

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

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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.



**COASTAL
FIELD GUIDELINES
FOR THE SELECTION OF
FREE GROWING STANDS TO SPACE**

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 COASTAL BRITISH COLUMBIA

1. The major crop tree species is: western hemlock, a true fir, western redcedar, Douglas-fir or Sitka spruce and located in the coastal mountains and islands physiographic region **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**
 - >12 m **low priority**
 - greater than minimum target height but less than 12 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?
 - >100 **do not treat**
 - 90–100 (show caution in high wind or snow areas) **low priority**
 - <90 **go to 5**
5. What is the number of total coniferous trees per hectare?
 - <900 **do not treat**
 - 900–1500 **low priority**
 - >1500 **go to 6**
6. What is the site index for the target crop tree species in the stand?
 - site index <20 m **do not treat**
 - site index ≥20 m **go to the Coastal Forest Health Decision Key and Matrices**

COASTAL FOREST HEALTH DECISION KEY MATRICES

The important forest health agents on the coast that you should be able to recognize are:

Root Diseases

Armillaria root disease – damage agent code DRA

Black stain root disease – DRB

Laminated root rot – DRL

Annosus root disease – DRN

Dwarf mistletoe

Western hemlock dwarf mistletoe – DMH

Insects

Spruce (white pine) weevil – IWS

Blackheaded budworm – IDH

Bark and twig beetles - IB

Stem rust

White pine blister rust – DSB

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 insect or disease risk level. Any density control 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:

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:

Then 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 root disease or less than 10 infected trees per hectare,

or

NO overtopping residual hemlock trees infected with dwarf mistletoe,

or

NO occurrence of white pine blister rust on white pine

or

Little or no hazard from spruce weevil due to the geographical location of the stand,

or

No recent bark beetle activity within the stand or in adjacent mature timber,

or

No current defoliation by blackheaded budworm.

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 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 reason to believe that the incidence of a forest health agent could constitute 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: DRL (Laminated root rot)

Location: Coast and Transition subzones

Incidence level based on: Line Transect survey method

There are two forms of the disease, one occurs on Douglas-fir and one on cedar. The cedar form occurs as a butt rot on western red cedar and yellow cedar at high elevations within the coast. Spacing treatments for the cedar form are not covered in this guidance. Guidance provided is applicable to the Douglas-fir form of the disease.

Below are the hosts reported for the Douglas-fir form of the disease.

Host Susceptibility ¹	Tree Species	Incidence of root disease based on survey		
		Low <2%	Moderate 2-5%	High >5%
High	Fd, Ba, Bg, Hm	M ²	A	I
Moderate	Lw, Hw, Ss, Se, Bl	M	M	A
Tolerant	Pw, Pl, Py	M	M	M
Immune	Cw, Cy, Decid,	-	-	-

¹ Host susceptibility: High, Moderate, Tolerant and Immune

² Disease treatment level: Minimal, Alternative and Intensive

For further information see British Columbia's coastal forests: Laminated root rot forest health stand establishment decision aid. BC Journal of Ecosystems and Management 7(3):41-43.

URL: http://www.forrex.org/publications/jem/ISS38/vol7_no3_art5.pdf

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 which also meet stand management objectives.

Alternate Disease Treatment Level:

There is a risk when spacing of increasing the problem from laminated root rot by increasing inoculum levels. High susceptibility host species should be restricted to less than 60% of the stand composition. And do not reduce stocking target levels if more than 60% of the trees are moderately or highly susceptible.

Strategy 1: is to favour immune or tolerant species especially where they can act as a buffer surrounding an infection centre or tree. Deciduous tree species may be the only other choice in areas with high levels of root disease and limited alternative coniferous species.

Strategy 2: to manage the root disease in young stands bridge trees should be felled concurrent with the spacing treatment 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.

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: DRA (Armillaria root disease)

Location: Transition 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%
High	Fd, Bl, Bg, Hw, S	M ²	A	I
Moderate	Pl, S, Pw,	M	M/A	A
Tolerant	Cw, Cy, Ac, At, Ep, Py Lw	M	M	M

¹ Host susceptibility: High, Moderate and Tolerant

² Disease treatment level: Minimal, Alternative and Intensive

For further information see British Columbia's southern interior forests: Armillaria 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 root disease 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. This practice will increase the number of barriers acting to deter the spread of the fungus between susceptible host species. The high susceptibility host species should be restricted to less than 20% of the stand composition.

Alternate Disease Treatment Level:

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

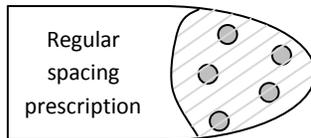
The main strategy to manage armillaria in young stands is to favour moderately susceptible species, especially where they can act as a buffer surrounding an infection centre or tree. It is important to retain these less susceptible tree species when they fall within 5 m of an infected tree or centre.

Broadleaf tree species may be 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 if considering treating these stands. Stands may require restratification (see Figure 1 for examples), alternative spacing techniques, delay in spacing activities, or no spacing at all. Consult with your regional forest health specialist before proceeding.

Block A – restratification possible



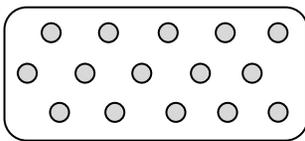
Disease localized (intensive level).
Recommendation: do not treat

Block B – restratification possible



Recommendation: (alternative level)
modify spacing prescription to use
pop up spacing

Block C – restratification not possible



Evenly spaced over entire block. Recommendation:
Alternate level: modify spacing prescription and space
where possible.
Intensive level: consult regional forest health specialist.

Figure 1. Examples of restratifications.

Restratification of a surveyed block may localize a pest agent problem (e.g., armillaria) and permit continuation of regular spacing on the remaining portion of the block. Blocks A and B demonstrate areas where restratification is possible. When Block A was surveyed, armillaria was found to have reached the intensive level. For this block spacing is not recommended in the hatched area. The rest of Block A can be spaced normally.

When Block B was surveyed, armillaria was found to have reached the alternative level. It was recommended that spacing be carried out in the shaded area of this block selecting for retention of tolerant and moderately susceptible species and regular spacing in the remaining sections of the block.

It was not possible to restratify Block C. The distribution of armillaria was uniform over the entire block. If the incidence of armillaria was found to have reached the alternative level, the spacing prescription could be modified to carry out pop-up spacing over the entire block. If the incidence level of armillaria was intensive, consult your regional forest health specialist before proceeding.

MATRIX NO. 2a

Forest Health Agent: DRA (Armillaria root disease)

Location: Coastal subzones

Incidence level based on: Line Transect survey method

Armillaria root disease does not cause significant damage in coastal subzones. Armillaria-caused mortality as single trees or small groups of trees is quite common on young coastal plantations, but mortality ceases at about age 20–25 years. The present problems with armillaria in young coastal stands are a direct result of reforestation with a single, susceptible species (i.e., Douglas-fir). Future problems can be minimized by mixed planting of two or more species to lower the chances of infections and reduce the impact of mortality on stocking.

MATRIX NO. 3

Forest Health Agent: DRN (Annosus root disease)

Location: Coast and Transition subzones

Incidence level based on: n/a

There is currently no formal survey or management threshold for the annosus root disease (DRN). 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 health specialist.

This pathogen is an aggressive colonizer of stumps. Infection occurs through wounds on stems or roots, or through cut surfaces of fresh stumps. The fungus moves to surrounding trees through root grafts or root contact. Damage by annosus is primarily in the form of butt rot that develops over the life of a stand. Hence, surveys won't detect it even if present. The pathogen is an aggressive invader of large wounds and, once it enters the bole, it can spread very quickly, causing extensive decay. Stand thinning treatments or damage to trees from logging operations can therefore intensify annosus root rot problems.

There are no restrictions on stand management operations where this is the sole root disease affecting the stand. However, where it occurs with one of the other root diseases, consider the total stand incidence level for all the root diseases for disease treatment level instructions.

A note of caution during any silviculture activity is not to wound residual stems, especially when spacing Hw, B, or Ss.

Host Susceptibility	Tree Species	Incidence of root disease based on survey		
		Low <2%	Moderate 2-5%	High >5%
High	Hw, S, A	M ¹	A ¹	I
Moderate	Cw, Fd	M	M/A ²	A ¹
Tolerant	PI	M	M	M/A ²
Immune	Deciduous	M	M	M

¹ Except transition subzones with armillaria or tomentosus, then the next highest treatment level is recommended.

² Check with Root Disease Management Guidebook.

MATRIX NO. 4

Forest Health Agent: DMH (Hemlock dwarf mistletoe)

Location: all coastal western hemlock stands

Incidence level based on: any ground survey

Western hemlock dwarf mistletoe significantly affects forests and forest resource management objectives in the coastal western hemlock forest type. The impacts of dwarf mistletoe include reduced tree growth, lowered wood quality and can result in tree mortality.

Management actions directed at dwarf mistletoe are best taken during harvesting. Cutblock design can help to minimize the spread of dwarf mistletoe into the young regenerated stand. 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 without any overtopping infected hemlock trees, 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 created would be unacceptably large, the infected trees left should have the least amount of crown mistletoe infection or be less than 3 m in height. All young trees with stem infections should be removed.

The highest priority for crop trees retention includes dominant and co-dominant non-infected 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.

For further information see Hemlock dwarf mistletoe Stand Establishment Decision Aid. BC Journal of Ecosystems and Management 5(1):7-9.

URL: http://www.forrex.org/publications/jem/ISS25/vol5_no1_art2.pdf

MATRIX NO. 5

Forest Health Agent: IWS (Spruce weevil)

Location: Coastal and Transition subzones (throughout the range of Sitka, Engelmann and white spruce but not on Haida Gwaii)

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 damage. 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 regions.

The Coast Forest Regions have species selection guidelines for each hazard area. Low hazard areas can have sitka spruce in accordance with the normal species selection guidelines. Areas identified as moderate hazard require caution, non-resistant spruce should be used conservatively (up to only 20% of the stand composition). High hazard areas should have an alternative tree species to spruce grown as the primary crop tree species and spruce should be limited to a maximum of 10% 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 is recommended.

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 the Spruce Weevil and Western Spruce Budworm Stand Establishment Decision Aid. BC Journal of Ecosystems and Management. 7(3):45–49

URL: http://www.forrex.org/publications/jem/ISS38/vol7_no3_art6.pdf

MATRIX NO. 6

Forest Health Agent: DSB (white pine blister rust)

Location: Coastal and Transition 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 the White Pine Blister Rust Forest Health Stand Establishment Decision Aid. BC Journal of Ecosystems and Management 10(1):97-100.

URL: http://www.forrex.org/publications/jem/ISS50/vol10_no1_art9.pdf

MATRIX NO. 7

Forest Health Agent: IDH (Blackheaded budworm)

Location: Coastal and Transition subzones

Incidence level based on: silviculture surveys

Western hemlock and true firs are the preferred hosts, but spruce and Douglas-fir can also be fed upon. The most serious defoliation is found on Haida Gwaii and northern Vancouver Island. Outbreaks are periodic and forest managers should expect recurrent outbreaks in the coastal regions. Plantations are most susceptible to damage when under the age of 25 yrs, older plantations are able to withstand defoliation with low levels of long-term impact. In addition, plantations under 2,000 sph incur substantially greater levels of damage than denser stands.

Strategy 1. In areas of historic severe defoliation stand density should be kept above 2000 sph to reduce overall stand susceptibility.

Strategy 2. Where spacing activities are desired in stands less than 25 years old, spacing should occur within a year or two following the collapse of an outbreak. This allows preferential felling of dead stems and trees with topkill. In addition, remaining stems should have sufficient time to outgrow the most susceptible stage prior to the next outbreak.

Strategy 3. Delay spacing until stands are older than 25 years to avoid creating conditions that are optimal for damage by blackheaded budworm.

MATRIX NO. 8

Forest Health Agent: IB (bark beetles)

Location: Coastal and Transition subzones

Incidence level based on: silviculture surveys

Bark and twig beetles can cause mortality in plantations when they build to high levels in either nearby slash or stressed standing timber. Do not space in plantations where there has been mortality due to bark beetles within the plantation or in adjacent standing timber in the last 2 years.