

**Field Guidelines
for the Selection
of Stands for Spacing (Interior)**

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Introduction

These field guidelines incorporate forest health considerations into the decision-making process for selecting free growing stands suitable for spacing. These guidelines address biological, financial and forest health factors that can affect the success of a spacing activity and the subsequent growth, yield and value of a spaced stand.

Remember: the decision key and forest health matrices are only guidelines to assist field personnel in selecting stands for spacing. They are structured to provide a logical process for selecting free growing stands for spacing; not to limit decision making in the field. In certain cases, local knowledge and experience, or other tools may be more accurate or appropriate than these guidelines.

How to use the Field Guidelines

These guidelines are a simple tool to assist field personnel in selecting stands for spacing. There are always exceptions (e.g., when a stand is eliminated from spacing through the decision key process but is still considered for spacing).

The process of working through these guidelines is as follows:

1. The guidelines are separated into coast and interior because different species and conditions exist. Determine whether your stand is under coastal or interior conditions (e.g., if in a transition area) and use the appropriate set of guidelines.
2. Candidate stands are first run through the biological decision key to eliminate the least desirable stands for spacing (e.g., too old, too young, poor site productivity). Key stand data (e.g., species, height, functional live crown ratio, stems/ha, site index) collected through various surveys are compared to appropriate biological criteria within the decision key to determine the eligibility of a stand for spacing. Compare stand data on a criterion-by-criterion basis until the stand is either eliminated by one or more biological criteria or is determined to be acceptable for spacing.

If a stand is eliminated by specific biological criteria, consider carefully whether the stand might be suitable for spacing at a later date.

Stands selected for spacing through this decision key process are then reviewed for forest health concerns. For guidance on spacing treatment options, the level of pest incidence in the stand is compared to the current incidence thresholds within the appropriate pest agent matrix. Stands with low pest incidence (minimal) may be spaced normally with brush or chain saw without concern for forest health. Where incidence increases (alternative or intensive), however, the matrices provide guidance on what options are available for carrying out a spacing activity.

These decision keys were made to assist new field personnel in selecting candidate free growing stands for spacing. This decision key process can be adapted to each species and localized where more species-specific information is required. Before using this decision key, you should collect as much information as possible from the following documents; the Silviculture Prescription (formerly Pre-Harvest Silviculture Prescription) for the stand, any silviculture surveys completed for the stand, and if possible, the pre-stand tending survey.

***IF THIS INFORMATION IS NOT AVAILABLE,
STOP NOW AND COLLECT IT.***

DECISION KEY FOR THE PRESCRIPTION OF SPACING FREE GROWING STANDS FOR INTERIOR BRITISH COLUMBIA

1. The major crop tree species is: lodgepole pine, ponderosa pine, white spruce, Engelmann spruce, redcedar, hemlock, western larch, interior Douglas-fir or subalpine fir..... **go to 2**

2. What will be the average height of the crop or leave trees after spacing?
 - less than the minimum target height requirement as specified in the Silviculture Prescription (SP) or Pre-Harvest Silviculture Prescription (PHSP) to be considered to be free growing **too young for treatment**
 - greater than 10 m **low priority**
 - greater than minimum target height but less than 10 m **go to 3**

3. What is the average functional live crown ratio for the 800 best crop or leave trees per hectare?
 - <30% **do not treat**
 - ≥30% **go to 4**

4. What will be the average height to diameter ratio in similar units (i.e., Ht (cm); DBH (cm)) for the planned residual stand after the spacing treatment?
 - >120 **do not treat**
 - 100–120 (show caution in high wind or snow areas) **low priority**
 - <100 **go to 5**

5. What is the target crop tree species?
 - lodgepole pine, spruce, true fir, wet belt Douglas-fir, redcedar or hemlock **go to 6**
 - dry belt Douglas-fir, Ponderosa pine, white pine or western larch..... **go to 9**

6. The number of total stems per hectare range from:
- <2500 **low priority**
 - ≥2500 **go to 7**
7. The ratio of the minimum to the maximum height (Hgt_{min} ; Hgt_{max})
- <60% **low priority**
 - ≥60% **go to 8**
8. What is the site index for the target tree species in the stand?
- site index <15m **very low priority**
 - site index ≥15m **go to the Interior Forest Health Decision Key and Matrices**
9. The number of total stems per hectare range from:
- <1500 **low priority**
 - ≥1500 **go to 10**
10. What is a visual assessment for the clumpiness of the stand's stems?
- distinctly clumpy distribution..... **go to 11**
 - only somewhat clumpy or unknown/unsure and with >2500 sph **low priority**
 - unknown, unsure or not clumpy and with ≤2500 sph **very low priority**
11. What is the site index class for the target crop tree species in the stand?
- site index <15 m **do not treat**
 - site index <15 m **go to the Interior Forest Health Decision Key and Matrices**

INTERIOR FOREST HEALTH DECISION KEY MATRICES

The important forest health agents in the interior that you should be able to recognize are:

Root Diseases

Armillaria root disease – damage agent code DRA

Laminated root rot – DRL

Tomentosus root rot – DRT

Blackstain root disease – DRB

Dwarf mistletoe

Lodgepole pine dwarf mistletoe – DMP

Western larch dwarf mistletoe – DML

Douglas-fir dwarf mistletoe – DMF

Insects

Spruce (white pine) weevil – IWS

Bark and twig beetles – IB

Warren's root collar weevil -IWW

Stem rust

White pine blister rust – DSB

Comandra blister rust – DSC

Stalactiform Blister rust - DSS

Western gall rust – DSG

Atropellis Canker - DSA

This decision key and the attached forest health agent threshold matrices are intended to be used in conjunction with the spacing decision key. This key is only applicable to those stands or strata of a stand that are being considered for spacing free growing stands. It is the purpose of this key to quickly place stands into a category of disease risk level. Any density control intended to fulfill the obligations of basic silviculture (e.g., to meet free growing) should be prescribed only after consulting the recommendations given in the Forest Health guidebooks.

STEP 1: Does the most recent survey for the candidate stand identify the presence of any of the above important forest health agents?

If YES go to STEP 4 If NO go to STEP 2

STEP 2: Are you working in a high hazard biogeoclimatic unit for the planned crop tree species and an important forest health agent? Use the Forest Health guidebooks, Stand Establishment Decision Aides (SEDAS) or other sources.

If YES go to STEP 4 If NO go to STEP 3

STEP 3: Have the appropriate alternative or intensive disease treatment measures to control and reduce the incidence of the forest health agent been taken?

Apply the Minimal Disease Treatment Level instructions:

There are no restrictions on stand management operations. However, unless root disease is completely absent from the stand, consideration should be given, where possible, to favouring tolerant or moderately susceptible tree species as crop trees where ecologically appropriate. Treat other health factors by selectively removing affected host trees during the spacing or removing infected parts.

STEP 4: Which of the following statements best describes the most recent stand survey information about the current stands forest health condition?

No information exists:

Conduct a pre-stand tending survey or a silviculture survey so that you can properly assess stand damage and the forest agent responsible (and **re-do STEP 4**).

Survey data indicate:

NO occurrence of DRA or DRL or DRT root diseases

or

less than 10 DRA infected or killed trees per hectare, or

less than 5 DRL infected or killed trees per hectare, or

less than 5 DRT infected or killed trees per hectare,

To a maximum combined total of 12 root disease infected or killed trees/ha.

or

NO overtopping residual trees infected with dwarf mistletoe,

or

NO occurrence or proximate occurrence of insect or animal damage,

or

NO occurrence of stem rusts on any portion of the crop trees.

or

Little or no recent bark beetle activity in adjacent mature timber or within the stand

If All Are True

Apply the Minimal Disease Treatment Level instructions:

There are no restrictions on stand management operations. However, unless root disease is completely absent from the stand, consideration should be given, where possible, to favouring tolerant or moderately susceptible tree species as crop trees where ecologically appropriate. Treat other health factors by selectively removing affected host trees during the spacing or removing infected parts.

If No — The survey data indicate:

There is a good reason to believe that the incidence of a forest health agent constitutes a pest and is therefore a risk to achieving resource management objectives. **Go to STEP 5.**

STEP 5: The resource management objectives for the stand or strata are primarily directed at the timber resource?

If YES go to STEP 6

If NO, consult the appropriate forest health guidebook for options and advice to achieve other resource management objectives and to lessen the risk from specific forest health agents. Evaluate the need for a forest health survey.

STEP 6: Determine the forest health agent's incidence level as per the survey techniques described in the appropriate forest health guidebooks. **Go to STEP 7.**

STEP 7: Consult the forest health agent incidence class-host susceptibility decision matrix or the general technical advice before implementing spacing. Make a note of the disease treatment level from the matrix and evaluate the recommended options for inclusion in the stand management prescription.

MATRIX NO. 1

Forest Health Agent: DRA (Armillaria root disease)

Location: Interior subzones

Incidence level based on: Line Transect survey method

Host Susceptibility ¹	Tree Species	Incidence of root disease based on survey		
		Low <2%	Moderate 2-5%	High >5%
H	S, Fd, B	A ²	I	I
M	Hw, Cw, Pl, Pw	M	M	A
T	Lw, Py, A, E	M	M	M

¹ Host susceptibility: High, Moderate and Tolerant

² Disease treatment level: Minimal, Alternative and Intensive

For further information see Armillaria Root Disease Stand Establishment Decision Aid. BC Journal of Ecosystems and Management 9(2):60–65.

URL: http://www.forrex.org/publications/jem/ISS48/vol9_no2_art7.pdf

Minimal Disease Treatment Level:

There are no restrictions on stand management operations. However, where Armillaria is not completely absent from the stand or stratum, one should attempt to favour tolerant or moderately susceptible species as crop trees where ecologically appropriate.

Alternate Disease Treatment Level:

There is a risk when spacing of increasing the problem from Armillaria root disease by increasing the inoculum levels. The highly susceptible host species should be restricted to less than 20% of the stand composition. Consult your regional forest health specialist for clarification.

The strategy to manage armillaria root disease in young stands is to favour moderately susceptible species especially where they can act as a buffer surrounding an infection centre or tree. It is important to retain these less susceptible tree species when they fall within 5 m of an infected tree or centre. Broadleaf tree species maybe the only choice in areas with high levels of root disease and limited alternative coniferous species.

Intensive Disease Treatment Level:

This level of incidence signals caution when treating these stands. Stands may require restratification,

alternative spacing techniques, delay spacing, or no spacing at all. Consult with your regional forest health specialist before proceeding.

MATRIX NO. 2

Forest Health Agent: DRL (Laminated root rot)

Location: Interior subzones

Incidence level based on: Line Transect survey method

Host Susceptibility ¹	Tree Species	Incidence of root disease based on survey		
		Low <2%	Moderate 2-5%	High >5%
H	Fd,	M ²	A	I
M	Lw, Hw, S	M	M	A
T	Pw, Pl, Py	M	M	M
I	Cw, A, E,	-	-	-

¹ Host susceptibility: High, Moderate, Tolerant and Immune

² Disease treatment level: Minimal, Alternative and Intensive

Minimal Disease Treatment Level:

There are no restrictions on stand management operations. However, where laminated root rot is not completely absent from the stand or stratum, one should attempt to favour immune, tolerant or moderately susceptible species as crop trees where ecologically appropriate and accomplishing stand management objectives.

Alternate Disease Treatment Level:

There is a risk when spacing of increasing the problem from the laminated root rot by increasing the inoculum levels. The high susceptibility host species should be restricted to less than 60% of the stand composition.

Strategy 1: To fall bridge trees concurrent with the spacing treatment and favour alternative tree species that are tolerant or immune where appropriate. This strategy of bridge tree removal is accomplished through the felling of what appear to be healthy “bridge trees” adjacent to an infected or symptomatic tree or infection centre. The goal is to impede the underground fungal pathways for tree-to-tree spread of the disease.

Strategy 2: To favour immune or tolerant species especially where they can act as a buffer surrounding an infection centre or tree. Broadleaf tree species maybe the only other choice in areas with high levels of root disease and limited alternative coniferous species.

Intensive Disease Treatment Level:

This level of incidence signals caution when treating these stands. Stands may require restratification, alternative spacing techniques, delay spacing, or no spacing at all. Consult with your regional forest health specialist. In extreme cases, these sites may require rehabilitation.

MATRIX NO. 3

Forest Health Agent: DRT (Tomentosus root rot)

Location: Interior subzones

Incidence level based on: Line Transect survey method

Host Susceptibility ¹	Tree Species	Incidence of root disease based on survey		
		Low <2%	Moderate 2-5%	High >5%
H	S	M ²	A	I
M	PI	M	M/A	I/A
T	B, Cw, Fd, Hw, Lw, Py	M	M	M
I	A, E	-	-	-

¹ Host susceptibility: High, Moderate, Tolerant and Immune

² Disease treatment level: Minimal, Alternative and Intensive

Minimal Disease Treatment Level:

There are no restrictions on stand management operations.

Alternate Disease Treatment Level:

When spacing using conventional means, favour immune, tolerant or moderately susceptible tree species where ecologically appropriate. Broadleaf tree species maybe the only choice in areas with high levels of root disease and limited alternative coniferous species. The highly susceptible host species should be restricted to less than 40% of the stand composition.

Intensive Disease Treatment Level:

This level of incidence signals caution when treating these stands. Stands may require restratification, alternative spacing techniques, delay spacing, or no spacing at all. Consult with your regional forest health specialist. In extreme cases, these sites may require rehabilitation.

MATRIX NO. 4

Forest Health Agent: DRB (Blackstain root disease)

Location: Interior subzones

Incidence level based on: n/a

There is currently no formal survey or management thresholds for blackstain root disease. Survey results for this disease may be recorded in stand opening files, but no treatment options are currently recommended. If this disease is present on your sites, consult with your regional forest pathologist.

There are no restriction on stand management operations where this is the sole root disease located in the stand. Where it occurs with one of the other three important interior root diseases, consider the total stand incidence level for all the root diseases.

For further information see Southern Interior Forest Region Forest Health Stand Establishment Decision Aids BC Journal of Ecosystems and Management 6(1):55–73

URL: http://www.forrex.org/publications/jem/ISS27/vol6_no1_art6.pdf

MATRIX NO. 5

Forest Health Agent: All Dwarf Mistletoes DMP, DML, DMF

Location: Interior subzones

Incidence level based on: any ground survey

The dwarf mistletoes significantly affect forests and forest resource management objectives in the interior lodgepole pine, southern interior Douglas-fir and western larch forest types. The evaluation and suitable prescriptions for this disease are required in these situations. The negative effects of dwarf mistletoes include reducing tree growth, lowering wood quality and causing mortality.

Management actions directed at dwarf mistletoe are best taken at the harvesting stage. Cutblock shape can help to minimize the spread of dwarf mistletoe into the young regenerated stand. If any overtopping trees are found with mistletoe infection they should be removed or girdled to create valuable wildlife tree habitat.

When spacing an infected stand on any site without overtopping infected trees of the same host tree species, the recommendation is that all infected stems be cut, even at the risk of creating a temporary void in the stand. If the void size would be unacceptably large, infected trees left should have the least amount of crown mistletoe infection. This includes any lodgepole pine, western larch or Douglas-fir less than 3 m in height and with a mistletoe infection limited to the lower half of the stem. All young trees with stem infections should be removed.

The highest priority for crop tree selection when spacing goes to dominant and co-dominant noninfected host species or acceptable non-susceptible tree species. Non-infected intermediate trees should have medium priority. Lowest priority is assigned to dominant and co-dominant trees with less than one half of the branches in the lower two thirds of the live crown infected with mistletoe.

MATRIX NO. 6

Forest Health Agent: IWS (Spruce weevil)

Location: Interior subzones (throughout the range of Engelmann and white spruce)

Incidence level based on: any ground survey

The spruce weevil attacks and kills the leading shoot of spruce trees. Although this damage causes no direct mortality, it can produce unacceptable growth loss and stem deformation in young spruce. High hazard ecosystems can be identified from observations, surveys and weather data.

There are two methods for identifying ecosystems that may be susceptible to spruce weevil infestations. The first method uses observations and survey data to delineate known areas of infestation. The second method is based on the developmental requirements of the weevil. The theoretical distribution of the weevil is based on climatic and topographic information. Hazard maps have been produced for some of the regions.

Low hazard areas can have spruce species in accordance with the normal species selection guidelines. Medium hazard areas are requiring of caution and spruce used conservatively, up to 20% of the stand composition is recommended. High hazard areas should have an alternative tree species to spruce grown as the crop tree species and a limit of spruce to 10% maximum of the total stocking. The use of resistant stock mitigates risk of spruce weevil damage, use stock with the highest resistance rating for your area.

Spacing in high hazard ecosystems may lead to increased weevil damage. It is recommended in high hazard areas to delay the spacing treatment until the average stand height reaches 12 m or about 25–30 years of age. In previously attacked stands, spacing can be used to remove the most severely deformed weevil attacked trees and allow for the increased radial growth of the residual trees.

For further information see Southern Interior Forest Region Forest Health Stand Establishment Decision Aids BC Journal of Ecosystems and Management 11(3):51–54

URL <http://jem.forrex.org/index.php/jem/article/viewFile/16/47>

MATRIX NO. 7

Forest Health Agent: DSC, DSG, DSS, DSA

Location: Interior subzones

Incidence level based on: Silviculture surveys

Rust Species	Lodgepole pine stem rust incidence		
	Low 0-5%	Moderate 10-15%	High >15%
DSC + DSS ¹	M ²	A	I
DSG	M	M	A

¹ Combined incidence of DSC and DSS

² Disease treatment level: Minimal, Alternative and Intensive

For further information see Southern Interior Forest Region Forest Health Stand Establishment Decision Aids BC Journal of Ecosystems and Management 6(1):55–73

URL: http://www.forrex.org/publications/jem/ISS27/vol6_no1_art6.pdf

Minimal Disease Treatment Level:

There are no restrictions on stand management operations. It is recommended to direct the cutting at infected stems as much as possible.

Alternate Disease Treatment Level:

Select non-host crop trees that are ecologically suited to the site. Cut all stems having lethal infections. Lethal infections are stem infections or branch infections within 60 cm of the stem for DSC and DSS and 10 cm for DSG. Schedule treatment for mid-May to mid-June to maximize the visibility of the infections.

For pure lodgepole pine stands, spacing to leave additional stems (target stocking plus additional stems/ha) is likely appropriate.

Intensive Disease Treatment Level:

If this site has not previously been surveyed it is recommended that spacing be delayed for 3–5 years, followed by a re-survey. One should delay the spacing until the incidence level is equal to or less than 15% or consider not treating the stand for this host species. Consult with your regional forest health specialist.

Atropellis Canker

Atropellis causes damage as longitudinal cankers on the stems of *Pinus contorta*. Trees less than 15 years old and older than 30 years are resistant to the canker, however, cankers from an infection when the tree was young can continue to grow on older trees and kill them, but new infections will not be initiated.

Atropellis canker incidence is highly variable, but it has been reported occurring in greater numbers in dense stands, than in open stands. Well-spaced vigorous trees are generally resistant to atropellis canker or can heal over existing cankers. If there is a high incidence of atropellis canker within the polygon consult the regional pathologist for treatment recommendations.

MATRIX NO. 8

Forest Health Agent: Western white pine blister rust (DSB)

Location: Interior subzones

Incidence level based on: Silviculture surveys

Thinning non-resistant wild white pine stock aims to protect uninfected trees and cull infected ones. However, thinning without pruning increases rates of infection by increasing spore dispersal. Where natural wild white pine stock is counted as an acceptable species toward total number of well-spaced stems/ha at free growing, pruning is required. If Idaho rust resistant stock is counted towards total well spaced stems/ha, pruning is not required.

Management of white pine is not possible if the majority of pine stems have lethal blister rust infections. A lethal infection is defined as either an infection of the stem (canker) or on a branch and within 15 cm of the stem. The sampling for this disease can be either through the usual silviculture survey plot technique or with the use of sample strips of fixed width. The ability to meet the guidelines in Appendix 2 of the Pine Stem Rust Management and Pruning guidebooks will help to determine if white pine can be managed in a particular stand type.

For further information see Southern Interior Forest Region Forest Health Stand Establishment Decision Aids BC Journal of Ecosystems and Management 6(1):55–73

URL: http://www.forrex.org/publications/jem/ISS27/vol6_no1_art6.pdf

MATRIX NO. 9

Forest Health Agent: Warren root collar weevil (IWW)

Location: Interior subzones

Incidence level based on: Silviculture surveys

Lodgepole pine is the most common host, followed by interior spruce and Douglas-fir. The majority of damage in stands occurs by age of 20 years, however older plantations that are adjacent to MPB killed stands can also be impacted.

In moderate to high weevil hazard subzones, delay spacing until the stand is at least 20 years old. If there are signs of active damage within the plantation consult the regional entomologist for treatment recommendations.

For further information see BC Journal of Ecosystems and Management Warren Root Collar Weevil Stand Establishment Decision Aid. 10(2):105–107

URL: http://www.forrex.org/publications/jem/ISS51/vol10_no2_art8.pdf

MATRIX NO. 10

Forest Health Agent: Bark and twig beetles (IB)

Location: Interior subzones

Incidence level based on: Silviculture surveys

Bark and twig beetles can cause mortality in plantations in the following scenarios:

- when they build to high levels in logging slash near to plantation
- when they build to high levels in adjacent stands of dead timber (withdthrow, MPB, fire)
- when adjacent mature stands have high levels of active MPB or other primary bark beetle, or levels have been high within the past 2 years

Do not space in plantations where there is evidence within the plantation of current mortality caused by any species of bark beetles.

Plantations near recently harvested areas that have high levels of slash should be avoided for 2 years post harvest to minimize the potential for the slash to act a source of insects.