLength = C_1 * height^{b}$$

4.3. Light behaviours

Light is the main resource in SORTIE-ND and all trees must have a light level assigned to them by a light behavior. Light levels are predicted with the Gap Light Index (GLI) (Canham 1988) which is 100 in full light and 0 in darkness. The light level at a given location is calculated using the position and allometry of the neighborhood trees, the sky brightness distribution, and species-specific crown openness. Species-specific crown openness is defined as the fraction of sky that on average can be seen through the crown of an individual tree of a given species. For a more detailed description of the light calculations see the SORTIE Help menu and Canham et al. (1999).

4.4. Growth

Seedling and sapling diameter increment are predicted from light availability and tree size. Aspen diameter10 increment is predicted with equation [1JG]. Spruce and subalpine-fir diameter10 increment is predicted with equation [2JG]. Logdepole pine diameter10 increment is predicted with [3JG].

[1JG] $$diameter_{10}increment = \frac{a}{1 + e^{(b - c \times GLI)}}$$

[2JG] $$diameter_{10}increment = \frac{a + b \times diameter10}{\left(1 + e^{(c - d \times GLI)}\right)}$$

[3JG] $$diameter_{10}increment = (a + b \times diameter10) \times (GLI/100)^{C}$$

Adult dbh increment is predicted from the target tree size, light availability, and crowding received from neighborhood trees. An individual tree’s dbh increment is calculated according to equation [1AG]:

[1AG] $$dbhincrement = MaxGrowth \times SizeEffect \times ShadingEffect \times Crowdingeffect$$

Where MaxGrowth is a user specified parameter, the SizeEffect is calculated with equation [2AG], the ShadingEffect is calculated with [3AG] where shading is the shade cast by neighbors (0 = no shade, 1 = full shade), and CrowdingEffect is calculated with [4AG] where NCI is the neighborhood crowding index which is calculated with [5AG]. In equation [5AG] dist is the distance to a given neighbor.

[2AG] $$SizeEffect = e^{-0.5\times\left(\frac{\ln(dbh/X_0)}{X_b}\right)^2}$$

[3AG] $$ShadingEffect = e^{-m\times shading}$$

[4AG] $$CrowdingEffect = e^{-c\times NCI}$$

[5AG] $$NCI_t = \sum_{i=1}^{s}\ \sum_{j=1}^{n}\lambda_{it}\frac{((dbh_{ij})/100)^{\alpha_t}}{(dist_{ij})^{\beta_t}}$$

4.5. Mortality

In SORTIE-ND a mortality behavior assigns a probability of mortality (Pr(Mortality)) to a given tree and hereafter a random number draw determines if the tree actually dies.

4.5.1. Seedling and sapling mortality

Random juvenile mortality is predicted with equation [1JM]. Seedling and sapling mortality due to low growth (caused by shading) is predicted with equation [2JM]. Early aspen self-thinning is predicted with equation [3JM].

[1JM] $$\Pr(Mortality) = a$$

[2JM] $$\Pr(Mortality) = e^{-e^{-m\times diameter10increment}}$$

[3JM] $$\Pr(Mortality) = \left(\frac{(A+(C\times meandiameter))\times density}{\frac{(A+(C\times meandiameter))}{S}+density}\right)$$

4.5.2. Adult tree mortality

Random adult mortality is predicted with equation [1AM]. Mortality due to low growth rate (caused by competition (crowding and shading)) is predicted with equation [2AM] where z and Max are user defined parameters. RelativeIncrement is calculated with equation [3AM] where the PredictedGrowth is the prediction from equation [1AG] and MaxGrowth and SizeEffect have the same meaning as in [1AG]. Mortality due to old age (large dbh) is predicted with the senescence equation [4AM].

[1AM] $\Pr(Mortality) = a$

[2AM] $\Pr(Mortality) = z^{RelativeIncrement/Max}$

[3AM] $RelativeIncrement = \dfrac{PredictedGrowth}{MaxGrowth \times SizeEffect}$

[4AM] $\Pr(Mortality) = \dfrac{e^{(a+b(dbh-c))}}{1+e^{(a+b(dbh-c))}}$

4.5.3. Snag mortality

Snags are already dead trees and the snag mortality behaviour control snag fall down rates rather than actual mortality. The Weibull Snag mortality behaviour determines the proportion (0-1) of standing snags at time T with equation [1SM].

[1SM] $S = e^{-(a*T)^b}$

5. Substrate

Seedlings germinate on a substrate and seedling germination success varies between different substrate types. In SORTIE-ND there are six kinds of substrate: forest floor litter, forest floor moss, scarified soil, tip-up mounds, decayed logs, and fresh logs. Fresh logs decay into decayed logs, which in turn, decay into forest floor litter and forest floor moss. Tip-up mounds and scarified soil also decay into forest floor litter and forest floor moss. Creation of new substrate occurs after two general disturbance types: (1) after a harvest, the substrate composition in a plot is changed according to the harvest type, and (2) new tip-up mounds and fresh logs are created when a tree falls. Thus, in absence of any type of disturbance 100% of the available substrate will over time turn into forest floor litter and forest floor moss. There are three main equation involved in the substrate behaviour. Equation [1S] describes the decay of the different substrate types into forest floor litter and forest floor moss. The area of fresh log substrate hat is created is approximated by the area of a triangle n is calculated with equation [2S]. The area of a tip-up mound is dependent on the size of the fallen tree and is determined with equation [3S].

[1S] $y = e^{\alpha * time^{\beta}}$

[2S] $FrsehLogArea = (DBH * h) / 2$

[3S] $Tip - upMoundArea = \pi * ((DBH / 100) * F)^2$

6. Seed dispersion

The two disperse behaviours, Non-spatial disperse and Gap spatial disperse, create and distribute seeds around the plot. In the SBS Research Parameter File Version 1.0, the Non-spatial disperse is only applied to create a background seed bath. In other words, the non-spatial disperse bahaviour allows species that are not currently present in the plot to establish in the plot. With the applied parameter estimates, the amount of seed bath is very low and does not make a very big contribution to the overall amount of predicted regeneration. The Gap spatial disperse determines the amount of seed that is placed in a given grid cell based on the distribution and sizes of parent trees. The amount of seed produced by an individual parent tree is dependent on the parent tree size. The spatial distribution of seed is controlled by a Weibull distribution. The amount of produced seeds is also dependent on the forest cover in a given cell, it the cell is a gap (e.g. no mature trees) the parameter estimates for STR and Beta are different than under an existing canopy. The actual seed dispersion equations are available in the online help menu.

7. Establishment

The Substrate Dependent Seed Survival With Gap Status behaviour determines the fraction of seeds that are successful, establish, and become seedlings. Seed survival is dependent on the substrate types and on the forest cover. Each of the six substrate type has an associated substrate favorability (0-1) which determines the fraction of seeds that survive on a given substrate type.

8. Analysis

Volume estimates are not part of the driving functions. Rather volume is estimated from dbh and height of each tree by a specified equation. For these simulations, the latest version of Kozaks's variable exponent taper equations (Kozak 2004) was incorporated into the model and was utilized to estimate volume.

9. Predictive ability

The predictive ability of SORTIE….

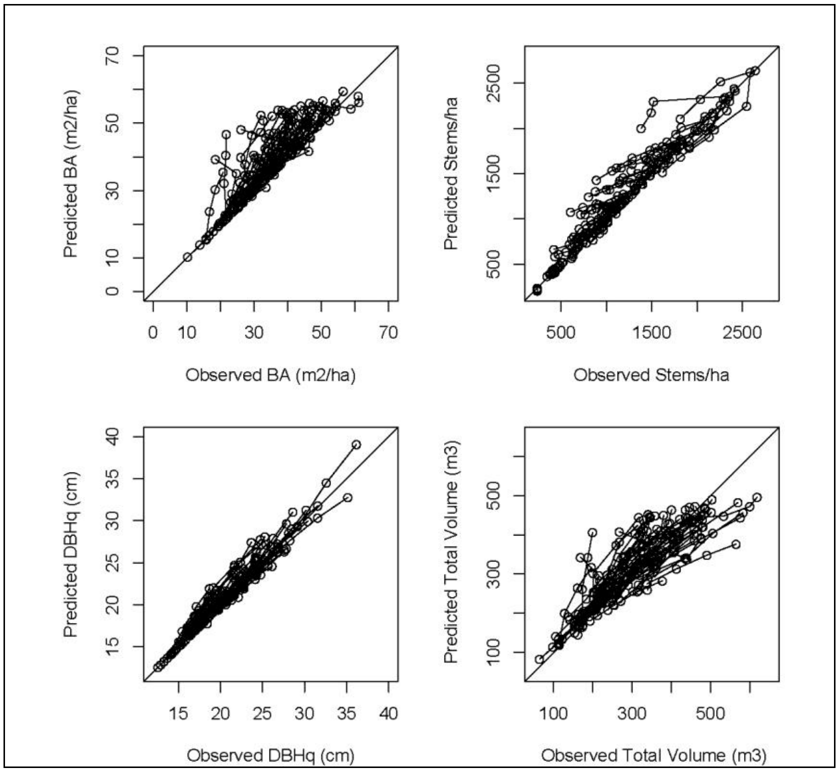

Figure 1 Comparison of all target species basal area, stems/ha, DBH, and total volume between SORTIE-ND predictions and PSP observations.

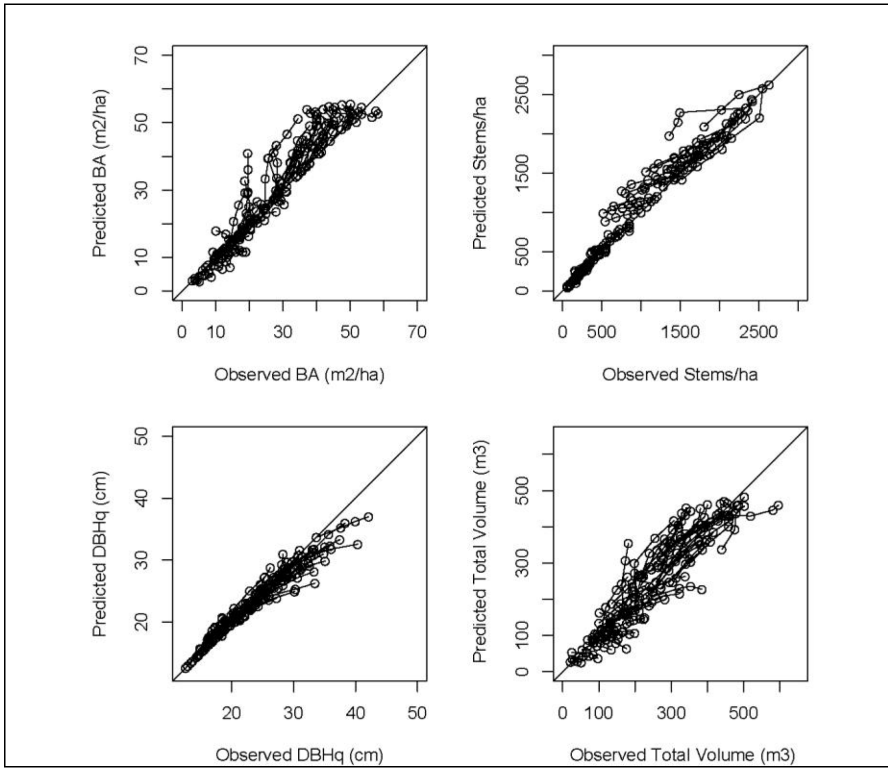

Figure 2 Comparison of lodgepole pine basal area, stems/ha, DBH, and total volume between SORTIE-ND predictions and PSP observations.

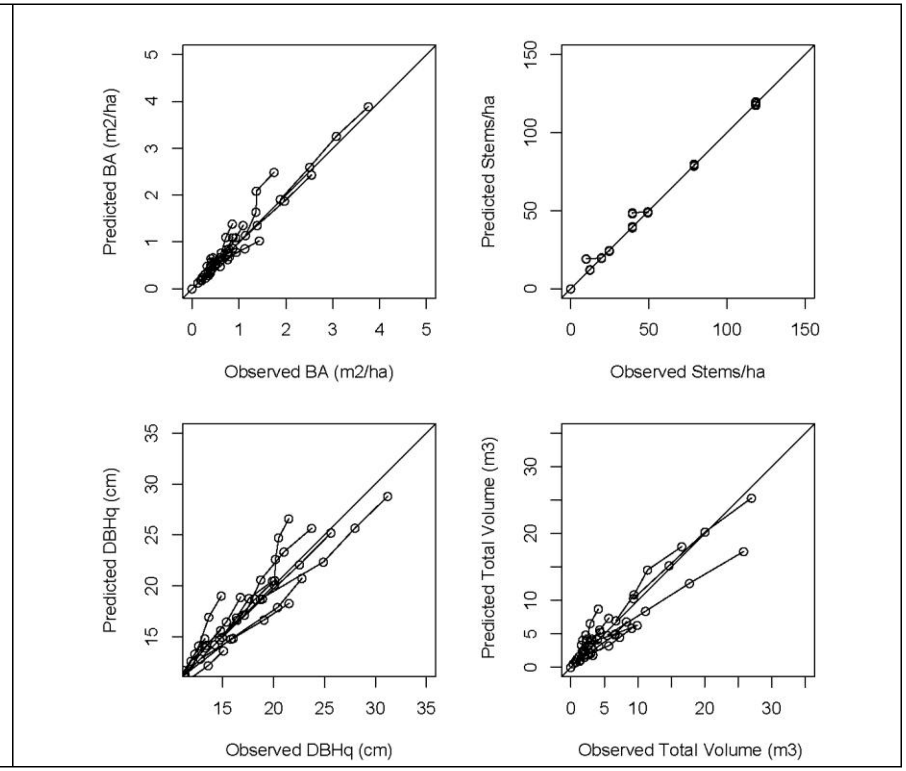

Figure 3 Comparison of subalpine fir basal area, stems/ha, DBH, and total volume between SORTIE-ND predictions and PSP observations.

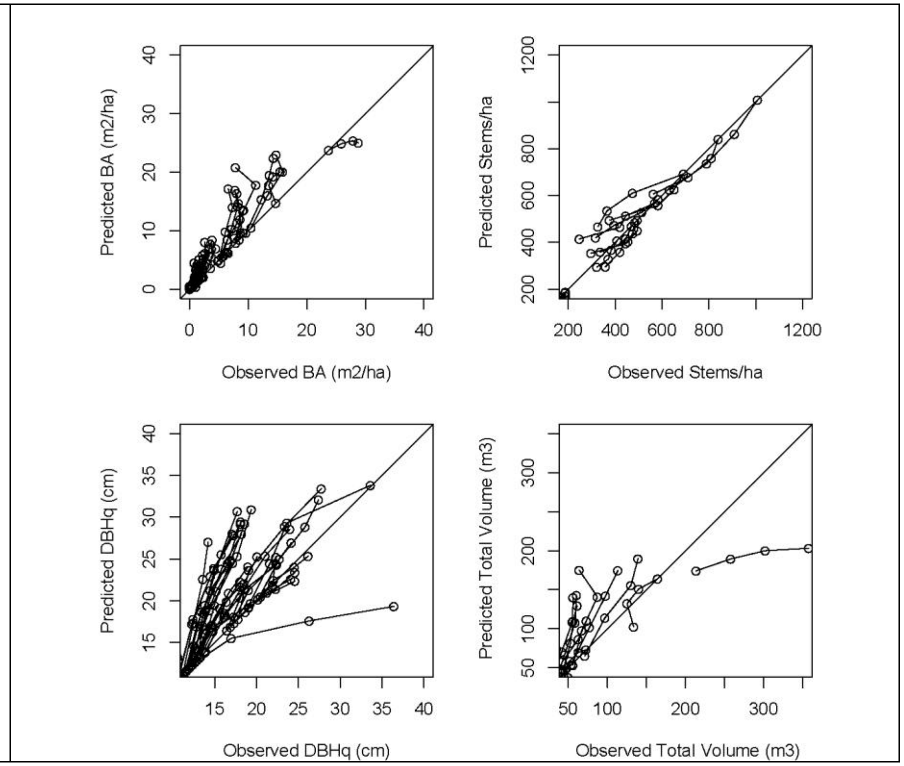

Figure 4 Comparison of interior spruce basal area, stems/ha, DBH, and total volume between SORTIE-ND predictions and PSP observations.

Figure 5 Comparison of trembling aspen basal area, stems/ha, DBH, and total volume between SORTIE-ND predictions and PSP observations.

10. Known problems

Aspen,…

11. Ongoing development for Version 2.0

12. References

Astrup, R. 2006. Reference Template gggggggggg gggggggggggggggg gggggg ggggggggggg

13. Appendix A: Parameter Estimates

13.1. Research Parameter File Version 1.0 SBS Planted Trees, No Regeneration, No Snags

Plot				
Number of Timesteps	100			
Current Timestep	0			
Random Seed	0			
Number of years per timestep	1			
Plot Length in the X (E-W) Direction, in meters	300			
Plot Length in the Y (N-S) Direction, in meters	300			
Plot Latitude, in decimal degrees	55			
Plot title	Plot			
Allometry				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Adult Height-Diameter Function	Standard	Standard	Standard	Standard
Sapling Height-Diameter Function	Standard	Standard	Standard	Standard
Seedling Height-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Sapling Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Height-Height Function	Standard	Standard	Standard	Standard
Sapling Crown Height-Height Function	Standard	Standard	Standard	Standard
Maximum Tree Height, in meters	35	23.34684	30	33.53
Slope of Asymptotic Crown Radius	0.0239	0.0303	0.0251	0.0328
Crown Radius Exponent	1	1	1	1
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Slope of Asymptotic Crown Height	0.405	0.201	0.454	0.301
Crown Height Exponent	1	1	1	1
Slope of DBH to Diameter at 10 cm Relationship	0.677076	0.77533	0.63795	0.7855
Intercept of DBH to Diameter at 10 cm Relationship	0	0	0	0
Slope of Asymptotic Height	0.029936	0.070728	0.030507	0.03746
Slope of Height-Diameter at 10 cm Relationship	0.02071	0.02468	0.01887	0.03979
Adult Linear Function Slope	0	0	0	0
Adult Linear Function Intercept	0	0	0	0
Adult Reverse Linear Function Slope	0	0	0	0
Adult Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Sapling Linear Function Slope	0	0	0	0
Sapling Linear Function Intercept	0	0	0	0
Sapling Reverse Linear Function Slope	0	0	0	0

Sapling Reverse Linear Function Intercept	0	0	0	0
Power Function "a"	0	0	0	0
Power Function Exponent "b"	0	0	0	0
Seedling Linear Function Slope	0	0	0	0
Seedling Linear Function Intercept	0	0	0	0
Seedling Reverse Linear Function Slope	0	0	0	0
Seedling Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Chapman-Richards Crown Radius Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Radius	0	0	0	0
Chapman-Richards Crown Radius Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Radius Shape 2 (c)	0	0	0	0
Chapman-Richards Crown Height Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Height	0	0	0	0
Chapman-Richards Crown Height Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Height Shape 2 (c)	0	0	0	0
Tree Population				
New Seedling Diameter at 10 cm	0.1			
Seedling Height Class 1 Upper Bound, in cm	16			
Seedling Height Class 2 Upper Bound, in cm	26			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum Adult DBH	3	5	5	5
Max Seedling Height (meters)	1.35	1.35	1.35	1.35
Initial Density (#/ha) - Seedling Height Class 1	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 2	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 3	0	0	0	0
Light				
Beam Fraction of Global Radiation	0.5			
Clear Sky Transmission Coefficient	0.65			
First Day of Growing Season	105			
Last Day of Growing Season	258			
Number of Azimuth Sky Divisions for Quadrat Light Calculations	18			
Number of Altitude Sky Divisions for Quadrat Light Calculations	12			
Minimum Solar Angle for Quadrat Light, in rad	0.785			
Height at Which GLI is Calculated for Quadrats, in meters	0.675			
Height of Fisheye Photo	Mid-crown			
Upper Age (Yrs) of Snag Light Transmission Class 1	7			
Upper Age (Yrs) of Snag Light Transmission Class 2	17			
Number of Azimuth Sky Divisions for GLI	18			

Light Calculations				
Number of Altitude Sky Divisions for GLI Light Calculations	12			
Minimum Solar Angle for GLI Light, in rad	0.785			
Sail Light Minimum Solar Angle, in degrees	30			
Sail Light Maximum Shading Neighbor Distance, in meters	15			
Calculated Crown Depth	All height			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Light Transmission Coefficient (0-1)	0.157	0.135	0.092	0.207
Snag Age Class 1 Light Transmission Coefficient (0-1)	0.446	0.376	0.423	0.695
Snag Age Class 2 Light Transmission Coefficient (0-1)	0.502	0.614	0.554	0.755
Snag Age Class 3 Light Transmission Coefficient (0-1)	0.673	0.878	0.713	0.883
Growth				
NCI DBH Divisor (q)	100			
Include Snags in NCI Calculations	FALSE			
	Lodgepole Pine	Trembling Aspen		
Logistic - Asymptotic Diam Growth - Full Light in mm/yr (a)	2.42859	3.85		
Logistic - Diam Shape Param 1 (b)	5.24117	2.7938		
Logistic - Diam Shape Param 2 (c)	0.11083	0.09018		
	Interior Spruce	Subalpine Fir		
Size Dep. Logistic - Diam Intercept (a)	1.7524	1.0738		
Size Dep. Logistic - Diam Slope (b)	0.6894	0.3825		
Size Dep. Logistic - Diam Shape Param 1 (c)	2.2544	1.3692		
Size Dep. Logistic - Diam Shape Param 2 (d)	0.06514	0.03727		
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Maximum Potential Growth, cm/yr	1.28275	1.312857	0.65276	1.0166
NCI Maximum Crowding Distance, in meters	14.166	8.782867	9.234646	14.35
NCI Alpha	1.46293	1.550891	2.521596	1.39263
NCI Beta	0.214879	0.488187	0.331455	0.203867
NCI Size Sensitivity to NCI (gamma)	0	0	0	0
NCI Crowding Effect Slope (C)	0.686994	2.195538	4.157065	0.394959
NCI Crowding Effect Steepness (D)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Medium (0-1)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Complete (0-1)	1	1	1	1
NCI Minimum Neighbor DBH, in cm	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Size Effect Mode, in cm (X0)	18.4473	10.60473	17.58768	8.51532
NCI Size Effect Variance, in cm (Xb)	1.08222	0.920013	3.206095	1.29918
NCI Shading Effect Coefficient (m)	0.538711	1.250565	0.386633	0.440771
NCI Shading Effect Exponent (n)	1	1	1	1
NCI Damage Effect - Medium Storm Damage (0-1)	1	1	1	1
NCI Damage Effect - Complete Storm Damage (0-1)	1	1	1	1

Interior Spruce NCI Lambda Neighbors	0.364451	0.690463	0.19327	0.8126
Lodgepole Pine NCI Lambda Neighbors	0.225631	0.506003	0.591955	0
Subalpine Fir NCI Lambda Neighbors	0.641792	1	1	5.06E-05
Trembling Aspen NCI Lambda Neighbors	0.3	0.5	0.358713	0.6914
Mortality				
DBH of Maximum Senescence Mortality Rate, as an integer in cm	100			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Mortality at Zero Growth	1	1	1	1
Light-Dependent Mortality	5.913	3.737	10.82	3.139
Senescence Mortality Alpha	-3.7	-3.7	-0.5	-3.7
Senescence Mortality Beta	0.12	0.12	0.15	0.1
DBH at Onset of Senescence, in cm	75	45	75	47
Adult Background Mortality Rate	5.00E-04	6.00E-04	5.00E-04	0.009
Juvenile Background Mortality Rate	0.0025	0.0025	0.001	0.0025
Competition Mortality Shape Parameter (Z)	3.00E-06	5.00E-04	3.00E-06	4.33E-06
Competition Mortality Maximum Parameter (max)	0.2	0.08	0.17	0.25
	Trembling Aspen			
Density Self-Thinning Asymptote (A)	0.1019			
Density Self-Thinning Density Effect (S)	8.78E-06			
Density Self-Thinning Diameter Effect (C)	0.5391			
Density Self-Thinning Minimum Density for Mortality (#/ha)	3000			
Density Self-Thinning Neighborhood Radius, in m	5			
Analysis				
Minimum Trunk Diameter for Volume Calculations, in cm	0			
Trunk Segment Length for Volume Calculations, in m	0.05			
Height to Begin Calculating Trunk Volume, in cm	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Taper Equation Initial Multiplier (a0)	0.843142	0.954651	0.958944	0.774001
Taper Equation DBH Exponent (a1)	1.00813	1.03911	0.99884	0.977164
Taper Equation Height Exponent (a2)	0.031402	-0.04035	0	0.078353
Taper Equation X Exponent 1 (b1)	0.319773	0.335144	0.33836	0.562123
Taper Equation X Exponent 2 (b2)	-0.62001	-0.6258	-0.6731	-0.40694
Taper Equation X Exponent 3 (b3)	0.607053	0.527018	0.646087	0.429284
Taper Equation X Exponent 4 (b4)	1.40353	1.07627	1.313	0.932614
Taper Equation X Exponent 5 (b5)	0.067863	0.050757	0.054767	0.036028
Taper Equation X Exponent 6 (b6)	-0.43892	-0.29784	-0.51971	-0.16949
Diameter-Outside-Bark Constant (a1)	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Diameter-Outside-Bark First Degree Parameter (a2)	1	1	1	1
Diameter-Outside-Bark Second Degree Parameter (a3)	0	0	0	0

13.2. Research Parameter File Version 1.0 SBS Planted Trees, Regeneration and Snags

Plot				
Number of Timesteps	100			
Current Timestep	0			
Random Seed	0			
Number of years per timestep	1			
Plot Length in the X (E-W) Direction, in meters	300			
Plot Length in the Y (N-S) Direction, in meters	300			
Plot Latitude, in decimal degrees	55			
Plot title	Plot			
Allometry				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Adult Height-Diameter Function	Standard	Standard	Standard	Standard
Sapling Height-Diameter Function	Standard	Standard	Standard	Standard
Seedling Height-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Sapling Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Height-Height Function	Standard	Standard	Standard	Standard
Sapling Crown Height-Height Function	Standard	Standard	Standard	Standard
Maximum Tree Height, in meters	35	23.34684	30	33.53
Slope of Asymptotic Crown Radius	0.0239	0.0303	0.0251	0.0328
Crown Radius Exponent	1	1	1	1
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Slope of Asymptotic Crown Height	0.405	0.201	0.454	0.301
Crown Height Exponent	1	1	1	1
Slope of DBH to Diameter at 10 cm Relationship	0.677076	0.77533	0.63795	0.7855
Intercept of DBH to Diameter at 10 cm Relationship	0	0	0	0
Slope of Asymptotic Height	0.029936	0.070728	0.030507	0.03746
Slope of Height-Diameter at 10 cm Relationship	0.02071	0.02468	0.01887	0.03979
Adult Linear Function Slope	0	0	0	0
Adult Linear Function Intercept	0	0	0	0
Adult Reverse Linear Function Slope	0	0	0	0
Adult Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Sapling Linear Function Slope	0	0	0	0
Sapling Linear Function Intercept	0	0	0	0
Sapling Reverse Linear Function Slope	0	0	0	0
Sapling Reverse Linear Function Intercept	0	0	0	0
Power Function "a"	0	0	0	0
Power Function Exponent "b"	0	0	0	0
Seedling Linear Function Slope	0	0	0	0
Seedling Linear Function Intercept	0	0	0	0
Seedling Reverse Linear Function Slope	0	0	0	0
Seedling Reverse Linear Function	0	0	0	0

Intercept				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Chapman-Richards Crown Radius Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Radius	0	0	0	0
Chapman-Richards Crown Radius Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Radius Shape 2 (c)	0	0	0	0
Chapman-Richards Crown Height Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Height	0	0	0	0
Chapman-Richards Crown Height Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Height Shape 2 (c)	0	0	0	0
Tree Population				
New Seedling Diameter at 10 cm	0.1			
Seedling Height Class 1 Upper Bound, in cm	16			
Seedling Height Class 2 Upper Bound, in cm	26			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum Adult DBH	3	5	5	5
Max Seedling Height (meters)	1.35	1.35	1.35	1.35
Initial Density (#/ha) - Seedling Height Class 1	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 2	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 3	0	0	0	0
Light				
Beam Fraction of Global Radiation	0.5			
Clear Sky Transmission Coefficient	0.65			
First Day of Growing Season	105			
Last Day of Growing Season	258			
Number of Azimuth Sky Divisions for Quadrat Light Calculations	18			
Number of Altitude Sky Divisions for Quadrat Light Calculations	12			
Minimum Solar Angle for Quadrat Light, in rad	0.785			
Height at Which GLI is Calculated for Quadrats, in meters	0.675			
Height of Fisheye Photo	Mid-crown			
Upper Age (Yrs) of Snag Light Transmission Class 1	7			
Upper Age (Yrs) of Snag Light Transmission Class 2	17			
Number of Azimuth Sky Divisions for GLI Light Calculations	18			
Number of Altitude Sky Divisions for GLI Light Calculations	12			
Minimum Solar Angle for GLI Light, in rad	0.785			
Sail Light Minimum Solar Angle, in degrees	30			
Sail Light Maximum Shading Neighbor Distance, in meters	15			

Calculated Crown Depth	All height			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Light Transmission Coefficient (0-1)	0.157	0.135	0.092	0.207
Snag Age Class 1 Light Transmission Coefficient (0-1)	0.446	0.376	0.423	0.695
Snag Age Class 2 Light Transmission Coefficient (0-1)	0.502	0.614	0.554	0.755
Snag Age Class 3 Light Transmission Coefficient (0-1)	0.673	0.878	0.713	0.883
Growth				
NCI DBH Divisor (q)	100			
Include Snags in NCI Calculations	FALSE			
	Lodgepole Pine	Trembling Aspen		
Logistic - Asymptotic Diam Growth - Full Light in mm/yr (a)	2.42859	3.85		
Logistic - Diam Shape Param 1 (b)	5.14117	2.7938		
Logistic - Diam Shape Param 2 (c)	0.11083	0.09018		
	Interior Spruce	Subalpine Fir		
Size Dep. Logistic - Diam Intercept (a)	1.7524	1.0738		
Size Dep. Logistic - Diam Slope (b)	0.6894	0.3825		
Size Dep. Logistic - Diam Shape Param 1 (c)	2.2544	1.3692		
Size Dep. Logistic - Diam Shape Param 2 (d)	0.06514	0.03727		
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Maximum Potential Growth, cm/yr	1.28275	1.312857	0.65276	1.0166
NCI Maximum Crowding Distance, in meters	14.166	8.782867	9.234646	14.35
NCI Alpha	1.46293	1.550891	2.521596	1.39263
NCI Beta	0.214879	0.488187	0.331455	0.203867
NCI Size Sensitivity to NCI (gamma)	0	0	0	0
NCI Crowding Effect Slope (C)	0.686994	2.195538	4.157065	0.394959
NCI Crowding Effect Steepness (D)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Medium (0-1)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Complete (0-1)	1	1	1	1
NCI Minimum Neighbor DBH, in cm	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Size Effect Mode, in cm (X0)	18.4473	10.60473	17.58768	8.51532
NCI Size Effect Variance, in cm (Xb)	1.08222	0.920013	3.206095	1.29918
NCI Shading Effect Coefficient (m)	0.538711	1.250565	0.386633	0.440771
NCI Shading Effect Exponent (n)	1	1	1	1
NCI Damage Effect - Medium Storm Damage (0-1)	1	1	1	1
NCI Damage Effect - Complete Storm Damage (0-1)	1	1	1	1
Interior Spruce NCI Lambda Neighbors	0.364451	0.690463	0.19327	0.8126
Lodgepole Pine NCI Lambda Neighbors	0.225631	0.506003	0.591955	0
Subalpine Fir NCI Lambda Neighbors	0.641792	1	1	5.06E-05
Trembling Aspen NCI Lambda Neighbors	0.3	0.5	0.358713	0.6914
Mortality				
DBH of Maximum Senescence Mortality	100			

Rate, as an integer in cm

	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Mortality at Zero Growth	1	1	1	1
Light-Dependent Mortality	5.913	3.737	10.82	3.139
Senescence Mortality Alpha	-3.7	-3.7	-0.5	-3.7
Senescence Mortality Beta	0.12	0.12	0.15	0.1
DBH at Onset of Senescence, in cm	75	45	75	47
Adult Background Mortality Rate	5.00E-04	6.00E-04	5.00E-04	0.009
Juvenile Background Mortality Rate	0.0025	0.0025	0.001	0.0025
Weibull Annual "a" Parameter for Snag Size Class 1 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 2 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 3 Mortality	0.05	0.05	0.05	0.05
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Annual "b" Parameter for Snag Size Class 1 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 2 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 3 Mortality	2.5	2.5	2.5	2.5
Weibull Upper DBH of Snag Size Class 1	8	8	8	8
Weibull Upper DBH of Snag Size Class 2	20	20	20	20
Competition Mortality Shape Parameter (Z)	3.00E-06	5.00E-04	3.00E-06	4.33E-06
Competition Mortality Maximum Parameter (max)	0.2	0.08	0.17	0.25

	Trembling Aspen
Density Self-Thinning Asymptote (A)	0.1019
Density Self-Thinning Density Effect (S)	8.78E-06
Density Self-Thinning Diameter Effect (C)	0.5391
Density Self-Thinning Minimum Density for Mortality (#/ha)	3000
Density Self-Thinning Neighborhood Radius, in m	5

Substrate	
Maximum Number of Years that Decay Occurs	15
Scarified Soil Annual Decay Alpha	-5.00E-07
Scarified Soil Annual Decay Beta	4.36
Tip-Up Mounds Annual Decay Alpha	-6.00E-07
Tip-Up Mounds Annual Decay Beta	4.34
Fresh Log Annual Decay Alpha	-2.00E-06
Fresh Log Annual Decay Beta	6.4
Decayed Log Annual Decay Alpha	-0.79851
Decayed Log Annual Decay Beta	1
Proportion of Forest Floor Litter/Moss Pool that is Moss	0
Uprooted Tree Radius Increase Factor for Root Rip-Out	3.1
Use Directional Tree Fall	TRUE
Initial Conditions Proportion of Scarified Soil	0
Initial Conditions Proportion of Tip-Up Mounds	0

Initial Conditions Proportion of Fresh Logs	0			
Initial Conditions Proportion of Decayed Logs	0.01			
Partial Cut Proportion of Scarified Soil	0.11			
Partial Cut Proportion of Tip-Up Mounds	0.17			
Partial Cut Proportion of Fresh Logs	0.15			
Partial Cut Proportion of Decayed Logs	0.06			
Gap Cut Proportion of Scarified Soil	0.04			
Gap Cut Proportion of Tip-Up Mounds	0.45			
Gap Cut Proportion of Fresh Logs	0.34			
Gap Cut Proportion of Decayed Logs	0.09			
Clear Cut Proportion of Scarified Soil	0			
Clear Cut Proportion of Tip-Up Mounds	0.36			
Clear Cut Proportion of Fresh Logs	0.34			
Clear Cut Proportion of Decayed Logs	0.17			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Proportion of Dead that Fall	0.1	0.1	0.1	0.1
Proportion of Fallen that Uproot	0.5	0.5	0.5	0.5
Proportion of Snags that Uproot	0.1	0.1	0.1	0.1
Disperse				
Seed Distribution	Deterministic			
Maximum Parent Trees Allowed in Gap Cell	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum DBH for Reproduction, in cm	15	15	15	15
Slope Mean Non-Spatial Seed Rain, seeds/m2/ha of BA/yr	0	0	0	0
Intercept of Mean Non-Spatial Seed Rain, seeds/m2/yr	0.005	0.005	0.005	0.005
Seed Dist. Std. Deviation (Normal or Lognormal)	0	0	0	0
Seed Dist. Clumping Parameter (Neg. Binomial)	0	0	0	0
Canopy Function Used	Weibull	Weibull	Weibull	Weibull
Gap Function Used	Weibull	Weibull	Weibull	Weibull
Weibull Canopy Annual STR	0.68824	0.12228	0.09768	0.2
Weibull Canopy Beta	2	2	2	2
Weibull Canopy Theta	3	3	3	3
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Canopy Dispersal	3.00E-05	2.80E-04	1.32E-04	3.80E-05
Weibull Gap Annual STR	0.47656	0.12228	0.09768	1.19088
Weibull Gap Beta	2	2	2	2
Weibull Gap Theta	3	3	3	3
Weibull Gap Dispersal	6.93E-06	2.80E-04	1.32E-04	3.80E-05
Lognormal Canopy Annual STR	0	0	0	0
Lognormal Canopy Beta	0	0	0	0
Lognormal Canopy Xb	0	0	0	0
Lognormal Canopy X0	0	0	0	0
Lognormal Gap Annual STR	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Lognormal Gap Beta	0	0	0	0

Lognormal Gap Xb	0	0	0	0
Lognormal Gap X0	0	0	0	0
STR for Stumps	0	0	0	2000
Beta for Stumps	0	0	0	2
Establishment				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Canopy Fresh Logs	0.071	0.566	0.028	0.017
Fraction Seeds Germinating on Canopy Decayed Logs	0.0542	0.008	0.55	0.18
Fraction Seeds Germinating on Canopy Tip-Up	0.778	0.155	0.278	0.013
Fraction Seeds Germinating on Canopy Scarified Soil	0.391	0.462	0.017	0.781
Fraction Seeds Germinating on Canopy Forest Floor Litter	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Canopy Forest Floor Moss	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Fresh Logs	0.042	0.566	0.028	0.017
Fraction Seeds Germinating on Gap Decayed Logs	0.307	0.008	0.55	0.18
Fraction Seeds Germinating on Gap Tip-Up	0.574	0.155	0.278	0.013
Fraction Seeds Germinating on Gap Scarified Soil	0.589	0.462	0.017	0.781
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Gap Forest Floor Litter	0.123	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Forest Floor Moss	0.123	0.004	0.019	0.01
Analysis				
Minimum Trunk Diameter for Volume Calculations, in cm	0			
Trunk Segment Length for Volume Calculations, in m	0.05			
Height to Begin Calculating Trunk Volume, in cm	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Taper Equation Initial Multiplier (a0)	0.843142	0.954651	0.958944	0.774001
Taper Equation DBH Exponent (a1)	1.00813	1.03911	0.99884	0.977164
Taper Equation Height Exponent (a2)	0.031402	-0.04035	0	0.078353
Taper Equation X Exponent 1 (b1)	0.319773	0.335144	0.33836	0.562123
Taper Equation X Exponent 2 (b2)	-0.62001	-0.6258	-0.6731	-0.40694
Taper Equation X Exponent 3 (b3)	0.607053	0.527018	0.646087	0.429284
Taper Equation X Exponent 4 (b4)	1.40353	1.07627	1.313	0.932614
Taper Equation X Exponent 5 (b5)	0.067863	0.050757	0.054767	0.036028
Taper Equation X Exponent 6 (b6)	-0.43892	-0.29784	-0.51971	-0.16949
Diameter-Outside-Bark Constant (a1)	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Diameter-Outside-Bark First Degree Parameter (a2)	1	1	1	1
Diameter-Outside-Bark Second Degree Parameter (a3)	0	0	0	0

13.3. Research Parameter File Version 1.0 SBS Natural Regeneration, Regeneration and Snags

Plot				
Number of Timesteps	100			
Current Timestep	0			
Random Seed	0			
Number of years per timestep	1			
Plot Length in the X (E-W) Direction, in meters	300			
Plot Length in the Y (N-S) Direction, in meters	300			
Plot Latitude, in decimal degrees	55			
Plot title	Plot			
Allometry				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Adult Height-Diameter Function	Standard	Standard	Standard	Standard
Sapling Height-Diameter Function	Standard	Standard	Standard	Standard
Seedling Height-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Sapling Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Height-Height Function	Standard	Standard	Standard	Standard
Sapling Crown Height-Height Function	Standard	Standard	Standard	Standard
Maximum Tree Height, in meters	35	23.34684	30	33.53
Slope of Asymptotic Crown Radius	0.0239	0.0303	0.0251	0.0328
Crown Radius Exponent	1	1	1	1
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Slope of Asymptotic Crown Height	0.405	0.201	0.454	0.301
Crown Height Exponent	1	1	1	1
Slope of DBH to Diameter at 10 cm Relationship	0.677076	0.77533	0.63795	0.7855
Intercept of DBH to Diameter at 10 cm Relationship	0	0	0	0
Slope of Asymptotic Height	0.029936	0.070728	0.030507	0.03746
Slope of Height-Diameter at 10 cm Relationship	0.02071	0.02468	0.01887	0.03979
Adult Linear Function Slope	0	0	0	0
Adult Linear Function Intercept	0	0	0	0
Adult Reverse Linear Function Slope	0	0	0	0
Adult Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Sapling Linear Function Slope	0	0	0	0
Sapling Linear Function Intercept	0	0	0	0
Sapling Reverse Linear Function Slope	0	0	0	0
Sapling Reverse Linear Function Intercept	0	0	0	0
Power Function "a"	0	0	0	0
Power Function Exponent "b"	0	0	0	0
Seedling Linear Function Slope	0	0	0	0
Seedling Linear Function Intercept	0	0	0	0
Seedling Reverse Linear Function Slope	0	0	0	0
Seedling Reverse Linear Function	0	0	0	0

Intercept				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Chapman-Richards Crown Radius Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Radius	0	0	0	0
Chapman-Richards Crown Radius Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Radius Shape 2 (c)	0	0	0	0
Chapman-Richards Crown Height Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Height	0	0	0	0
Chapman-Richards Crown Height Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Height Shape 2 (c)	0	0	0	0
Tree Population				
New Seedling Diameter at 10 cm	0.1			
Seedling Height Class 1 Upper Bound, in cm	16			
Seedling Height Class 2 Upper Bound, in cm	26			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum Adult DBH	3	5	5	5
Max Seedling Height (meters)	1.35	1.35	1.35	1.35
Initial Density (#/ha) - Seedling Height Class 1	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 2	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 3	0	0	0	0
Light				
Beam Fraction of Global Radiation	0.5			
Clear Sky Transmission Coefficient	0.65			
First Day of Growing Season	105			
Last Day of Growing Season	258			
Number of Azimuth Sky Divisions for Quadrat Light Calculations	18			
Number of Altitude Sky Divisions for Quadrat Light Calculations	12			
Minimum Solar Angle for Quadrat Light, in rad	0.785			
Height at Which GLI is Calculated for Quadrats, in meters	0.675			
Height of Fisheye Photo	Mid-crown			
Upper Age (Yrs) of Snag Light Transmission Class 1	7			
Upper Age (Yrs) of Snag Light Transmission Class 2	17			
Number of Azimuth Sky Divisions for GLI Light Calculations	18			
Number of Altitude Sky Divisions for GLI Light Calculations	12			
Minimum Solar Angle for GLI Light, in rad	0.785			
Sail Light Minimum Solar Angle, in degrees	30			
Sail Light Maximum Shading Neighbor Distance, in meters	15			

Calculated Crown Depth	All height			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Light Transmission Coefficient (0-1)	0.157	0.135	0.092	0.207
Snag Age Class 1 Light Transmission Coefficient (0-1)	0.446	0.376	0.423	0.695
Snag Age Class 2 Light Transmission Coefficient (0-1)	0.502	0.614	0.554	0.755
Snag Age Class 3 Light Transmission Coefficient (0-1)	0.673	0.878	0.713	0.883
Growth				
NCI DBH Divisor (q)	100			
Include Snags in NCI Calculations	FALSE			
	Lodgepole Pine	Trembling Aspen		
Logistic - Asymptotic Diam Growth - Full Light in mm/yr (a)	2.42859	3.85		
Logistic - Diam Shape Param 1 (b)	5.24117	2.7938		
Logistic - Diam Shape Param 2 (c)	0.11083	0.09018		
	Interior Spruce	Subalpine Fir		
Size Dep. Logistic - Diam Intercept (a)	1.7524	1.0738		
Size Dep. Logistic - Diam Slope (b)	0.6894	0.3825		
Size Dep. Logistic - Diam Shape Param 1 (c)	2.2544	1.3692		
Size Dep. Logistic - Diam Shape Param 2 (d)	0.06514	0.03727		
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Maximum Potential Growth, cm/yr	1.28275	1.312857	0.65276	1.0166
NCI Maximum Crowding Distance, in meters	14.166	8.782867	9.234646	14.35
NCI Alpha	1.46293	1.550891	2.521596	1.39263
NCI Beta	0.214879	0.488187	0.331455	0.203867
NCI Size Sensitivity to NCI (gamma)	0	0	0	0
NCI Crowding Effect Slope (C)	0.686994	2.195538	4.157065	0.394959
NCI Crowding Effect Steepness (D)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Medium (0-1)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Complete (0-1)	1	1	1	1
NCI Minimum Neighbor DBH, in cm	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Size Effect Mode, in cm (X0)	18.4473	10.60473	17.58768	8.51532
NCI Size Effect Variance, in cm (Xb)	1.08222	0.920013	3.206095	1.29918
NCI Shading Effect Coefficient (m)	0.538711	1.250565	0.386633	0.440771
NCI Shading Effect Exponent (n)	1	1	1	1
NCI Damage Effect - Medium Storm Damage (0-1)	1	1	1	1
NCI Damage Effect - Complete Storm Damage (0-1)	1	1	1	1
Interior Spruce NCI Lambda Neighbors	0.364451	0.690463	0.19327	0.8126
Lodgepole Pine NCI Lambda Neighbors	0.225631	0.506003	0.591955	0
Subalpine Fir NCI Lambda Neighbors	0.641792	1	1	5.06E-05
Trembling Aspen NCI Lambda Neighbors	0.3	0.5	0.358713	0.6914
Mortality				
DBH of Maximum Senescence Mortality Rate, as an integer in cm	100			

	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Mortality at Zero Growth	1	1	1	1
Light-Dependent Mortality	5.913	3.737	10.82	3.139
Senescence Mortality Alpha	-3.7	-3.7	-0.5	-3.7
Senescence Mortality Beta	0.12	0.12	0.15	0.1
DBH at Onset of Senescence, in cm	75	45	75	47
Adult Background Mortality Rate	5.00E-04	6.00E-04	5.00E-04	0.009
Juvenile Background Mortality Rate	0.01	0.01	0.01	0.01
Weibull Annual "a" Parameter for Snag Size Class 1 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 2 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 3 Mortality	0.05	0.05	0.05	0.05
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Annual "b" Parameter for Snag Size Class 1 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 2 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 3 Mortality	2.5	2.5	2.5	2.5
Weibull Upper DBH of Snag Size Class 1	8	8	8	8
Weibull Upper DBH of Snag Size Class 2	20	20	20	20
Competition Mortality Shape Parameter (Z)	3.00E-06	5.00E-04	3.00E-06	4.33E-06
Competition Mortality Maximum Parameter (max)	0.2	0.08	0.17	0.25
	Trembling Aspen			
Density Self-Thinning Asymptote (A)	0.1019			
Density Self-Thinning Density Effect (S)	8.78E-06			
Density Self-Thinning Diameter Effect (C)	0.5391			
Density Self-Thinning Minimum Density for Mortality (#/ha)	3000			
Density Self-Thinning Neighborhood Radius, in m	5			
Substrate				
Maximum Number of Years that Decay Occurs	15			
Scarified Soil Annual Decay Alpha	-5.00E-07			
Scarified Soil Annual Decay Beta	4.36			
Tip-Up Mounds Annual Decay Alpha	-6.00E-07			
Tip-Up Mounds Annual Decay Beta	4.34			
Fresh Log Annual Decay Alpha	-2.00E-06			
Fresh Log Annual Decay Beta	6.4			
Decayed Log Annual Decay Alpha	-0.79851			
Decayed Log Annual Decay Beta	1			
Proportion of Forest Floor Litter/Moss Pool that is Moss	0			
Uprooted Tree Radius Increase Factor for Root Rip-Out	3.1			
Use Directional Tree Fall	TRUE			
Initial Conditions Proportion of Scarified Soil	0			
Initial Conditions Proportion of Tip-Up Mounds	0			
Initial Conditions Proportion of Fresh Logs	0			

Initial Conditions Proportion of Decayed Logs	0.01			
Partial Cut Proportion of Scarified Soil	0.11			
Partial Cut Proportion of Tip-Up Mounds	0.17			
Partial Cut Proportion of Fresh Logs	0.15			
Partial Cut Proportion of Decayed Logs	0.06			
Gap Cut Proportion of Scarified Soil	0.04			
Gap Cut Proportion of Tip-Up Mounds	0.45			
Gap Cut Proportion of Fresh Logs	0.34			
Gap Cut Proportion of Decayed Logs	0.09			
Clear Cut Proportion of Scarified Soil	0			
Clear Cut Proportion of Tip-Up Mounds	0.36			
Clear Cut Proportion of Fresh Logs	0.34			
Clear Cut Proportion of Decayed Logs	0.17			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Proportion of Dead that Fall	0.1	0.1	0.1	0.1
Proportion of Fallen that Uproot	0.5	0.5	0.5	0.5
Proportion of Snags that Uproot	0.1	0.1	0.1	0.1
Disperse				
Seed Distribution	Deterministic			
Maximum Parent Trees Allowed in Gap Cell	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum DBH for Reproduction, in cm	15	15	15	15
Slope Mean Non-Spatial Seed Rain, seeds/m2/ha of BA/yr	0	0	0	0
Intercept of Mean Non-Spatial Seed Rain, seeds/m2/yr	0.005	0.005	0.005	0.005
Seed Dist. Std. Deviation (Normal or Lognormal)	0	0	0	0
Seed Dist. Clumping Parameter (Neg. Binomial)	0	0	0	0
Canopy Function Used	Weibull	Weibull	Weibull	Weibull
Gap Function Used	Weibull	Weibull	Weibull	Weibull
Weibull Canopy Annual STR	0.68824	0.12228	0.09768	0.2
Weibull Canopy Beta	2	2	2	2
Weibull Canopy Theta	3	3	3	3
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Canopy Dispersal	3.00E-05	2.80E-04	1.32E-04	3.80E-05
Weibull Gap Annual STR	0.47656	0.12228	0.09768	1.19088
Weibull Gap Beta	2	2	2	2
Weibull Gap Theta	3	3	3	3
Weibull Gap Dispersal	6.93E-06	2.80E-04	1.32E-04	3.80E-05
Lognormal Canopy Annual STR	0	0	0	0
Lognormal Canopy Beta	0	0	0	0
Lognormal Canopy Xb	0	0	0	0
Lognormal Canopy X0	0	0	0	0
Lognormal Gap Annual STR	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Lognormal Gap Beta	0	0	0	0
Lognormal Gap Xb	0	0	0	0

Lognormal Gap X0	0	0	0	0
STR for Stumps	0	0	0	2000
Beta for Stumps	0	0	0	2
Establishment				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Canopy Fresh Logs	0.071	0.566	0.028	0.017
Fraction Seeds Germinating on Canopy Decayed Logs	0.0542	0.008	0.55	0.18
Fraction Seeds Germinating on Canopy Tip-Up	0.778	0.155	0.278	0.013
Fraction Seeds Germinating on Canopy Scarified Soil	0.391	0.462	0.017	0.781
Fraction Seeds Germinating on Canopy Forest Floor Litter	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Canopy Forest Floor Moss	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Fresh Logs	0.042	0.566	0.028	0.017
Fraction Seeds Germinating on Gap Decayed Logs	0.307	0.008	0.55	0.18
Fraction Seeds Germinating on Gap Tip-Up	0.574	0.155	0.278	0.013
Fraction Seeds Germinating on Gap Scarified Soil	0.589	0.462	0.017	0.781
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Gap Forest Floor Litter	0.123	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Forest Floor Moss	0.123	0.004	0.019	0.01
Analysis				
Minimum Trunk Diameter for Volume Calculations, in cm	0			
Trunk Segment Length for Volume Calculations, in m	0.05			
Height to Begin Calculating Trunk Volume, in cm	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Taper Equation Initial Multiplier (a0)	0.843142	0.954651	0.958944	0.774001
Taper Equation DBH Exponent (a1)	1.00813	1.03911	0.99884	0.977164
Taper Equation Height Exponent (a2)	0.031402	-0.04035	0	0.078353
Taper Equation X Exponent 1 (b1)	0.319773	0.335144	0.33836	0.562123
Taper Equation X Exponent 2 (b2)	-0.62001	-0.6258	-0.6731	-0.40694
Taper Equation X Exponent 3 (b3)	0.607053	0.527018	0.646087	0.429284
Taper Equation X Exponent 4 (b4)	1.40353	1.07627	1.313	0.932614
Taper Equation X Exponent 5 (b5)	0.067863	0.050757	0.054767	0.036028
Taper Equation X Exponent 6 (b6)	-0.43892	-0.29784	-0.51971	-0.16949
Diameter-Outside-Bark Constant (a1)	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Diameter-Outside-Bark First Degree Parameter (a2)	1	1	1	1
Diameter-Outside-Bark Second Degree Parameter (a3)	0	0	0	0

13.4. Research Parameter File Version 1.0 SBS MPB Natural Regeneration, Regeneration and Snags

Plot				
Number of Timesteps	100			
Current Timestep	0			
Random Seed	0			
Number of years per timestep	1			
Plot Length in the X (E-W) Direction, in meters	300			
Plot Length in the Y (N-S) Direction, in meters	300			
Plot Latitude, in decimal degrees	55			
Plot title	Plot			
Allometry				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Adult Height-Diameter Function	Standard	Standard	Standard	Standard
Sapling Height-Diameter Function	Standard	Standard	Standard	Standard
Seedling Height-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Sapling Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Height-Height Function	Standard	Standard	Standard	Standard
Sapling Crown Height-Height Function	Standard	Standard	Standard	Standard
Maximum Tree Height, in meters	35	23.34684	30	33.53
Slope of Asymptotic Crown Radius	0.0239	0.0303	0.0251	0.0328
Crown Radius Exponent	1	1	1	1
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Slope of Asymptotic Crown Height	0.405	0.201	0.454	0.301
Crown Height Exponent	1	1	1	1
Slope of DBH to Diameter at 10 cm Relationship	0.677076	0.77533	0.63795	0.7855
Intercept of DBH to Diameter at 10 cm Relationship	0	0	0	0
Slope of Asymptotic Height	0.029936	0.070728	0.030507	0.03746
Slope of Height-Diameter at 10 cm Relationship	0.02071	0.02468	0.01887	0.03979
Adult Linear Function Slope	0	0	0	0
Adult Linear Function Intercept	0	0	0	0
Adult Reverse Linear Function Slope	0	0	0	0
Adult Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Sapling Linear Function Slope	0	0	0	0
Sapling Linear Function Intercept	0	0	0	0
Sapling Reverse Linear Function Slope	0	0	0	0
Sapling Reverse Linear Function Intercept	0	0	0	0
Power Function "a"	0	0	0	0
Power Function Exponent "b"	0	0	0	0
Seedling Linear Function Slope	0	0	0	0
Seedling Linear Function Intercept	0	0	0	0
Seedling Reverse Linear Function Slope	0	0	0	0
Seedling Reverse Linear Function	0	0	0	0

Intercept

	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Chapman-Richards Crown Radius Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Radius	0	0	0	0
Chapman-Richards Crown Radius Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Radius Shape 2 (c)	0	0	0	0
Chapman-Richards Crown Height Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Height	0	0	0	0
Chapman-Richards Crown Height Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Height Shape 2 (c)	0	0	0	0
Tree Population				
New Seedling Diameter at 10 cm	0.1			
Seedling Height Class 1 Upper Bound, in cm	16			
Seedling Height Class 2 Upper Bound, in cm	26			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum Adult DBH	3	5	5	5
Max Seedling Height (meters)	1.35	1.35	1.35	1.35
Initial Density (#/ha) - Seedling Height Class 1	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 2	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 3	0	0	0	0
Light				
Beam Fraction of Global Radiation	0.5			
Clear Sky Transmission Coefficient	0.65			
First Day of Growing Season	105			
Last Day of Growing Season	258			
Number of Azimuth Sky Divisions for Quadrat Light Calculations	18			
Number of Altitude Sky Divisions for Quadrat Light Calculations	12			
Minimum Solar Angle for Quadrat Light, in rad	0.785			
Height at Which GLI is Calculated for Quadrats, in meters	0.675			
Height of Fisheye Photo	Mid-crown			
Upper Age (Yrs) of Snag Light Transmission Class 1	7			
Upper Age (Yrs) of Snag Light Transmission Class 2	17			
Number of Azimuth Sky Divisions for GLI Light Calculations	18			
Number of Altitude Sky Divisions for GLI Light Calculations	12			
Minimum Solar Angle for GLI Light, in rad	0.785			
Sail Light Minimum Solar Angle, in degrees	30			
Sail Light Maximum Shading Neighbor Distance, in meters	15			

Calculated Crown Depth	All height			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Light Transmission Coefficient (0-1)	0.157	0.135	0.092	0.207
Snag Age Class 1 Light Transmission Coefficient (0-1)	0.446	0.376	0.423	0.695
Snag Age Class 2 Light Transmission Coefficient (0-1)	0.502	0.614	0.554	0.755
Snag Age Class 3 Light Transmission Coefficient (0-1)	0.673	0.878	0.713	0.883
Growth				
NCI DBH Divisor (q)	100			
Include Snags in NCI Calculations	FALSE			
	Lodgepole Pine	Trembling Aspen		
Logistic - Asymptotic Diam Growth - Full Light in mm/yr (a)	2.42859	3.85		
Logistic - Diam Shape Param 1 (b)	5.24117	2.7938		
Logistic - Diam Shape Param 2 (c)	0.11083	0.09018		
	Interior Spruce	Subalpine Fir		
Size Dep. Logistic - Diam Intercept (a)	1.7524	1.0738		
Size Dep. Logistic - Diam Slope (b)	0.6894	0.3825		
Size Dep. Logistic - Diam Shape Param 1 (c)	2.2544	1.3692		
Size Dep. Logistic - Diam Shape Param 2 (d)	0.06514	0.03727		
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Maximum Potential Growth, cm/yr	1.28275	1.312857	0.65276	1.0166
NCI Maximum Crowding Distance, in meters	14.166	8.782867	9.234646	14.35
NCI Alpha	1.46293	1.550891	2.521596	1.39263
NCI Beta	0.214879	0.488187	0.331455	0.203867
NCI Size Sensitivity to NCI (gamma)	0	0	0	0
NCI Crowding Effect Slope (C)	0.686994	2.195538	4.157065	0.394959
NCI Crowding Effect Steepness (D)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Medium (0-1)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Complete (0-1)	1	1	1	1
NCI Minimum Neighbor DBH, in cm	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Size Effect Mode, in cm (X0)	18.4473	10.60473	17.58768	8.51532
NCI Size Effect Variance, in cm (Xb)	1.08222	0.920013	3.206095	1.29918
NCI Shading Effect Coefficient (m)	0.538711	1.250565	0.386633	0.440771
NCI Shading Effect Exponent (n)	1	1	1	1
NCI Damage Effect - Medium Storm Damage (0-1)	1	1	1	1
NCI Damage Effect - Complete Storm Damage (0-1)	1	1	1	1
Interior Spruce NCI Lambda Neighbors	0.364451	0.690463	0.19327	0.8126
Lodgepole Pine NCI Lambda Neighbors	0.225631	0.506003	0.591955	0
Subalpine Fir NCI Lambda Neighbors	0.641792	1	1	5.06E-05
Trembling Aspen NCI Lambda Neighbors	0.3	0.5	0.358713	0.6914
Mortality				
DBH of Maximum Senescence Mortality Rate, as an integer in cm	100			

	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Mortality at Zero Growth	1	1	1	1
Light-Dependent Mortality	5.913	3.737	10.82	3.139
Senescence Mortality Alpha	-3.7	-3.7	-0.5	-3.7
Senescence Mortality Beta	0.12	0.12	0.15	0.1
DBH at Onset of Senescence, in cm	75	45	75	47
Adult Background Mortality Rate	5.00E-04	6.00E-04	5.00E-04	0.009
Juvenile Background Mortality Rate	0.01	0.01	0.01	0.01
Weibull Annual "a" Parameter for Snag Size Class 1 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 2 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 3 Mortality	0.05	0.05	0.05	0.05
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Annual "b" Parameter for Snag Size Class 1 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 2 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 3 Mortality	2.5	2.5	2.5	2.5
Weibull Upper DBH of Snag Size Class 1	8	8	8	8
Weibull Upper DBH of Snag Size Class 2	20	20	20	20
Competition Mortality Shape Parameter (Z)	3.00E-06	5.00E-04	3.00E-06	4.33E-06
Competition Mortality Maximum Parameter (max)	0.2	0.08	0.17	0.25
	Trembling Aspen			
Density Self-Thinning Asymptote (A)	0.1019			
Density Self-Thinning Density Effect (S)	8.78E-06			
Density Self-Thinning Diameter Effect (C)	0.5391			
Density Self-Thinning Minimum Density for Mortality (#/ha)	3000			
Density Self-Thinning Neighborhood Radius, in m	5			
Substrate				
Maximum Number of Years that Decay Occurs	15			
Scarified Soil Annual Decay Alpha	-5.00E-07			
Scarified Soil Annual Decay Beta	4.36			
Tip-Up Mounds Annual Decay Alpha	-6.00E-07			
Tip-Up Mounds Annual Decay Beta	4.34			
Fresh Log Annual Decay Alpha	-2.00E-06			
Fresh Log Annual Decay Beta	6.4			
Decayed Log Annual Decay Alpha	-0.79851			
Decayed Log Annual Decay Beta	1			
Proportion of Forest Floor Litter/Moss Pool that is Moss	0			
Uprooted Tree Radius Increase Factor for Root Rip-Out	3.1			
Use Directional Tree Fall	TRUE			
Initial Conditions Proportion of Scarified Soil	0			
Initial Conditions Proportion of Tip-Up Mounds	0			
Initial Conditions Proportion of Fresh Logs	0			

Initial Conditions Proportion of Decayed Logs	0.01			
Partial Cut Proportion of Scarified Soil	0.11			
Partial Cut Proportion of Tip-Up Mounds	0.17			
Partial Cut Proportion of Fresh Logs	0.15			
Partial Cut Proportion of Decayed Logs	0.06			
Gap Cut Proportion of Scarified Soil	0.04			
Gap Cut Proportion of Tip-Up Mounds	0.45			
Gap Cut Proportion of Fresh Logs	0.34			
Gap Cut Proportion of Decayed Logs	0.09			
Clear Cut Proportion of Scarified Soil	0			
Clear Cut Proportion of Tip-Up Mounds	0.36			
Clear Cut Proportion of Fresh Logs	0.34			
Clear Cut Proportion of Decayed Logs	0.17			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Proportion of Dead that Fall	0.1	0.01	0.1	0.1
Proportion of Fallen that Uproot	0.5	0.5	0.5	0.5
Proportion of Snags that Uproot	0.1	0.1	0.1	0.1
Disperse				
Seed Distribution	Deterministic			
Maximum Parent Trees Allowed in Gap Cell	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum DBH for Reproduction, in cm	15	15	15	15
Slope Mean Non-Spatial Seed Rain, seeds/m2/ha of BA/yr	0	0	0	0
Intercept of Mean Non-Spatial Seed Rain, seeds/m2/yr	0.005	0.005	0.005	0.005
Seed Dist. Std. Deviation (Normal or Lognormal)	0	0	0	0
Seed Dist. Clumping Parameter (Neg. Binomial)	0	0	0	0
Canopy Function Used	Weibull	Weibull	Weibull	Weibull
Gap Function Used	Weibull	Weibull	Weibull	Weibull
Weibull Canopy Annual STR	0.68824	0.12228	0.09768	0.2
Weibull Canopy Beta	2	2	2	2
Weibull Canopy Theta	3	3	3	3
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Canopy Dispersal	3.00E-05	2.80E-04	1.32E-04	3.80E-05
Weibull Gap Annual STR	0.47656	0.12228	0.09768	1.19088
Weibull Gap Beta	2	2	2	2
Weibull Gap Theta	3	3	3	3
Weibull Gap Dispersal	6.93E-06	2.80E-04	1.32E-04	3.80E-05
Lognormal Canopy Annual STR	0	0	0	0
Lognormal Canopy Beta	0	0	0	0
Lognormal Canopy Xb	0	0	0	0
Lognormal Canopy X0	0	0	0	0
Lognormal Gap Annual STR	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Lognormal Gap Beta	0	0	0	0
Lognormal Gap Xb	0	0	0	0

Lognormal Gap X0	0	0	0	0
STR for Stumps	0	0	0	2000
Beta for Stumps	0	0	0	2
Establishment				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Canopy Fresh Logs	0.071	0.566	0.028	0.017
Fraction Seeds Germinating on Canopy Decayed Logs	0.0542	0.008	0.55	0.18
Fraction Seeds Germinating on Canopy Tip-Up	0.778	0.155	0.278	0.013
Fraction Seeds Germinating on Canopy Scarified Soil	0.391	0.462	0.017	0.781
Fraction Seeds Germinating on Canopy Forest Floor Litter	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Canopy Forest Floor Moss	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Fresh Logs	0.042	0.566	0.028	0.017
Fraction Seeds Germinating on Gap Decayed Logs	0.307	0.008	0.55	0.18
Fraction Seeds Germinating on Gap Tip-Up	0.574	0.155	0.278	0.013
Fraction Seeds Germinating on Gap Scarified Soil	0.589	0.462	0.017	0.781
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Gap Forest Floor Litter	0.123	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Forest Floor Moss	0.123	0.004	0.019	0.01
Analysis				
Minimum Trunk Diameter for Volume Calculations, in cm	0			
Trunk Segment Length for Volume Calculations, in m	0.05			
Height to Begin Calculating Trunk Volume, in cm	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Taper Equation Initial Multiplier (a0)	0.843142	0.954651	0.958944	0.774001
Taper Equation DBH Exponent (a1)	1.00813	1.03911	0.99884	0.977164
Taper Equation Height Exponent (a2)	0.031402	-0.04035	0	0.078353
Taper Equation X Exponent 1 (b1)	0.319773	0.335144	0.33836	0.562123
Taper Equation X Exponent 2 (b2)	-0.62001	-0.6258	-0.6731	-0.40694
Taper Equation X Exponent 3 (b3)	0.607053	0.527018	0.646087	0.429284
Taper Equation X Exponent 4 (b4)	1.40353	1.07627	1.313	0.932614
Taper Equation X Exponent 5 (b5)	0.067863	0.050757	0.054767	0.036028
Taper Equation X Exponent 6 (b6)	-0.43892	-0.29784	-0.51971	-0.16949
Diameter-Outside-Bark Constant (a1)	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Diameter-Outside-Bark First Degree Parameter (a2)	1	1	1	1
Diameter-Outside-Bark Second Degree Parameter (a3)	0	0	0	0

13.5. Research Parameter File Version 1.0 SBS MPB Planted trees, Regeneration and snags

Plot				
Number of Timesteps	100			
Current Timestep	0			
Random Seed	0			
Number of years per timestep	1			
Plot Length in the X (E-W) Direction, in meters	300			
Plot Length in the Y (N-S) Direction, in meters	300			
Plot Latitude, in decimal degrees	55			
Plot title	Plot			
Allometry				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Adult Height-Diameter Function	Standard	Standard	Standard	Standard
Sapling Height-Diameter Function	Standard	Standard	Standard	Standard
Seedling Height-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Sapling Crown Radius-Diameter Function	Standard	Standard	Standard	Standard
Adult Crown Height-Height Function	Standard	Standard	Standard	Standard
Sapling Crown Height-Height Function	Standard	Standard	Standard	Standard
Maximum Tree Height, in meters	35	23.34684	30	33.53
Slope of Asymptotic Crown Radius	0.0239	0.0303	0.0251	0.0328
Crown Radius Exponent	1	1	1	1
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Slope of Asymptotic Crown Height	0.405	0.201	0.454	0.301
Crown Height Exponent	1	1	1	1
Slope of DBH to Diameter at 10 cm Relationship	0.677076	0.77533	0.63795	0.7855
Intercept of DBH to Diameter at 10 cm Relationship	0	0	0	0
Slope of Asymptotic Height	0.029936	0.070728	0.030507	0.03746
Slope of Height-Diameter at 10 cm Relationship	0.02071	0.02468	0.01887	0.03979
Adult Linear Function Slope	0	0	0	0
Adult Linear Function Intercept	0	0	0	0
Adult Reverse Linear Function Slope	0	0	0	0
Adult Reverse Linear Function Intercept	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Sapling Linear Function Slope	0	0	0	0
Sapling Linear Function Intercept	0	0	0	0
Sapling Reverse Linear Function Slope	0	0	0	0
Sapling Reverse Linear Function Intercept	0	0	0	0
Power Function "a"	0	0	0	0
Power Function Exponent "b"	0	0	0	0
Seedling Linear Function Slope	0	0	0	0
Seedling Linear Function Intercept	0	0	0	0
Seedling Reverse Linear Function Slope	0	0	0	0
Seedling Reverse Linear Function	0	0	0	0

Intercept				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Chapman-Richards Crown Radius Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Radius	0	0	0	0
Chapman-Richards Crown Radius Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Radius Shape 2 (c)	0	0	0	0
Chapman-Richards Crown Height Intercept	0	0	0	0
Chapman-Richards Asymptotic Crown Height	0	0	0	0
Chapman-Richards Crown Height Shape 1 (b)	0	0	0	0
Chapman-Richards Crown Height Shape 2 (c)	0	0	0	0
Tree Population				
New Seedling Diameter at 10 cm	0.1			
Seedling Height Class 1 Upper Bound, in cm	16			
Seedling Height Class 2 Upper Bound, in cm	26			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum Adult DBH	3	5	5	5
Max Seedling Height (meters)	1.35	1.35	1.35	1.35
Initial Density (#/ha) - Seedling Height Class 1	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 2	0	0	0	0
Initial Density (#/ha) - Seedling Height Class 3	0	0	0	0
Light				
Beam Fraction of Global Radiation	0.5			
Clear Sky Transmission Coefficient	0.65			
First Day of Growing Season	105			
Last Day of Growing Season	258			
Number of Azimuth Sky Divisions for Quadrat Light Calculations	18			
Number of Altitude Sky Divisions for Quadrat Light Calculations	12			
Minimum Solar Angle for Quadrat Light, in rad	0.785			
Height at Which GLI is Calculated for Quadrats, in meters	0.675			
Height of Fisheye Photo	Mid-crown			
Upper Age (Yrs) of Snag Light Transmission Class 1	7			
Upper Age (Yrs) of Snag Light Transmission Class 2	17			
Number of Azimuth Sky Divisions for GLI Light Calculations	18			
Number of Altitude Sky Divisions for GLI Light Calculations	12			
Minimum Solar Angle for GLI Light, in rad	0.785			
Sail Light Minimum Solar Angle, in degrees	30			
Sail Light Maximum Shading Neighbor Distance, in meters	15			

Calculated Crown Depth	All height			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Light Transmission Coefficient (0-1)	0.157	0.135	0.092	0.207
Snag Age Class 1 Light Transmission Coefficient (0-1)	0.446	0.376	0.423	0.695
Snag Age Class 2 Light Transmission Coefficient (0-1)	0.502	0.614	0.554	0.755
Snag Age Class 3 Light Transmission Coefficient (0-1)	0.673	0.878	0.713	0.883
Growth				
NCI DBH Divisor (q)	100			
Include Snags in NCI Calculations	FALSE			
	Lodgepole Pine	Trembling Aspen		
Logistic - Asymptotic Diam Growth - Full Light in mm/yr (a)	2.42859	3.85		
Logistic - Diam Shape Param 1 (b)	5.24117	2.7938		
Logistic - Diam Shape Param 2 (c)	0.11083	0.09018		
	Interior Spruce	Subalpine Fir		
Size Dep. Logistic - Diam Intercept (a)	1.7524	1.0738		
Size Dep. Logistic - Diam Slope (b)	0.6894	0.3825		
Size Dep. Logistic - Diam Shape Param 1 (c)	2.2544	1.3692		
Size Dep. Logistic - Diam Shape Param 2 (d)	0.06514	0.03727		
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Maximum Potential Growth, cm/yr	1.28275	1.312857	0.65276	1.0166
NCI Maximum Crowding Distance, in meters	14.166	8.782867	9.234646	14.35
NCI Alpha	1.46293	1.550891	2.521596	1.39263
NCI Beta	0.214879	0.488187	0.331455	0.203867
NCI Size Sensitivity to NCI (gamma)	0	0	0	0
NCI Crowding Effect Slope (C)	0.686994	2.195538	4.157065	0.394959
NCI Crowding Effect Steepness (D)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Medium (0-1)	1	1	1	1
NCI Neighbor Storm Damage (eta) - Complete (0-1)	1	1	1	1
NCI Minimum Neighbor DBH, in cm	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
NCI Size Effect Mode, in cm (X0)	18.4473	10.60473	17.58768	8.51532
NCI Size Effect Variance, in cm (Xb)	1.08222	0.920013	3.206095	1.29918
NCI Shading Effect Coefficient (m)	0.538711	1.250565	0.386633	0.440771
NCI Shading Effect Exponent (n)	1	1	1	1
NCI Damage Effect - Medium Storm Damage (0-1)	1	1	1	1
NCI Damage Effect - Complete Storm Damage (0-1)	1	1	1	1
Interior Spruce NCI Lambda Neighbors	0.364451	0.690463	0.19327	0.8126
Lodgepole Pine NCI Lambda Neighbors	0.225631	0.506003	0.591955	0
Subalpine Fir NCI Lambda Neighbors	0.641792	1	1	5.06E-05
Trembling Aspen NCI Lambda Neighbors	0.3	0.5	0.358713	0.6914
Mortality				
DBH of Maximum Senescence Mortality Rate, as an integer in cm	100			

	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Mortality at Zero Growth	1	1	1	1
Light-Dependent Mortality	5.913	3.737	10.82	3.139
Senescence Mortality Alpha	-3.7	-3.7	-0.5	-3.7
Senescence Mortality Beta	0.12	0.12	0.15	0.1
DBH at Onset of Senescence, in cm	75	45	75	47
Adult Background Mortality Rate	5.00E-04	6.00E-04	5.00E-04	0.009
Juvenile Background Mortality Rate	0.0025	0.0025	0.0025	0.0025
Weibull Annual "a" Parameter for Snag Size Class 1 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 2 Mortality	0.05	0.05	0.05	0.05
Weibull Annual "a" Parameter for Snag Size Class 3 Mortality	0.05	0.05	0.05	0.05
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Annual "b" Parameter for Snag Size Class 1 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 2 Mortality	2.5	2.5	2.5	2.5
Weibull Annual "b" Parameter for Snag Size Class 3 Mortality	2.5	2.5	2.5	2.5
Weibull Upper DBH of Snag Size Class 1	8	8	8	8
Weibull Upper DBH of Snag Size Class 2	20	20	20	20
Competition Mortality Shape Parameter (Z)	3.00E-06	5.00E-04	3.00E-06	4.33E-06
Competition Mortality Maximum Parameter (max)	0.2	0.08	0.17	0.25
	Trembling Aspen			
Density Self-Thinning Asymptote (A)	0.1019			
Density Self-Thinning Density Effect (S)	8.78E-06			
Density Self-Thinning Diameter Effect (C)	0.5391			
Density Self-Thinning Minimum Density for Mortality (#/ha)	3000			
Density Self-Thinning Neighborhood Radius, in m	5			
Substrate				
Maximum Number of Years that Decay Occurs	15			
Scarified Soil Annual Decay Alpha	-5.00E-07			
Scarified Soil Annual Decay Beta	4.36			
Tip-Up Mounds Annual Decay Alpha	-6.00E-07			
Tip-Up Mounds Annual Decay Beta	4.34			
Fresh Log Annual Decay Alpha	-2.00E-06			
Fresh Log Annual Decay Beta	6.4			
Decayed Log Annual Decay Alpha	-0.79851			
Decayed Log Annual Decay Beta	1			
Proportion of Forest Floor Litter/Moss Pool that is Moss	0			
Uprooted Tree Radius Increase Factor for Root Rip-Out	3.1			
Use Directional Tree Fall	TRUE			
Initial Conditions Proportion of Scarified Soil	0			
Initial Conditions Proportion of Tip-Up Mounds	0			
Initial Conditions Proportion of Fresh Logs	0			

Initial Conditions Proportion of Decayed Logs	0.01			
Partial Cut Proportion of Scarified Soil	0.11			
Partial Cut Proportion of Tip-Up Mounds	0.17			
Partial Cut Proportion of Fresh Logs	0.15			
Partial Cut Proportion of Decayed Logs	0.06			
Gap Cut Proportion of Scarified Soil	0.04			
Gap Cut Proportion of Tip-Up Mounds	0.45			
Gap Cut Proportion of Fresh Logs	0.34			
Gap Cut Proportion of Decayed Logs	0.09			
Clear Cut Proportion of Scarified Soil	0			
Clear Cut Proportion of Tip-Up Mounds	0.36			
Clear Cut Proportion of Fresh Logs	0.34			
Clear Cut Proportion of Decayed Logs	0.17			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Proportion of Dead that Fall	0.1	0.01	0.1	0.1
Proportion of Fallen that Uproot	0.5	0.5	0.5	0.5
Proportion of Snags that Uproot	0.1	0.1	0.1	0.1
Disperse				
Seed Distribution	Deterministic			
Maximum Parent Trees Allowed in Gap Cell	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Minimum DBH for Reproduction, in cm	15	15	15	15
Slope Mean Non-Spatial Seed Rain, seeds/m2/ha of BA/yr	0	0	0	0
Intercept of Mean Non-Spatial Seed Rain, seeds/m2/yr	0.005	0.005	0.005	0.005
Seed Dist. Std. Deviation (Normal or Lognormal)	0	0	0	0
Seed Dist. Clumping Parameter (Neg. Binomial)	0	0	0	0
Canopy Function Used	Weibull	Weibull	Weibull	Weibull
Gap Function Used	Weibull	Weibull	Weibull	Weibull
Weibull Canopy Annual STR	0.68824	0.12228	0.09768	0.2
Weibull Canopy Beta	2	2	2	2
Weibull Canopy Theta	3	3	3	3
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Weibull Canopy Dispersal	3.00E-05	2.80E-04	1.32E-04	3.80E-05
Weibull Gap Annual STR	0.47656	0.12228	0.09768	1.19088
Weibull Gap Beta	2	2	2	2
Weibull Gap Theta	3	3	3	3
Weibull Gap Dispersal	6.93E-06	2.80E-04	1.32E-04	3.80E-05
Lognormal Canopy Annual STR	0	0	0	0
Lognormal Canopy Beta	0	0	0	0
Lognormal Canopy Xb	0	0	0	0
Lognormal Canopy X0	0	0	0	0
Lognormal Gap Annual STR	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Lognormal Gap Beta	0	0	0	0
Lognormal Gap Xb	0	0	0	0

Lognormal Gap X0	0	0	0	0
STR for Stumps	0	0	0	2000
Beta for Stumps	0	0	0	2
Establishment				
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Canopy Fresh Logs	0.071	0.566	0.028	0.017
Fraction Seeds Germinating on Canopy Decayed Logs	0.0542	0.008	0.55	0.18
Fraction Seeds Germinating on Canopy Tip-Up	0.778	0.155	0.278	0.013
Fraction Seeds Germinating on Canopy Scarified Soil	0.391	0.462	0.017	0.781
Fraction Seeds Germinating on Canopy Forest Floor Litter	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Canopy Forest Floor Moss	0.009	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Fresh Logs	0.042	0.566	0.028	0.017
Fraction Seeds Germinating on Gap Decayed Logs	0.307	0.008	0.55	0.18
Fraction Seeds Germinating on Gap Tip-Up	0.574	0.155	0.278	0.013
Fraction Seeds Germinating on Gap Scarified Soil	0.589	0.462	0.017	0.781
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Fraction Seeds Germinating on Gap Forest Floor Litter	0.123	0.004	0.019	0.01
Fraction Seeds Germinating on Gap Forest Floor Moss	0.123	0.004	0.019	0.01
Analysis				
Minimum Trunk Diameter for Volume Calculations, in cm	0			
Trunk Segment Length for Volume Calculations, in m	0.05			
Height to Begin Calculating Trunk Volume, in cm	0			
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Taper Equation Initial Multiplier (a0)	0.843142	0.954651	0.958944	0.774001
Taper Equation DBH Exponent (a1)	1.00813	1.03911	0.99884	0.977164
Taper Equation Height Exponent (a2)	0.031402	-0.04035	0	0.078353
Taper Equation X Exponent 1 (b1)	0.319773	0.335144	0.33836	0.562123
Taper Equation X Exponent 2 (b2)	-0.62001	-0.6258	-0.6731	-0.40694
Taper Equation X Exponent 3 (b3)	0.607053	0.527018	0.646087	0.429284
Taper Equation X Exponent 4 (b4)	1.40353	1.07627	1.313	0.932614
Taper Equation X Exponent 5 (b5)	0.067863	0.050757	0.054767	0.036028
Taper Equation X Exponent 6 (b6)	-0.43892	-0.29784	-0.51971	-0.16949
Diameter-Outside-Bark Constant (a1)	0	0	0	0
	Interior Spruce	Lodgepole Pine	Subalpine Fir	Trembling Aspen
Diameter-Outside-Bark First Degree Parameter (a2)	1	1	1	1
Diameter-Outside-Bark Second Degree Parameter (a3)	0	0	0	0