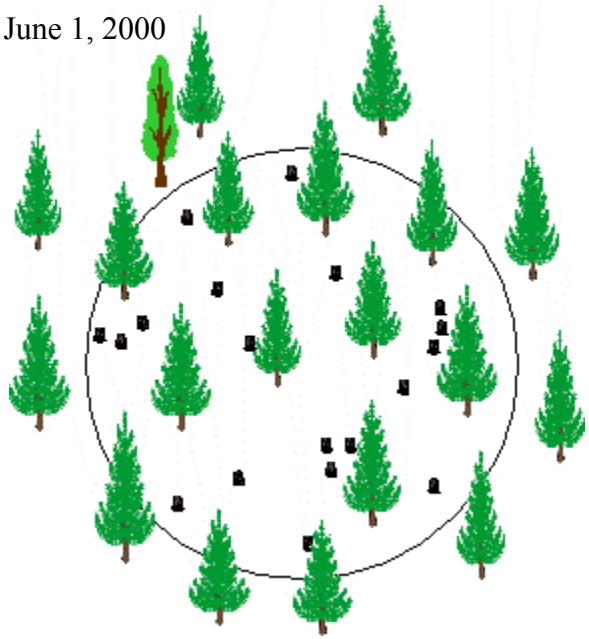
JUVENILE SPACING QUALITY INSPECTION

June 1, 2000



This document is being distrubuted as an operational draft. The intent is to provide this document to interested persons who may wish to apply this new survey methodology on juvenile spacing projects in 2000.

It is expected that comments will be incorporated at the end of 2000, and the final version be published in booklet style for use in the spring of 2001.

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Introduction

The juvenile spacing quality inspection system is a procedure intended to be used to determine the quality of treatment and subsequently the payment percentage of the work performed on a juvenile spacing project.

A “standard” inspection procedure is required so that all parties involved in juvenile spacing projects understand how the success of the project will be measured. The “rules” for measuring the success of juvenile spacing projects are found in the Stand Management Prescription (SMP), in the contract and in this document.

It is important to follow the procedures described in this document to ensure that a fair and equal application of the “rules” are applied consistently to all juvenile spacing projects. With an inspection system that is openly known by all parties, the frequency of disputes should be reduced.

The juvenile spacing quality inspection procedures involve the establishment of sample plots within the work area. The inspector records data such as the number of total trees, crop trees, reworkable errors and non reworkable faults. The plot data is then used in a mathematical calculation to determine the Quality Percent. This Quality Percent is then used to determine a Payment Percent. The original bid price per hectare multiplied by the Payment Percent determines the final amount that the contractor will be paid for the work completed.

The intent of these juvenile spacing quality inspection procedures is to determine how closely the work completed corresponds to the standards found in the SMP and in the contract. If the quality of work completed is below 92.6%, then payment is reduced based on a graduated payment system.

This update of the juvenile spacing quality inspection procedures introduces new concepts to deal with the natural variation commonly found within young forests.

Survey Principles

The juvenile spacing quality inspection procedure is a sampling process that uses circular sample plots. The total tree and crop tree densities and faults found in the plots are assumed to be representative of the work area in and around the plot locations.

Circular plots with a known radius are the key to the sampling procedure. We know that a plot with a radius of 3.99 metres (m) has an area of 50 m^2. This is determined using the formula for calculating the area of a circle. A hectare is 10 000 m^2. This means a 3.99 metre circular plot represents 1/200th of a hectare. The plot multiplier is determined by dividing 10 000 m^2 by 50 m^2. Therefore, the plot multiplier is 200. For example, if you have 7 crop trees within a plot, you can calculate that there are 1400 crop trees per hectare by multiplying 7 crop trees by 200.

The same mathematical principles can be applied to a plot radius of 5.64 m. The plot multiplier is 100. Therefore, the average density per hectare is equal to the average number of crop trees in a plot multiplied by 100.

The most common sampling methodology involves the positioning of plots along predetermined strip lines. Plots are positioned at regular intervals along the strip lines. Many people refer to this as a "grid pattern".

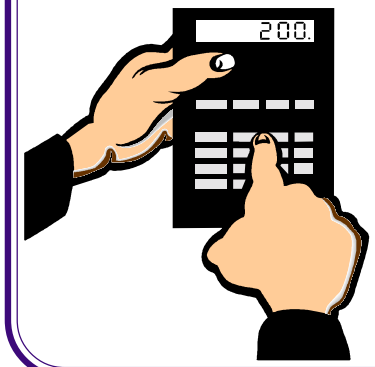
This systematic method is only one of the possible methodologies. Any method that produces a non-biased, random sample is acceptable.

Sample Plots

Area of a plot (circle)
$(3.99\ m)^2 \times 3.14 = 50\ m^2$

Area of a hectare
1 hectare = 100 m x 100 m = 10 000 m^2

Plot Multiplier
10 000 $m^2 \div$ 50 m^2 = 200



1 tree in a plot represents 200 trees per ha

1 error in a plot represents 200 errors per ha

The number of plots to be determined is not regulated. The contract may specify the sampling intensity. However, over the years an accepted standard of 1 plot per hectare has become quite common. When considering how many plots to establish, one should consider the following;

- the variation in stand density prior to treatment,
- visual impressions of the consistency of the treatment,
- confidence with the historic quality of work performed by the Contractor.

Less than one plot per hectare can often provide the desired precision required for determining payment.

Choosing a Plot Radius

All plots established within a single stratum must use the same plot radius.

On average, for statistical purposes, the optimum number of crop trees within each plot is 7 - 10. This would accurately represent the quality of the juvenile spacing treatment completed.

In the interior of the province, a plot radius of 3.99 metres is commonly used. On the coast, a larger plot radius of 5.64 metres is commonly used. A larger plot radius may be selected for special situations, such as cluster treatments.

Density Range for 7 to 10 trees	Plot Radius	Plot Multiplier
3500 - 5000tr/ha	2.52m	500
1400 - 2000	3.99	200
700 - 1000	5.64	100
350 - 500	7.98	50
140 - 200	11.28	20

Survey Methodology and Data Collection

Throughout the work area, evenly distribute quality inspection plots with a radius of:

- 3.99 m, if the target stems per hectare are greater than or equal to 1000.
- 5.64 m, if the target stems per hectare are less than 1000.

Establish the plot centre and mark its location in the field in such a manner that the plot can be relocated within 3 months (or until it is covered by snow, whichever is sooner).

Record the plot locations on a survey map. The Inspector then records every uncut tree above the specified minimum cutting height, tallied by species and size class, as well as the total number of crop trees. When recording total trees, all living coniferous and broadleaf species present within the plot are tallied. These procedures are consistent with the Silviculture Surveys Guidebook. Trees which fall on the plot boundary are considered “borderline trees”. These borderline trees are tallied as “in” the plot if more than half of the tree’s diameter, measured at breast height, is within the plot. Borderline trees are also tallied as “in” the plot if the point of germination is within the plot.

The Inspector also records the number of excess trees, as well as the number and associated codes of reworkable errors, and non reworkable errors. The Inspector must also record the number of voids, the average stand height, the average stand age, and the percent crown closure, to the standards necessary for developing inventory and silviculture labels. An inventory label and sample tree data should be recorded at every fourth plot. A minimum of three inventory labels and three sample trees per stratum or per block are required.

Any instances of non-compliance with other specifications applicable to the work area must also be recorded.

The following table describes the standard Inventory and Growth and Yield Size Classes.

Size Classes	**Midpoint of Size Class**
0 - 1.3 m in height	R (regen)
1.3 m in height - 7.4 cm	5
7.5 cm - 12.4 cm	10
12.5 cm - 17.4 cm	15
17.5 cm - 22.4 cm	20
22.5 cm - 27.4 cm	25

These size classes are optional. Size classes should be chosen to suit the site and stand characteristics, and tailored to meet the objectives in the SMP.

Conventions Used in this Document

The plots shown in this document are not drawn to scale, and are for demonstration purposes only. All examples are based on:

- a plot radius of 3.99 metres, 1/200 of a hectare;
- a target number of 1800 crop trees per hectare, or 9 crop trees within a plot;
- a minimum number of 1600 crop trees per hectare, or 8 crop trees within a plot;
- a maximum number of 2000 crop trees per hectare, or 10 crop trees within a plot;
- an inter-tree distance of 2.5 metres;
- a minimum inter-tree distance of 1.0 metre;
- no conifers less than 1.0 metre in height shall be cut;
- no conifers greater than 10.0 cm in diameter, measured at breast height shall be cut (leave tree).

The above data is for the sample plots within this document and do not represent default standards.

Throughout this document, we have called all Prescriptions 'Stand Management Prescriptions' (SMP's). Juvenile spacing is normally carried out under a SMP. These inspection procedures are recommended for juvenile spacing carried out on Crown land in British Columbia.

The Ministry of Forests has developed field cards that can be used to record the plot data. The FS 749 field card depicted on page 23 is available in a waterproof format from: www.for.gov.bc.ca/ISB/Planning/Forms/index.htm.

The 749a found on page 25 is only a conceptual proof available in this document at this time.

Correlation between Pre Stand Tending Surveys, SMPs and Juvenile Spacing Treatments

Pre stand tending surveys should be done using the same survey parameters as the intended juvenile spacing treatment. Otherwise, the post spacing objectives prescribed in the SMP may not be achieved.

The SMP must prescribe a wide variation in the inter-tree distance between crop trees in stands with high variability in density. This is key in allowing the Contractor to choose the optimum crop tree. Without this flexibility, the optimum crop trees may be sacrificed because of a specified inter-tree distance. The loss of optimum crop trees would reduce the expressed site index and decrease potential volume at the next rotation.

A **Crop Tree** is defined as a preferred or acceptable species; equal to or greater than the minimum inter-tree distance from any other crop tree; equal to or greater than a specified minimum cutting height; equal to or less than the maximum diameter.

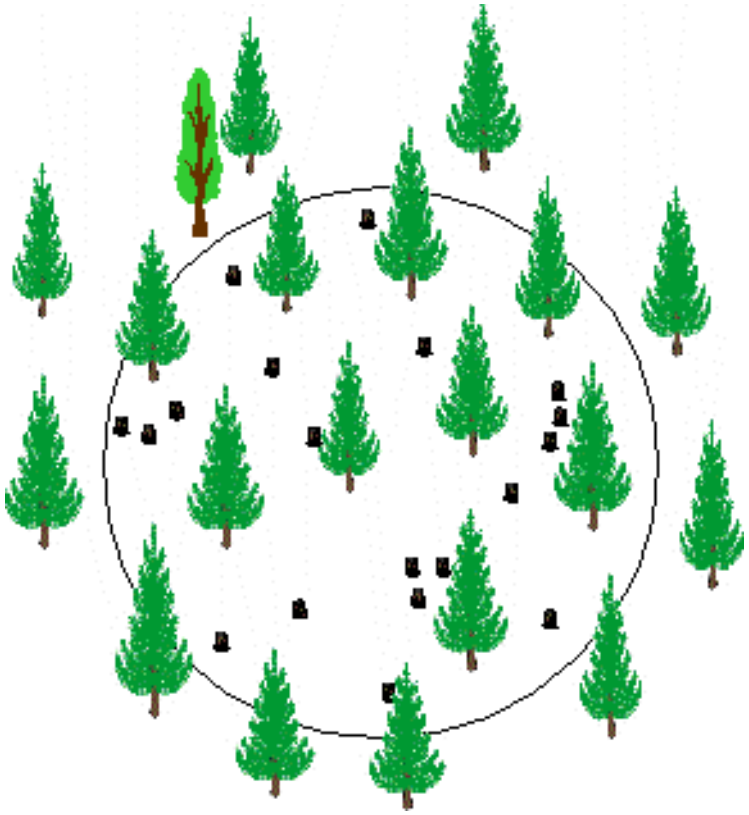
Inter-tree Distance is defined as the horizontal distance between two trees on a centre to centre basis, calculated or measured to the nearest 1/10 of a metre, unless otherwise specified in the contract.

Plot 1 - Plot in an Evenly Spaced Stand

This plot is commonly found when the crop trees prior to juvenile spacing are fairly evenly distributed, are of similar quality and there are a number of choices of suitable crop trees present.

This plot is one where:

- the number of crop trees tallied in the plot are all within the allowable inter-tree distance variation,
- the number of crop trees tallied in the plot are within the minimum and maximum density prescribed in the SMP,
- there are no reworkable or non reworkable errors found in the plot.



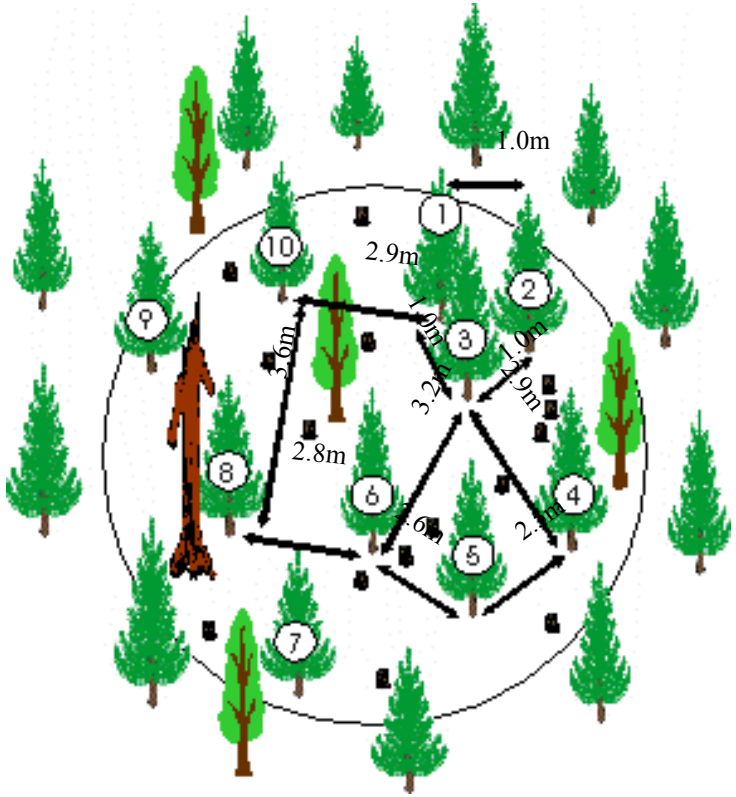
PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
1	Pl		5	4				9	9	0	0	0		
	Sx													
N	Fd													
100m														

Plot 2 - Variation in the Inter-Tree Distance

This plot shows an example of the variation in the inter-tree spacing distance that should be prescribed in the SMP to allow the Contractor to choose the optimum crop trees.

The inter-tree distance between crop trees #1, #2 and #3 is 1.0 metre. This distance is the minimum inter-tree distance used in the examples provided in this document. The remainder of the crop trees within the plot are spaced slightly wider; however, the number of crop trees left in the plot in this example is within the minimum and maximum prescribed in the SMP. The rationale of having a small minimum inter-tree distance is to allow the Contractor the flexibility to chose the optimum crop trees throughout the entire work area.

This plot has 10 crop trees. The 10 crop trees chosen are the best quality and the largest crop trees. The trees that were cut down were of poor quality, with significant forest health factors noted on a number of them. There are no excess faults assessed to the Contractor, as the maximum number of crop trees per hectare has not been exceeded. No other faults have been assessed to the Contractor as there were no reworkable or non reworkable faults noted in this plot.



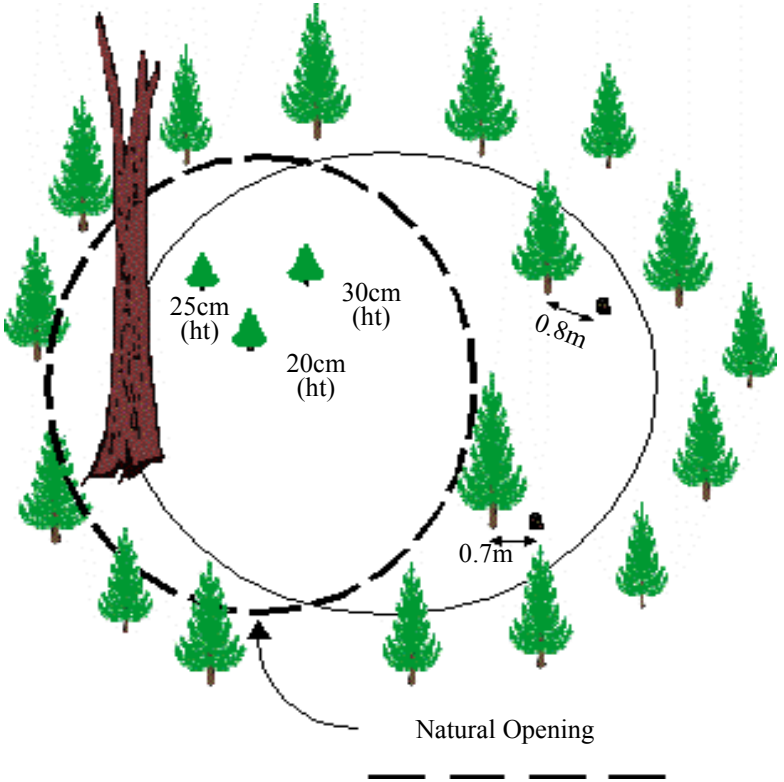
PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
2	Pl		4	5	1			12	10	0	0	0		
	Sx													
N	Fd													
100m	At			2										

Plot 3 - Natural Openings in the Plot

If a portion or all of a quality plot falls within a natural opening, the plot is assessed where it falls. The plot is not to be moved to another location. The Contractor is not faulted for 'creating' a void, as the opening is considered a natural opening; there are no cut stumps as a result of the juvenile spacing treatment. The two trees within the plot that were cut were less than the minimum inter-tree distance from the remaining crop trees. Therefore, no faults are assessed to the Contractor.

The three trees which are less than the minimum cutting height; (20 cm, 25 cm, and 30 cm) are included in the total crop tree column. They are tallied on the plot card as regen (R).

A **Natural Opening** is defined as an area in the original stand that has no trees above the specified minimum cutting height, and has an average diameter greater than twice the target inter-tree distance.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
3	Pl	3	1	1				5	2	0	0	0		
	Sx													
N	Fd													
100m														

Plot 4 - Natural Opening and Reducing the Inter-Tree Distance

When the target number of crop trees per plot cannot be achieved due to a natural opening, the inter-tree distance should be reduced to the minimum inter-tree distance, but only around the perimeter of the natural opening. Reducing the inter-tree distance is permitted throughout the entire work area to ensure the best crop tree is chosen; however, the maximum density prescribed in the SMP should not be exceeded.

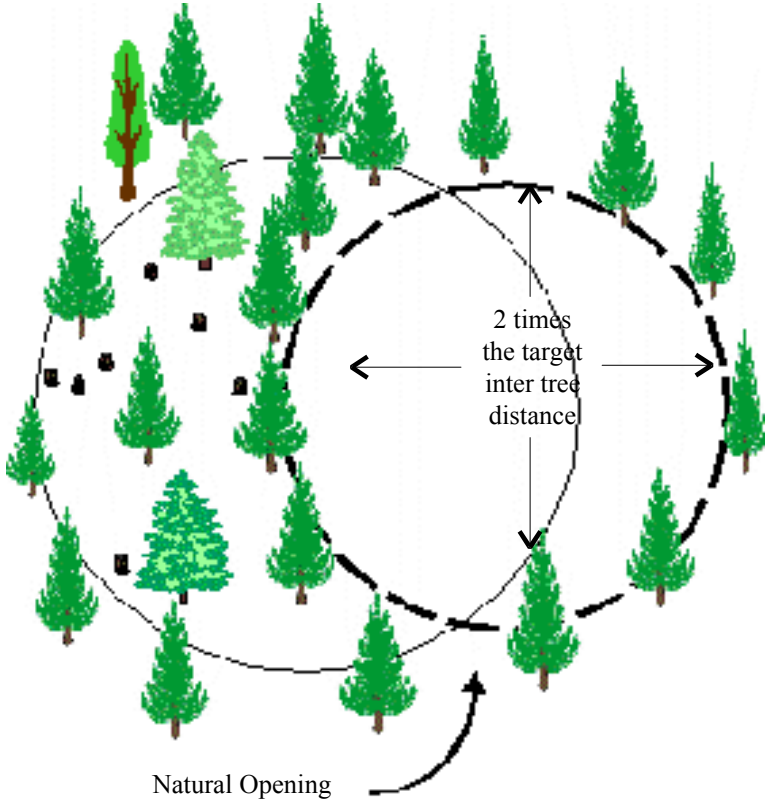
An **Opening** is defined as an area in the original stand that has no trees above the specified minimum cutting height, and has an average diameter greater than twice the target inter-tree distance.

If there are no trees or if a poor quality, unacceptable leave tree, greater than the specified maximum diameter, is within the natural opening, the Contractor should reduce the minimum inter-tree distance, but only around the perimeter of the natural opening.

If a good quality leave tree, greater than the specified maximum diameter, is within the natural opening, the opening is no longer considered a natural opening. Therefore, the Contractor is not required to reduce the inter-tree distance to the minimum inter-tree distance around the perimeter; however, they may need to reduce the inter-tree distance (to the minimum) in order to achieve the density prescribed in the SMP.

If the minimum inter-tree distance is preventing the Contractor from choosing the best crop tree and achieving the target density prescribed in the SMP, the Contractor must stop work before the density is reduced below the minimum prescribed in the SMP. A recommendation should be made to reduce the minimum inter-tree distance to suit the site and stand characteristics.

A **Leave Tree** is defined as a tree other than a crop tree that is specified not to be cut.



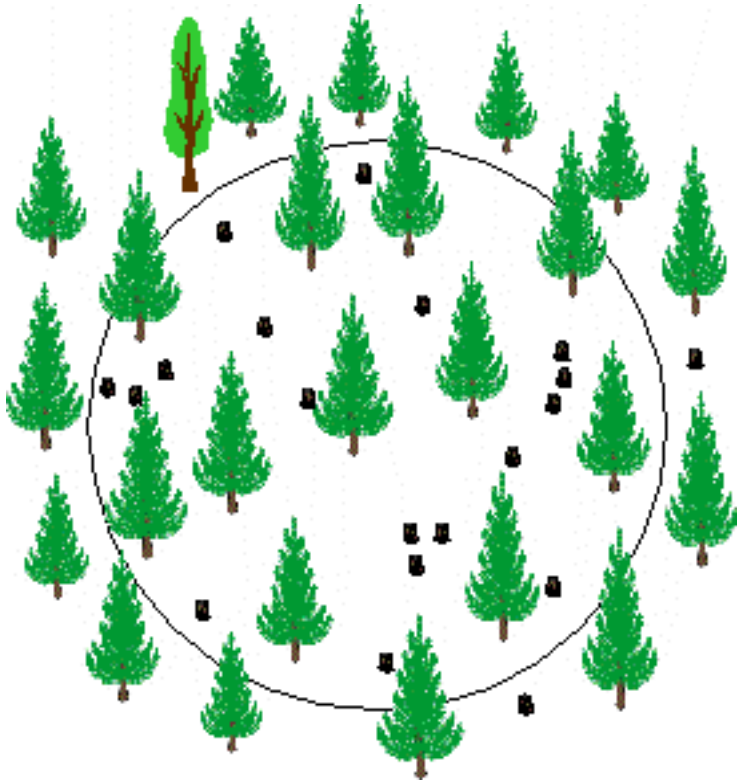
PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
4	Pl		4	3				9	9	0	0	0	4.1	12
	Sx		1	1										
N	Fd													
100m														
									P 10-13-4.2-4 %					

Plot 5 - Excess Trees

Even though, in this plot, the Contractor has spaced all of the crop trees greater than the minimum inter-tree distance, they may be assessed for excess trees, depending on the size of the area. The maximum density prescribed is 2000 crop trees per hectare, which is 10 crop trees in a plot. The Contractor left 11 crop trees in the plot. Additional density plots are suggested in this case. Refer to page 38 for establishing and determining density plots. If the average density of the original plot and the four density plots is higher than the maximum density specified in the SMP, the Contractor is then faulted for the number of excess trees in the original plot (in this example, the Contractor is faulted for one excess tree). This is recorded as 1 R1, (one excess tree).

Based on site and stand characteristics, the Inspector has the discretion to request that the Contractor rework this area to bring the densities in line with those prescribed in the SMP. If the area is reworked, new plots must be established. The Inspector also has the option to ribbon out the contiguous area of unsatisfactory performance, or to continue with plots, adding density plots where and when necessary to determine whether or not this is an isolated problem.

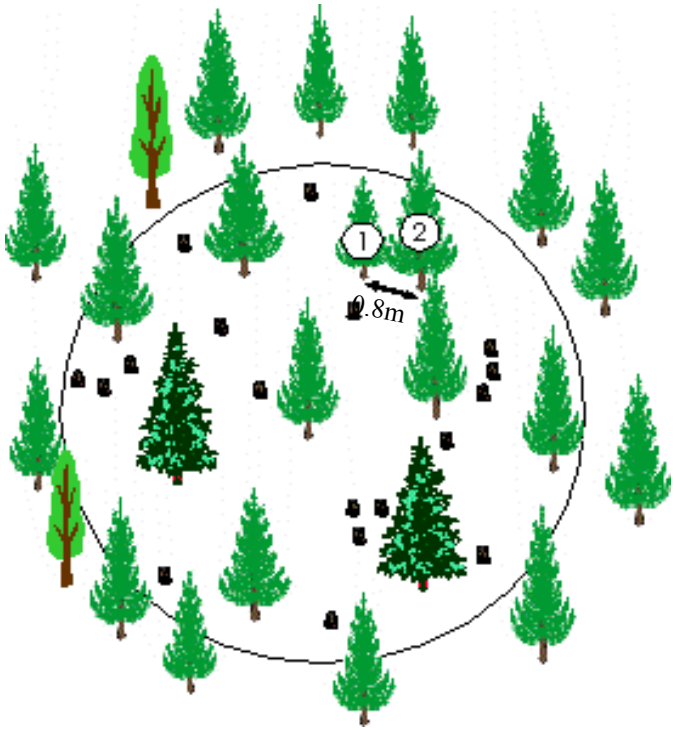
If the average density of the original plot and the four density plots is within the range of the minimum and the maximum densities specified in the SMP, the Contractor is not assessed any excess faults.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
5	Pl		6	5				11	10	1 R1	0	0		
	Sx													
N	Fd													
100m														

Plot 6 - Designated Tree Uncut

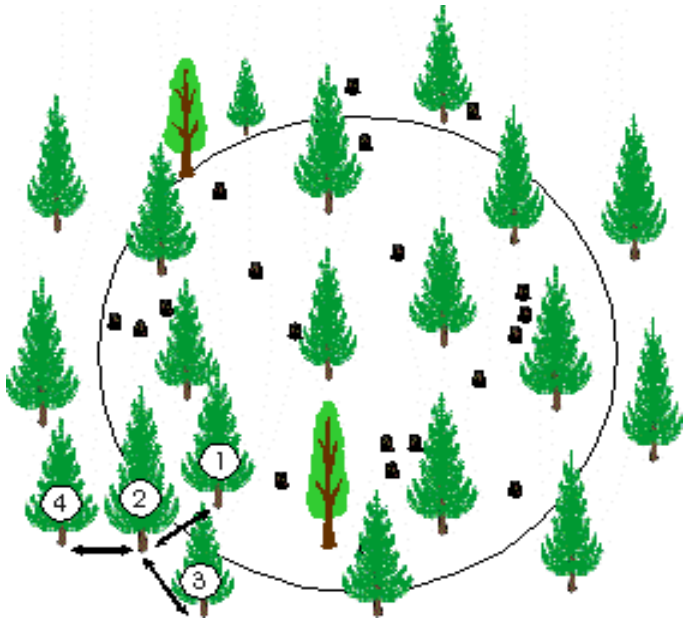
In this plot the Contractor has left crop trees #1 and #2, 0.8 metres apart. This distance is less than the minimum inter-tree distance allowed. Therefore, only 9 crop trees are suitable to be in the plot. The fault is recorded on the plot card as 1 R7, (one designated tree uncut).



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
6	Pl		3	5				10	9	1	0	0		
	Sx		1	1						R7				
N	Fd													
100m														

Plot 7 - Close Spacing – Inside or Outside the Plot Boundary

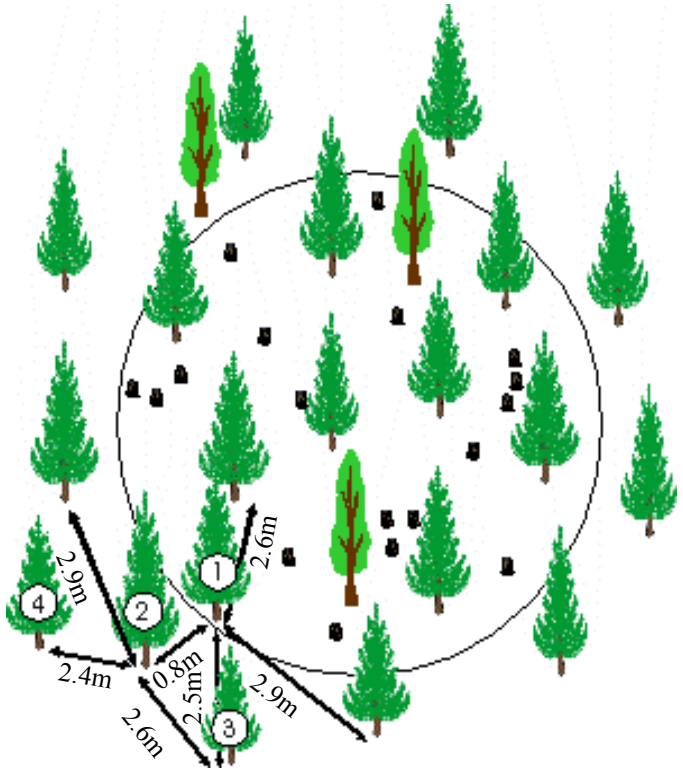
Two situations can occur regarding the faulting of crop trees inside or outside the plot boundary. One situation is when crop tree #1 is inside the plot and is less than the minimum inter-tree distance from crop tree #2, located outside the plot. If crop tree #2 is less than the minimum inter-tree distance from crop trees #1, #3, and #4, then crop tree #2 is the obvious fault tree. No fault is assessed to the Contractor. Plot 8 illustrates the second situation.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
7	Pl		5	4				10	9	0	0	0		
	Sx													
N	Fd													
100m	At			1										

Plot 8 - Close Spacing – Inside or Outside the Plot Boundary

The other situation that can occur regarding the faulting of crop trees inside or outside the plot boundary is when crop tree #1 and crop tree #2 are less than the minimum inter-tree distance apart. All of the neighbouring trees that surround crop trees #1 and #2 are spaced greater than the minimum inter-tree distance prescribed. The removal of either crop tree #1 or crop tree #2 would solve the problem. When it is not clear which crop tree is incorrectly spaced, the crop tree outside the plot is considered the fault tree. The benefit of the doubt in this situation would go to the Contractor.

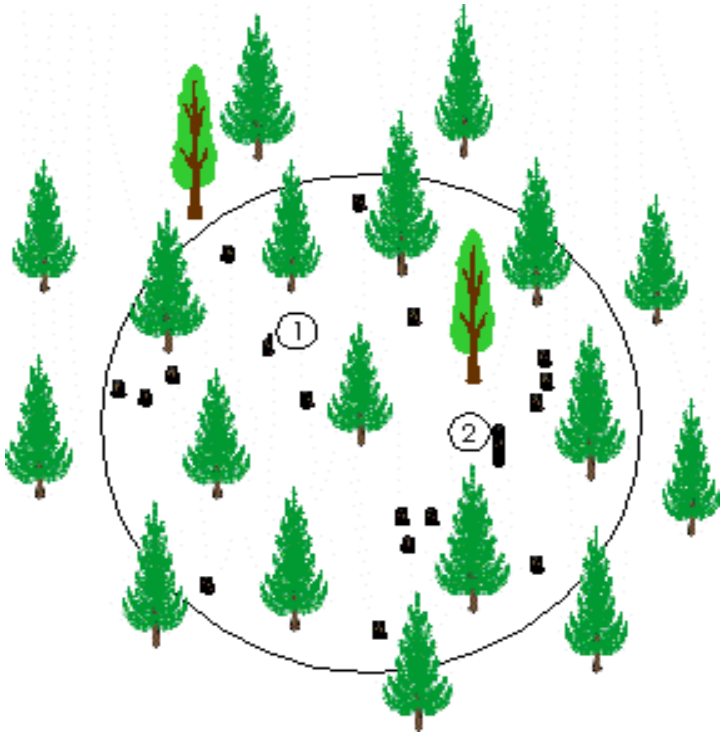


PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
8	Pl		5	4				11	9	0	0	0	4.4	13
E	Sx													
100m	Fd													
	Ep		1	1										
									Plg Sx 1-12-4.1-5%					

Plot 9 - Reworkable Errors

This plot describes two reworkable errors that can occur in a plot. Stump #1 has a stump cut angle greater than the allowable stump cut angle specified in the contract. This fault is recorded on the plot card as 1 R5, (one stump cut angle).

Stump #2 is taller than the allowable stump height specified in the contract. This fault is recorded on the plot card as 1 R6, (one high stump).



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
9	Pl		8	1				10	9	1 R5	0	0		
S	Sx													
100m	Fd													
	At		1							1 R6				

Plot 10 - Over Cutting

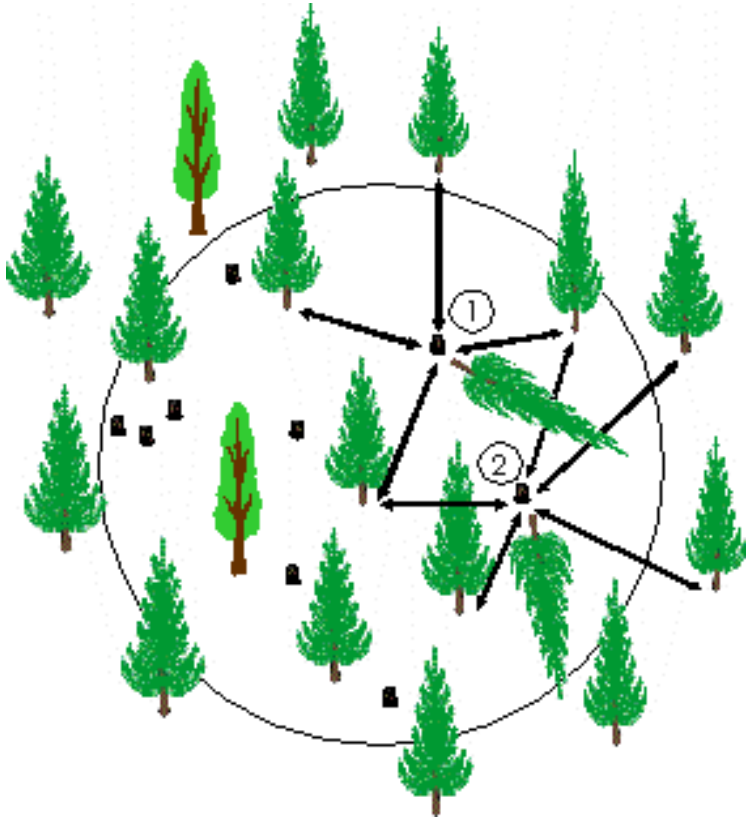
When assessing over cutting, determine the minimum number of crop trees per hectare prescribed in the SMP. If there is no minimum density prescribed in the SMP, then the following procedure is to be followed: determine the target stocking standard (TSS) for the stand and subtract 10% of the target stocking standard to get the original TSS. For example, with a target stocking standard of 1800, 10% is 180. Therefore, the minimum density is 1620.

When assessing the plot, the Inspector must confirm the species' acceptability and the quality of the crop trees cut. In this example, the two crop trees cut are acceptable species and are superior quality crop trees. The Contractor has left only 6 crop trees in the plot. The minimum density prescribed is 1600 stems per hectare, which equates to 8 crop trees in the plot. The remaining crop trees and the cut stumps are all spaced at a distance greater than the minimum inter-tree distance prescribed. The two crop trees cut, trees #1 and #2, are considered non reworkable errors and recorded on the plot card as 2 NR1, (two cutting or damaging crop trees).

Additional density plots are suggested to assist the Inspector in determining the extent of over cutting. Refer to page 20 for establishing and determining density plots.

If the average density of the original plot and the four density plots is less than the minimum density prescribed in the SMP, the Contractor is faulted for the number of non reworkable errors in the original plot. If the area of over cutting is a contiguous area greater than the minimum specified in the contract, the Contractor will also receive no payment for this area. Over cutting is considered a very serious fault, as it results in lost productivity of the stand.

If the average density in the five plots is not below the minimum, no fault is recorded.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
10	Pl		3	3				7	6	0	2 NR1	0		
S 100m	Sx													
	Fd													
	At		1											

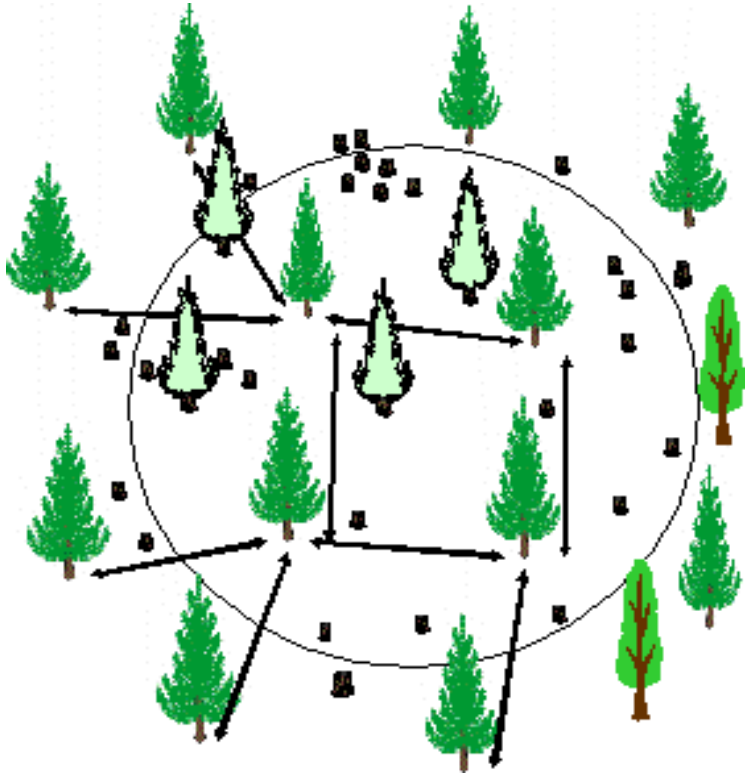
Plot 11 - Wide Spacing

Wide spacing occurs when, due to over cutting, a group of two or more crop trees inside an inspection plot are spaced further than the extended inter-tree distance from each other and all their neighbours, inside or outside the plot.

Extended inter-tree distance is calculated based on the following formula:

$$\sqrt{\frac{11\ 547}{\text{SMP minimum prescribed density}}}$$

When wide spacing occurs, the Inspector ignores the widely spaced trees and reassess the potential crop trees that could have been left within the plot. Crop trees and potential crop trees are assessed using a distance between the maximum inter-tree distance and the minimum inter-tree distance. The Inspector ignores the widely spaced crop trees and determines the number of crop trees that should have been left if the Contractor had not used wide spacing. The crop trees left in the plot are recorded under total crop trees and the additional crop trees that should have been left are recorded as non reworkable errors.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
12	Pl		2	2				4	4	0	4			
S	Sx										NR1			
100m	Fd													

These trees could have been left but were not.

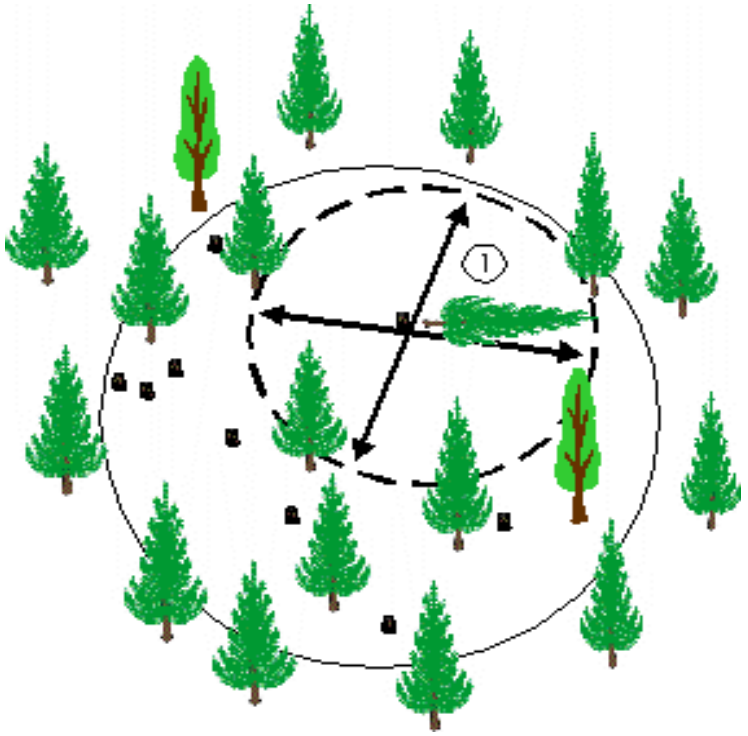
Plot 12- Over Cutting and Creating a Void

If the Contractor cuts too many crop trees, a void may occur.

A **Void** is an area within a spaced stand that, as a result of over cutting, has no crop trees within the target inter-tree distance of its centre.

In this case, the void was created when crop tree #1 was cut, because this crop tree was greater than the target inter-tree distance away from any other crop tree. In this example, crop tree #1 was an acceptable species and a superior quality crop tree. This fault is considered a non reworkable error and recorded on the plot card as 1 NR1, (one cutting or damaging crop tree).

Voids result in the reduction of potential productive growing space. This results in a payment deduction for the Contractor. Refer to the contract for the actual assessment amount.



Arrows represent target inter-tree distance

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
11	Pl		4	2				7	6	0	1	1		
S	Sx										NR1			
100m	Fd													
	Ep			1										

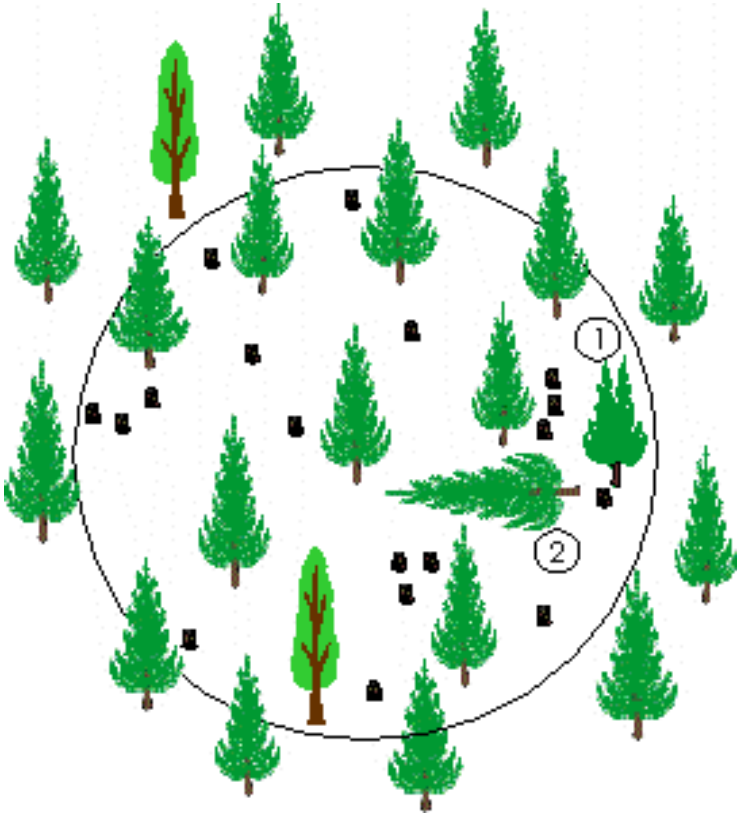
Plot 13 - Improper Crop Tree Selection

Improper crop tree selection results in reduced productivity of the stand.

The following plot describes the procedures to follow when assessing improper crop tree selection. Crop tree #1 (smaller, and forked more than 5 years ago) was left in the plot and crop tree #2 was cut. Crop tree #2 should have been left, as it is a taller, more superior crop tree than crop tree #1.

If crop tree #1 was short and not forked, the same fault would be assessed, since crop tree # 2 is still the superior tree. The fault should be recorded on the plot card as 1 NR 3, (one improper crop tree selection).

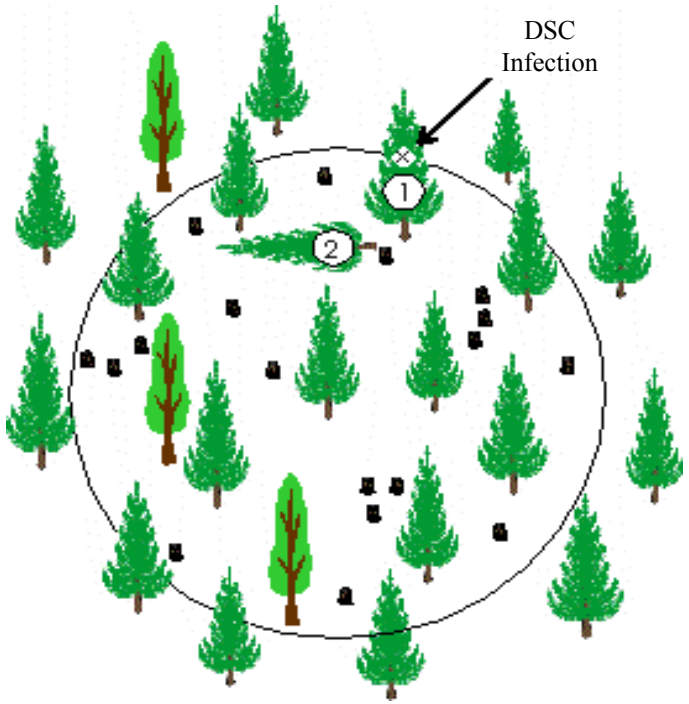
All other things being equal, the largest trees should be left as crop trees.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
13	Pl		4	5				10	8	0	1	0	4.4	14
S	Sx										NR3			
100m	Fd													
	At		1						Pl10-13-4.3-5%					

Plot 14 - Improper Crop Tree Selection

The following plot describes another situation when assessing improper crop tree selection. Crop tree #1 was left in the plot. However, it has a stem infection of commandra blister rust (DSC). Crop tree #2 was cut, but it should have been left, as it is not infected. The fault should be recorded on the plot card as 1 NR 3, (one improper crop tree selection).

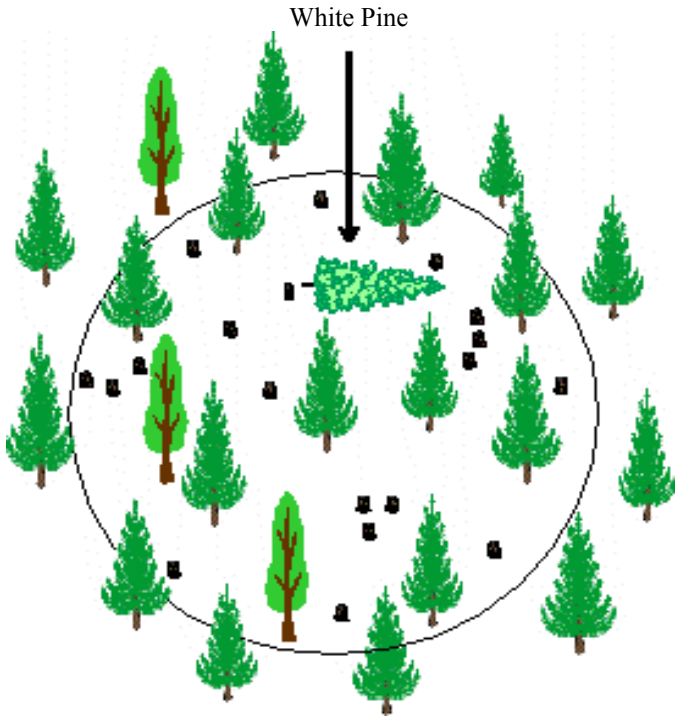


PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
14 S 100m	Pl		4	5				11	8	0	1 NR3	0	4.4	14
	Sx													
	Fd													
	At		1	1										

Plot 15 - Cutting or Damaging Leave Trees

SMP's often specify trees that must not be cut. It is common to have a statement in the SMP indicating that trees larger than a specified diameter must not be cut. Further, species may also be specified as ones not to cut. White pine is an example of a species often specified as a tree not to cut.

Where a leave tree is cut or damaged, it is recorded as 1 NR 2, (cutting or damaging leave trees).



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
15	Pl		4	5				11	9	0	1	0	4.4	14
	Sx													
S	Fd										NR2			
100m	At		1	1										

Procedures for Establishing & Determining Density Plots

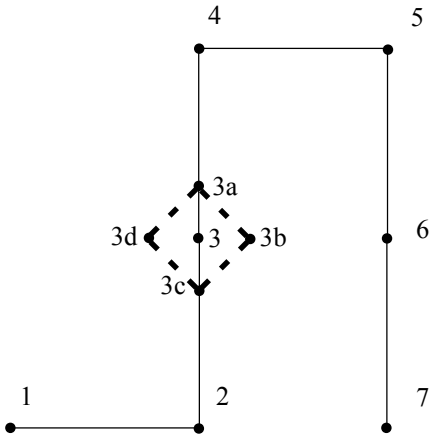
Where densities fall outside the range of the minimum or maximum density prescribed, additional density plots are suggested. Density plots are established to determine the extent of the over cutting or the excess tree situation.

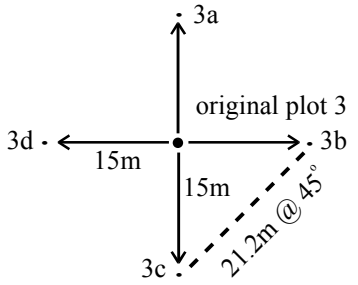
Density plots should be established 15 metres, or another pre-determined distance from the center of the original plot, along each of the cardinal bearings.

If a combination of all of the density plots and the original plot indicate a low density caused by the Contractor, the area of low density should be ribboned out, and traversed. If the area is larger than the minimum specified in the contract, the Contractor will not be paid for that area. Despite any minimum specifications in the contract, the Contractor is expected to achieve the densities prescribed throughout the entire work area.

If a combination of all of the density plots and the original plot indicate a high density caused by the Contractor, the Inspector has the discretion, based on site and stand characteristics, to: 1) request that the Contractor rework the area; 2) ribbon out and traverse the high density area, or; 3) reduce the payment for the contiguous area of unsatisfactory performance.

If density plots are established, the original low or high density plot(s) and the additional density plots are not combined with the plots from the satisfactorily treated area. The original plots and the density plots from the low or high density area(s) are summarized separately, as a separate stratum.





Reworkable Errors

Reworkable errors are those errors that can be corrected. These can include any of the following errors:

Excess Trees

Additional trees over and above the prescribed amount are left within a plot. These faults are recorded on the plot card as R1, (excess tree).

Hinged Tree

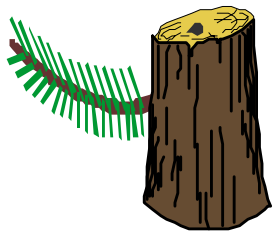
A tree that is still partially attached to the stump due to an incomplete cut. There must be some cambium still attached to the stump to be considered a hinged tree. A hinged tree may continue to grow and to compete with crop trees. These faults are recorded on the plot card as R2, (hinged tree).

Leaner

A tree that has been cut and which is leaning on a crop tree is considered a leaner. Leaning trees can damage crop trees, reducing the crop tree's potential growth. These faults are recorded on the plot card as R3, (leaner).

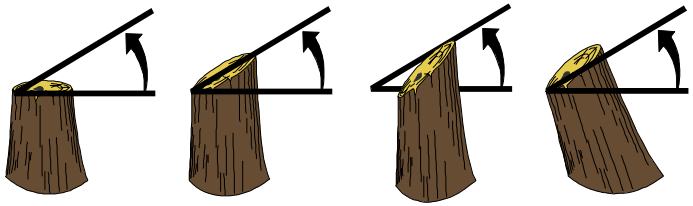
Live Branches

Trees are to be cut below the lowest live branch. Live branches are commonly referred to as 'live limbs'. These live branches may turn up and continue to grow. These faults are recorded on the plot card as R4, (live branches).



Stump Cut Angle

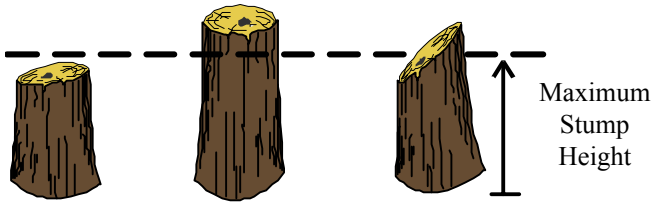
The rise of the stump should be no more than presribed in the SMP. Excessive sharp angles may pose a hazard for wildlife and recreational users of the forest. These faults are recorded on the plot card as R5, (stump angle).



Acceptable Marginal Unacceptable Unacceptable

High Stump

Stumps are to be cut at a height less than specified in the SMP. High stumps may pose a hazard for wildlife and recreational users of the forest. These faults are recorded on the plot card as R6, (high stump).



Acceptable Unacceptable Unacceptable

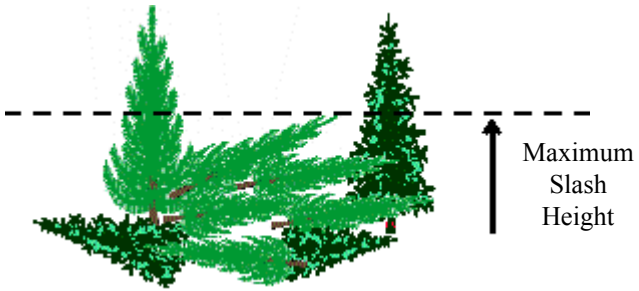
* Flexibility should be exercised when assessing high stumps which are adjacent to obstacles such as rocks, other crop trees, or large pieces of debris.

Designated Tree Uncut

Any conifer, deciduous or diseased tree that should have been cut but was not, is considered a designated tree uncut. For example, a lodgepole pine with western gall rust on its stem that should have been cut, but was not, is considered a designated tree uncut. These faults are recorded on the plot card as R7, (designated tree uncut).

Unsatisfactory Slash Disposal

The SMP states the maximum height of slash resulting from the treatment that can be left. The closer the slash is to the ground, the faster the rate of decomposition and the lower the hazard to wildlife, range and recreational users of the forest. These faults are recorded on the plot card as R8, (unsatisfactory slash disposal).



Other

This category is used for other reworkable faults that may occur within the plot. An example of this type of fault would be slash resulting from the treatment leaning against a fence, or across game or cattle trails. These faults are recorded on the plot card as R9, (other).

Non reworkable errors

Non reworkable errors are faults which damage the stand or crop trees, and cannot be corrected. These may include any of the following errors:

Cutting or Damaging Crop Trees

Cutting a crop tree down results in a loss of productive growing space. Damaging a crop tree by nicking it with a saw may also result in a loss of productivity or act as an entry point for insects and disease. These faults are recorded on the plot card as NR1, (cutting or damaging crop trees).

Cutting or Damaging Leave Trees

Some conifers and/or deciduous trees may be specified in the SMP to be reserved. If any one of these leave species are cut, these are considered faults. These faults are recorded on the plot card as NR2, (cutting or damaging reserve species).

Improper Crop Tree Selection

Prior to faulting for improper crop tree selection, the cut crop trees must be assessed to determine if they would have been more suitable than the crop trees left. Examples of improper crop tree selection are:

- a shorter crop tree is favoured over an adjacent, taller crop tree,
- a crop tree of a less desirable species is favoured over a more desirable species,
- a diseased tree is favoured over a healthy crop tree,
- a tree of poor form and vigor is favoured over a healthy crop tree.

These faults are recorded on the plot card as NR3, (improper crop tree selection).

Juvenile Spacing Quality Inspection Plot Card

BRITISH COLUMBIA

JUVENILE SPACING QUALITY INSPECTION

PROJECT IDENTIFICATION	PROJECT UNIT	MAPSHEET & OPENING NO.	
LICENCE NO.	CP NO.	BLOCK NO.	ATU or STRATUM
SURVEYOR NAME			DATE YY MM DD
SPACING CONTRACTOR			PAGE OF
PRESCRIPTION DETAILS/ SURVEY PARAMETERS			PLOT RADIUS m

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
.....														
.....														
.....														
.....														

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
.....														
.....														
.....														
.....														
TOTALS ALL PLOTS													Avg. Ht.	Avg. Age
TOTAL / ha														
		Avg. DBH												

NOTES

INFRACTION CODES

REWORKABLE ERRORS		NON-REWORKABLE ERRORS
R1 - Excess trees	R6 - High stump	NR1 - Cutting or damaging crop trees
R2 - Hinged tree	R7 - Designated tree uncut	NR2 - Cutting or damaging leave trees
R3 - Leaner	R8 - Unsatisfactory slash disposal	NR3 - Improper crop tree selection
R4 - Live branches		
R5 - Stump cut angle	R9 - Other	

FS 749 HSP (Prifor 2000/2/15)

Payment Calculations

The payment for juvenile spacing projects is based on the graduated payment system. Payment percentage increases as the quality of work increases. One hundred percent payment is reached when the quality of work surpassess 92.5%. If the quality of work drops below 85% and the quality of work can be increased by reworking the treatment area, reworking should be enforced.

For all juvenile spacing projects, the quality of work begins at 100%. To calculate **Quality of Work**, subtract the reworkable and non reworkable error percentages from 100%, and add the specified error tolerance percentage. To determine the error percentages of reworkable and non reworkable errors, the following mathematical calculations are done:

$$\text{Reworkable error \%} = \frac{\text{Total No. of Reworkable Errors}}{\text{(No. of Plots X target \# Crop Trees / plot)}} \times 100$$

$$\text{Non reworkable error \%} = \frac{\text{Total No. of Non Reworkable Errors}}{\text{(No. of Plots X target \# Crop Trees / plot)}} \times 200$$

An **error tolerance percentage** is an amount not to exceed 5%, which may be specified to allow for variable terrain and/or work conditions. If no error tolerance percentage is specified, the amount shall be 0%.

Juvenile Spacing Payment Calculation Card

JUVENILE SPACING PAYMENT CALCULATION

PROJECT IDENTIFICATION	PROJECT UNIT	MAPSHEET & OPENING NO.	
LICENCE NO.	CP NO.	BLOCK NO.	ATU or STRATUM
SURVEYOR NAME			DATE YY MM DD
SPACING CONTRACTOR			PAGE OF

REWORKABLE ERRORS %:

(REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 100 =

(_____ ÷ (_____ x _____)) x 100 =

START WITH 100% QUALITY OF WORK

MINUS

_____%

NON-REWORKABLE ERRORS %:

(NON-REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 200 =

(_____ ÷ (_____ x _____)) x 200 =

MINUS

_____%

REFER TO JUVENILE SPACING PAYMENT QUICK REFERENCE GUIDE FOR % PAYMENT

_____%

EQUALS FINAL QUALITY OF WORK

_____%

SPACING CONTRACTOR'S SIGNATURE: _____

SURVEYOR'S SIGNATURE: _____

(Prifor 749A 2000/6/15)

Juvenile Spacing Payment Quick Reference Guide

Quality of Work %	Pay %	Quality of Work %	Pay %	Quality of Work %	Pay %
100.00	100.00	90.50	97.10	87.40	90.46
99.00	100.00	90.40	96.93	87.30	90.20
98.00	100.00	90.30	96.76	87.20	89.94
96.00	100.00	90.20	96.58	87.10	89.67
95.00	100.00	90.10	96.40	87.00	89.40
94.00	100.00	90.00	96.22	86.90	89.13
93.00	100.00	89.90	96.03	86.80	88.85
92.90	100.00	89.80	95.85	86.70	88.57
92.80	100.00	89.70	95.66	86.60	88.29
92.70	100.00	89.60	95.46	86.50	88.01
92.60	100.00	89.50	95.27	86.40	87.72
92.50	99.90	89.40	95.07	86.30	87.43
92.40	99.79	89.30	94.86	86.20	87.14
92.30	99.67	89.20	94.66	86.10	86.84
92.20	99.55	89.10	94.45	86.00	86.54
92.10	99.43	89.00	94.24	85.00	83.40
92.00	99.31	88.90	94.02	84.00	79.96
91.90	99.18	88.80	93.81	83.00	76.22
91.80	99.05	88.70	93.59	81.00	67.89
91.70	98.92	88.60	93.36	80.00	63.28
91.60	98.78	88.50	93.14	79.00	58.38
91.50	98.65	88.40	92.91	78.00	53.19
91.40	98.50	88.30	92.68	77.00	47.71
91.30	98.36	88.20	92.44	76.00	41.94
91.20	98.21	88.10	92.21	75.00	35.88
91.10	98.06	88.00	91.96	74.00	29.52
91.00	97.91	87.90	91.72	73.00	22.87
90.90	97.75	87.80	91.48	72.00	15.93
90.80	97.60	87.70	91.23	71.00	8.70
90.70	97.43	87.60	90.97	70.00	1.18
90.60	97.27	87.50	90.72	69.00	0.00

Performance Summary

Area Identifier(s)		Date	
Area-Based Performance		**Area (ha)**	**Pay (%)**
(a) Untreated area which the Province considers treatable.			**0**
(b) Density exceeds the maximum number of trees/ha to be retained.			**0**
(c) Density below minimum number of preferred trees/ha to be retained.			**0**
(d) Density below minimum number of preferred and acceptable trees/ha to be retained.			**0**
(e) Excluding any above area, area on which the performance quality (P.Q.) is less than 70%.			**0**
(f) Excluding any above area, area where performance quality is equal to or greater than 70% but less than 92.60%. Performance quality = _____%.			
(g) Excluding any above area, area where performance quality is equal to or greater than 92.60%.			**100**
Total Area (must equal 100% of the Work Area)			
Other Performance		**Number**	**Payment Reduction**
(h) Number of separate occurrences where spacing took place within a No Treatment Zone. $250 per occurrence X			=
(i) Number of Voids created. $100 per Void X			=
(j) (specify)			

Inter-Tree Distances and Corresponding Stand Densities

Inter-tree Distance (m)	Density in SPH	No. of Trees in 0.01ha (5.64m)	No. of Trees in 0.005ha (3.99m)
2.1	2618 (2600)	26	13
2.2	2386 (2400)	24	12
2.3	2183 (2200)	22	11
2.4	2005 (2000)	20	10
2.5	1848 (1800)	18	9
2.7	1584 (1600)	16	8
2.9	1373 (1400)	14	7
3.1	1202 (1200)	12	6
3.4	999 (1000)	10	5
3.8	800 (800)	8	4
3.93	747 (750)	7	3
4.4	596 (600)	6	3
4.8	501 (500)	5	2
5.4	396 (400)	4	2

Extended inter-tree distance is calculated based on the following formula:

$$\sqrt{\frac{11\ 547}{\text{SMP minimum prescribed density}}}$$